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# EFFECT OF WATER QUALITY AND SOIL CONDITIONERS ON SOME CHEMICAL AND BIOCHEMICAL PROPERTIES OF CULTIVATED CALCAREOUS SOIL

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## ABSTRACT

**This study was conducted to evaluate the effect of water quality and soil conditioners on some chemical, biochemical properties, yield and leaf and fruits macronutrients content of Eggplant (*Solanum melongena* L.) grown on calcareous soil. Two successive seasons field experiments were carried out at El-Bostan Experimental Station of the Faculty of agriculture Damanhour, Alex. Univ. Two types of water (fresh and wastewater) and five soil conditioners (Cement Portlandy, Slag; Sewage Sludge, chicken manure and sulfur were used. The irrigation was applied when 45% of available water occurred to refill water content to saturation under flood system. Surface soil samples were collected at four times (at transplanting time and after one, two and three months of transplanting) and plant samples were collected.**

**Soil salinity showed significant reduction in soils irrigated by canal water compared to that irrigated by wastewater. Irrigation with wastewater under all soil conditioners and times significantly decreased the soil pH and basal soil respiration (BSR) while increased the soil organic carbon (OC), biomass carbon (BC), biomass nitrogen (BN) and biomass phosphorus (BP) than soil irrigated with canal water. Soil treated with cement and slag increased significantly soil pH while, soil treated with sludge, chicken manure and sulfur significantly decreased soil pH. The highest soil OC was found under sludge treatment followed by chicken manure treatment with relative increase of**

**27.9% and 31.1%; and19.8% and 26.0% for canal and wastewater treatments, respectively. BC, BN and BP under chicken manure increased by 38.06%, 76.67% and 100% relative to the control treatment, while they were decreased with time from transplanting to harvest by 9.26%, 35.52% and 15.37%, respectively. At the same time, Chicken manure treatment gave the highest BSR with relative increase of 63.59%, followed by sulfur then sludge with relative increase of 26.38% and 13.03% to control.**

**Irrigation by wastewater increase significantly total fresh yield and N, P and K concentrations in the leaves and fruits of eggplant when compared to canal water. The highest total fresh yield was found under chicken manure followed by sludge treatment, meanwhile the lowest total fresh yield was found under the cement treatment. Plants grown on chicken manure treated soils had the highest concentration of N, P and K in leaves and fruits. While, the lowest total P in leaves and fruits were noticed in plants grown under cement treatment which decreased significantly.**

**Keywords:** wastewater, eggplant, conditioners, calcareous soil, BC, BN, BP, and BSR.

## INTRODUCTION

Egypt is an arid country depending almost entirely upon the water of Nile River. In the time being, agriculture consumes about 84% of the total fresh water resources in the country. In order to fulfill the needs of the growing population, prospective plan is projected to reclaim land in the eastern and western deserts which requires excess water for irrigation (Hamdy and Lacirignola, 1998). Efforts should focus upon water conservation, reducing water losses, enhancing water saving and promoting reuse of unconventional water resources such as drainage water and treated wastewater. Reusing wastewater in irrigation, beside it is a water resource, has a beneficial return because it supplies much of the nutrients required by plants, especially when it is in the desert calcareous soil of Egypt which is very poor in nutrients and organic matter. Also treated sewage sludge as a byproduct of waste water treatments is valuable; as a source of plant nutrients and as a soil conditioner. (Metcalf and Eddy, 1997). A combination of irrigation water and soil conditioners would improve soil quality as a medium for plant growth. Also, the maintenance of soil organic matter is important for the productivity of calcareous soil.

Several studies showed that irrigation with wastewater had increased soil salinity depending on the periods of irrigation time. This increase of salinity could be in the range of plant acceptance (El-Motaium and Badawy 2000; and Selem *et al*., 2000). El-Fayoumy *et al*., (2001) found that ECe was significantly increased with increasing sewage sludge application. While, Koreim (1993) noticed that sewage application showed a significant decrease in ECe. Miyittah and Inubushi (2003) reported that soil EC values increased significantly with increasing chicken manure applications. Furthermore, the soil $EC_e$ values were increased with increasing sulfur application at low soil salinity (Alromian and El-Fakhrani, 2002; and Khalifa and Youssef, 2002).

Values of soil pH were decreased by 1 to 6% with increasing the rate of sewage sludge from 5 to 40 ton/fed (El-Dawwy and Morsy, 2000). On the other side, Saviozzi *et al*., (1999) noticed no effects on soil pH with sewage sludge applications.

Also, application of chicken manure to sandy loam calcareous soil had decreased soil pH (Abdel-Aziz *et al*., 1996). In addition, treated calcareous soil with sulfur at rates of 3 to 5% decreased the pH value by 7 to 10% (Awad *et al*., 1996 and Makary 2002).

Also, it has been found that organic carbon, nitrogen and phosphorus in soil were increased during the irrigation by wastewater (Fliessbach *et al*., 1994; and Kandeler *et al*., 1996). treatment with sewage sludge (57 t/fed.), chicken manure (40 $m^3$/fed.) and sulfur (0.50 t/fed.) increased organic carbon by 79.36%, 21.73% and 43.75% relative to untreated soils, respectively (Mahmoud, 2000; Crecchio *et al*., 2001). Saviozzi *et al.* (1999) reported that cultivation treated soil with sewage sludge for a long time caused a reduction in biomass carbon and soil respiration. At the same time, El-Maghraby *et al*., (1996) found that applying elemental sulfur in highly calcareous sandy soil increased soil respiration.

Sewage sludge effects on yield were studied by Villar *et al.*, (1998) who found that carrot root; Faba bean green pod, onion yield increased as sewage sludge application rate increased. At the same time, Abdel-Ati (1998) reported that application of chicken manure increased the yield of potato tubers, wheat and increased the phytomass production of onion. Wassif *et al*., (1995) showed that sulfur application increased wheat grain yield by 48.0%, whereas Faba bean yield increased by 15.54% at sulfur rate of 300 kg/fed. Potato tuber yield was increased by 28.44% with sulfur rate of 0.04% (El-Fayoumy and El-Gamal, 1998). Zhao *et al*. (1999); and El-Shafie and El-Gamaily (2002) found that sulfur application had increased the dry weight of pea and root weight of sugar beet and increased plant height and grain yield of corn and onion bulb.

The objectives of this study were to (i) evaluate the reuse of secondary wastewater from Damanhour Wastewater Treatment Plant for irrigating the calcareous soil pretreated with different soil conditioners: sludge, cement, slag, chicken manure and sulfur and cultivated with eggplant; (ii) assess the effect of quality of irrigation, soil conditioners and time on some soil chemical and biochemical properties; and (iii) evaluate the yield and the fruit quality of eggplant grown on these treated soil under irrigation by canal water or wastewater.

## MARTERIALS AND METHODS

Field experiments were carried out at El-Bostan Farm Experimental Station (latitude 30˚ 12′ N, longitude 30˚ 30′ E, altitude 7.4 m), Faculty of Agriculture, Damanhour, Alexandria University for two successive seasons. The soil of the farm is calcareous of loamy sand texture and the source of water of irrigation is El-Nubariya canal. The mean physical and chemical characteristics of the experimental soil are given in Table (1).

**Experimental Layout:**

The experimental design used was split-split plot. The experimental treatments arranged randomly in the experimental plots and data were analyzed using the STATISTICA computer software to test the significance of the effects of irrigation waters and soil conditioners. Comparison between means of treatments was carried out according to (Walter and Duncan, 1969). Five soil conditioners were used; Cement Portlandy (0.5%) and Slag (0.5%) as immobilizing agents; Sewage Sludge (10 t/fed.) and Chicken Manure (20 t/fed.) as organic agents; and Sulfur (2.0 t/fed.) as pH reduction agents (Table 3). Each conditioner was mixed with the upper 25 cm soil layer in the plot.

**Table (1): The mean values of the physical and chemical characteristics of the experimental soil.**

| Parameter | | | Mean value |
|---|---|---|---|
| Particle size distribution: | | | |
| | Clay | *g /kg soil* | 100 |
| | Silt | *g /kg soil* | 57.6 |
| | Fine sand | *g /kg soil* | 100 |
| | Coarse sand | *g /kg soil* | 742.4 |
| Texture Class | | | loamy sand |
| Bulk density | | *Mg* $m^{-3}$ | 1.39 |
| Total soil porosity | | *%* | 47.62 |
| Saturation percentage (S.P.) | | ($cm^3/cm^{-3}$) | 0.2945 |
| PH* | | | 8.23 |
| $EC_e$** | | dS $m^{-1}$ | 6.43 |
| Total Carbonate | | % | 12.49 |
| Organic Carbon | | % | 0.18 |
| Total Nitrogen | | % | 0.03 |
| C:N ratio | | | 7.5 |
| Water soluble ions** | | | |
| | $Ca^{++}$ | *meq /L* | 22.5 |
| | $Mg^{++}$ | *meq /L* | 7.6 |
| | $Na^{+}$ | *meq /L* | 36.4 |
| | $K^{+}$ | *meq /L* | 0.7 |
| | $HCO_3^-$ | *meq/L* | 4.6 |
| | $Cl^-$ | *meq /L* | 38.9 |
| | $SO_4^{--}$ | *meq /L* | 23.7 |
| SAR | | | 9.4 |
| ESP | | | 11.2 |
| Available P | | *mg /kg soil* | 6.11 |
| Available K | | *mg /kg soil* | 95.30 |

* measured in 1:2.5 soil water suspension
** measured in saturated soil paste extract

Eggplant (*Solanum melongena* L.) variety Black Beauty was transplanted at June in 36 $m^2$ plots area. The recommended fertilizers requirements were 400 kg/fed. of ammonium sulfate (20.5% N), 300 kg/fed. of super phosphate (15.5% $P_2O_5$) and 300 kg/fed. potassium sulfate (48.5% $K_2O$) to meet full crop nutrient requirements. Two types of water, El-Nubariya canal (as fresh water from Nile River) and secondary treated wastewater obtained from Damanhour wastewater treatment plant. The main chemical composition of irrigation water is given in Table (2). The water of irrigation was applied when 45% of available water depletion occurred to refill water content to saturation under flood system. Irrigation was carried during the period from 25 June to 21 July by canal water then by the two water types from 25 July to 8 October. Plants have been harvested at 1 September and 8 October to measure yield and for measuring N, P and K. Samples of the upper soil layer (0-30 cm) were collected for analysis, from each experimental plot, at 25 June, 21 July, 25 August and 25 September.

The tested soil Physical properties (saturation percentage, bulk density, total porosity, particle size distribution) were carried out according to Klute (1986). The chemical analyses of conditioner, **s**oil and water were conducted according to Page *et al*. (1982). Biomass carbon, biomass nitrogen, biomass phosphorus and soil respiration were determined by extraction fumigation method as described by Page *et al*. (1982). The plant materials were first washed by tap water then by distilled water and oven-dried, ground and wet digested by $H_2SO_4$ and $H_2O_2$ as reported by Carter (1993) to determine plant content of N, P and K.

**Table (2): The mean values of chemical properties of El-Noubarya canal water and secondary wastewater.**

| **Parameter** | **Canal water** | **Wastewater** |
|---|---|---|
| pH | 7.65 | 7.80 |
| EC, *dS* $m^{-1}$ | 0.45 | 0.57 |
| $Ca^{++}$, *meq/l* | 1.7 | 1.9 |
| $Mg^{++}$, *meq/l* | 0.7 | 1.0 |
| $Na^{+}$, *meq/l* | 2.0 | 2.6 |
| $K^{+}$, *meq/l* | 0.1 | 0.2 |
| $HCO_3^{-}$, *meq/l* | 0.9 | 1.1 |
| $Cl^{-}$, *meq/l* | 2.1 | 2.7 |
| $SO_4^{--}$, *meq/l* | 1.5 | 1.9 |
| SAR | 1.8 | 2.2 |

**Table (3): Some chemical characteristics of Portlandy cement, Slag and Sulfur.**

| Parameter | Portlandy cement | Slag | Sulfur |
|---|---|---|---|
| pH* | 9.29 | 8.71 | 6.13 |
| EC** dS $m^{-1}$ | 4.20 | 0.10 | 0.08 |
| Water soluble $Ca^{++}$ mg/kg | 400 | 56 | 360 |
| Water soluble $Mg^{++}$ mg/kg | 108 | 5 | 80 |
| Water soluble $Na^{+}$ mg/kg | 2165 | 2.7 | 7.6 |
| Water soluble $K^{+}$ mg/kg | 15 | 0.3 | 0.4 |
| Water soluble $Cl^{-}$ mg/kg | 99 | 11 | 14.2 |

* measured in 1:5 soil : water suspension
** measured in saturated soil paste extract

**Table (4): Some chemical characteristics of the used sewage sludge and chicken manure.**

| Parameter | Sewage sludge | Chicken manure |
|---|---|---|
| pH* | 7.67 | 4.57 |
| EC** dS $m^{-1}$ | 2.80 | 3.80 |
| Water soluble $Ca^{++}$ mg/kg | 1720 | 2260 |
| Water soluble $Mg^{++}$ mg/kg | 60 | 82 |
| Water soluble $Na^{+}$ mg/kg | 2 | 10 |
| Water soluble $K^{+}$ mg/kg | 10 | 80 |
| Total carbonate, % | 4.3 | 2.2 |
| Organic matter, % | 44.27 | 28.66 |
| Organic carbon, % | 25.68 | 16.62 |
| Total nitrogen, % | 3.44 | 1.53 |
| C/N ratio | 8.14/1 | 10.87/1 |
| Available phosphorus, mg/kg | 6430 | 2280 |

* in (1:5) sludge: water ratio.
****** in (1:10) chicken manure : water ratio.

## RESULTS AND DISCCUSSION

**1- Soil Salinity ($EC_e$):**

Data in Table (5) revealed that soils irrigated with canal water had significantly lower soil salinity than that irrigated with wastewater. Also the soil $EC_e$ decreased with time under soil conditioner treatments and under both water treatments as compared with $EC_e$ before water treatment initiated. At transplanted date, all conditioners increased the $EC_e$ values except slag relative to the control ($EC_e$= 3.87 $dSm^{-1}$). The relative increase of $EC_e$ due to sludge, cement, chicken manure and sulfur treatments were 22.4%, 55.8%, 24.4% and 221.5%, respectively. Figure (1) showed the average $EC_e$ values of soils under the two water types, conditioners and time. The average relative reduction of soil $EC_e$ at transplanted time ranged between 18.5% and 44.9%. At harvest time, soil irrigated with wastewater for two months, the relative decrease of $EC_e$ was lower than that of soil fully irrigated with canal water. Under wastewater irrigation, relative decrease of $EC_e$ ranged between 0.7% and 42.8% for slag and chicken manure treatments, respectively. Similar results were obtained by Miyittah and Inubushi (2003) and Alromian and El-Fakhrani (2002).

**Table (5): Mean values of EC, pH and Biochemical properties as influenced by water quality, conditioner and time treatments in two seasons.**

| Treatments | EC $dSm^{-1}$ | pH | OC % | BC µg/kg | BN µg/kg | BP µg/kg | BSR mg $CO_2$-C/g |
|---|---|---|---|---|---|---|---|
| Canal | 3.82b | 8.11 a | 0.18 b | 243.4 b | 34.93 b | 11.17 b | 13.14 a |
| Wastewater | 3.99 a | 8.10 b | 0.19 a | 249.4 a | 35.37 a | 11.29 a | 13.12 b |
| $LSD_{0.05}$ | 0.02 | 0.003 | 0.001 | 0.892 | 0.064 | 0.0176 | 0.004 |
| $LSD_{0.01}$ | 0.06 | 0.007 | 0.002 | 2.058 | 0.148 | 0.0406 | 0.010 |
| Control | 2.63 d | 8.20 b | 0.16 c | 215.4 f | 27.52 e | 9.00 c | 12.36 d |
| Sludge | 3.22 c | 8.03 c | 0.23 b | 284.6 b | 44.68 b | 15.13 b | 13.97 c |
| Cement | 4.09 b | 8.22 ab | 0.16 c | 223.6 e | 29.32 d | 7.78 e | 8.28 e |
| Slag | 1.79 e | 8.26 a | 0.15 d | 230.4 c | 29.06 d | 8.15 d | 8.33 e |
| Chick Man | 3.27 c | 7.96 d | 0.25 a | 297.4 a | 48.62 a | 18.07 a | 20.22 a |
| Sulfur | 8.44 a | 7.95 d | 0.16 c | 227.0 d | 31.72 c | 9.26 c | 15.62 b |
| $LSD_{0.05}$ | 0.17 | 0.051 | 0.003 | 2.541 | 0.657 | 0.310 | 0.330 |
| $LSD_{0.01}$ | 0.23 | 0.061 | 0.004 | 3.467 | 0.896 | 0.422 | 0.450 |
| At harvest | 5.13 a | 8.27 a | 0.21 a | 258.1 a | 41.95 a | 11.91 a | 10.36 d |
| One month | 3.61 c | 8.12 b | 0.18 b | 248.4 b | 37.24 b | 11.79 b | 11.74 c |
| Two months | 3.76 b | 8.02 c | 0.18 c | 245.0 c | 34.37 c | 11.14 c | 13.83 b |
| Three months | 3.13 d | 8.00 c | 0.17 d | 234.2 d | 27.05 d | 10.08 d | 16.59 a |
| $LSD_{0.05}$ | 0.03 | 0.004 | 0.0007 | 0.343 | 0.197 | 0.038 | 0.089 |
| $LSD_{0.01}$ | 0.04 | 0.006 | 0.001 | 0.455 | 0.261 | 0.051 | 0.118 |

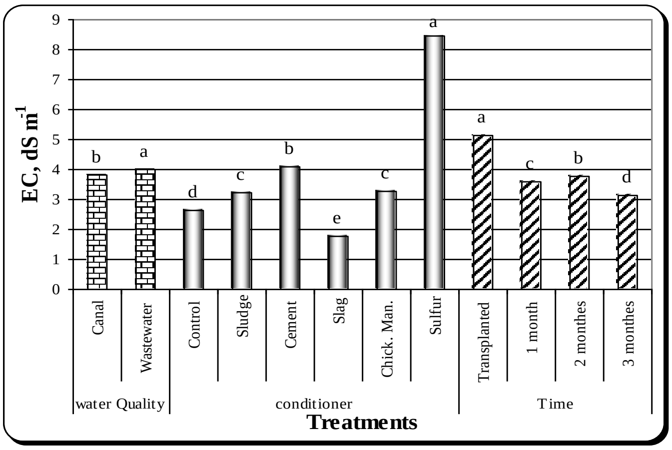



**Fig. (1): Average values of $EC_e$ ($dSm^{-1}$) of soils due to water quality, conditioners and time treatments.**

**2- Soil pH:**

Irrigation with wastewater under all soil conditioners and times significantly reduced soil pH as compared with that irrigated with canal water (Table 5). Generally, soil treated with cement and slag had significantly higher soil pH, while soil treated with sludge, chicken manure and sulfur had low pH values than that of the control soil. Meanwhile, no significant difference was observed due to chicken manure and sulfur treatments.

Soil irrigated by canal water and at transplanting time showed that application of cement and slag increased the soil pH by 2.3% and 1.9% as compared with the control soil. On the other hand, pH of soils treated with sulfur, chicken manure and sludge were decreased by 1.7%, 1.1% and 0.6% as compared with the control treatment. The acid effect of sulfur was observed only in the soils irrigated for two and three months. At harvest, irrigation by canal water decreased of soil pH values between 0.2% in control and 3.3% in chicken manure treatment. On the other side, soil irrigated by wastewater for two months, the relative decrease in soil pH ranged between 0.5% in control and 3.6% in chicken manure treatment. The decrease in pH may be due to (i) decomposition of sludge and chicken manure and producing organic acids, (ii) increased partial pressure of $CO_2$ of the soil atmosphere due to increased microbiological activity, and (iii) the oxidation of sulfur to sulfuric acid by soil microorganisms. This reduction in soil pH could increase both the availability of plant nutrients and consequently the yield (El- El-Fayoumy *et al*., 2001; Alromian and El-Fakharani, 2002 and Makary, 2002).

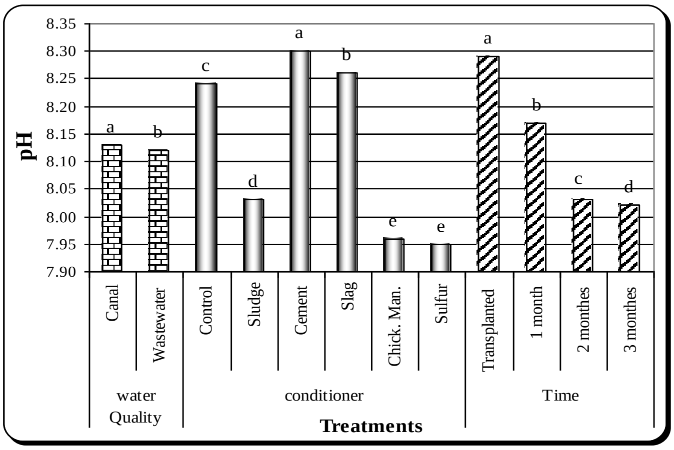



**Fig. (2): Average values of pH of soil due to water quality, soil conditioners and time treatments.**

**3- Organic Carbon (OC):**

Data in Table (5) and Figure (3) showed that the level of OC in soils irrigated by wastewater was significantly increased by 3.3% relative to that irrigated by canal water irrigation. Application of chicken manure or sludge significantly increased the soil organic carbon. On the other hand, application of cement and slag significantly decreased the soil OC while no significant variation was found with sulfur application when compared to the control. Soil organic carbon in soil decreased through the duration from transplanting to harvest. At transplanting time and under two water quality treatments, application of chicken manure produced the highest OC followed by sludge which significantly increased the soil OC by 86.4% and 49.4%. Similar data were obtained by Villar *et al.* (1998). However sulfur, slag and cement treatments decreased soil OC by 2.3, 0.9 and 0.6% relative to control. Similar results were obtained by El-Maghraby *et al*. (1996). At harvest time, the highest soil OC was observed under sludge followed by chicken manure treatment with relative increase of 27.9% and 31.1%; and19.8% and 26.0% for canal and wastewater irrigation, respectively. These indicate that decomposition of chicken manure under these conditions was higher than that of sludge, in spite of the fact that sludge has higher OC than chicken manure (Miyittah and Inubushi, 2003).

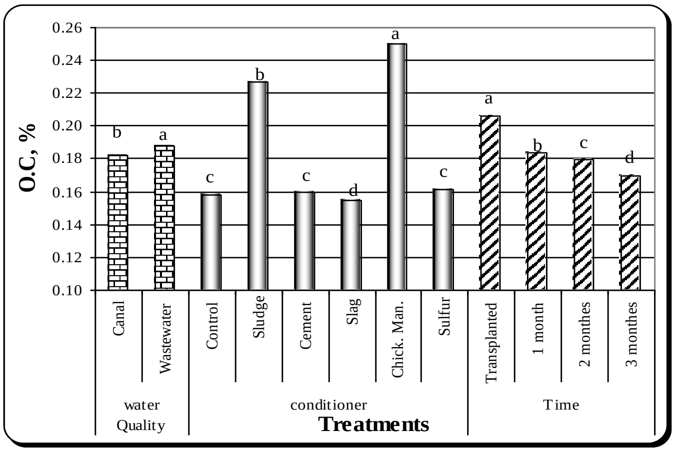



**Fig. (3): Average values of OC (%) for water quality, conditioners and time treatments.**

**4- Biomass carbon (BC), Nitrogen (BN) and Phosphorus (BP):**

As shown in Table (5), irrigation with wastewater under all soil conditioners and time significantly increased BC, BN and BP compared to soil irrigated with canal water. The relative increase of BC, BN and BP were 2.5%, 1.3% and 1.1%, respectively. Chicken manure treatment caused significant increase in BC, BN and BP, when compared to all other conditioners and control treatment, followed by sludge treatment, where BC, BN and BP under chicken manure increased by 38.06%, 76.67% and 100% relative to the control treatment. Under sludge treatment, these increases were 32.12%, 62.35% and 68.11% relative to the control treatment. In general, under sludge, chicken manure and sulfur treatments, the BC and BN increased significantly as compared with control treatment except cement and slag treatments which decreased BP by 13.6% and 9.4% relative to the control treatment. This is due to that cement and slag treatments had increased soil pH and consequently decreased the available soil phosphorus required to soil micro organisms. At the same time, no significant difference was detected in BP between sulfur and control treatment. On the whole, the BC, BN and BP were decreased with time from transplanting to harvest by 9.26%, 35.52% and 15.37%, respectively. Saviozzi *et al.* (1999) had obtained similar results.

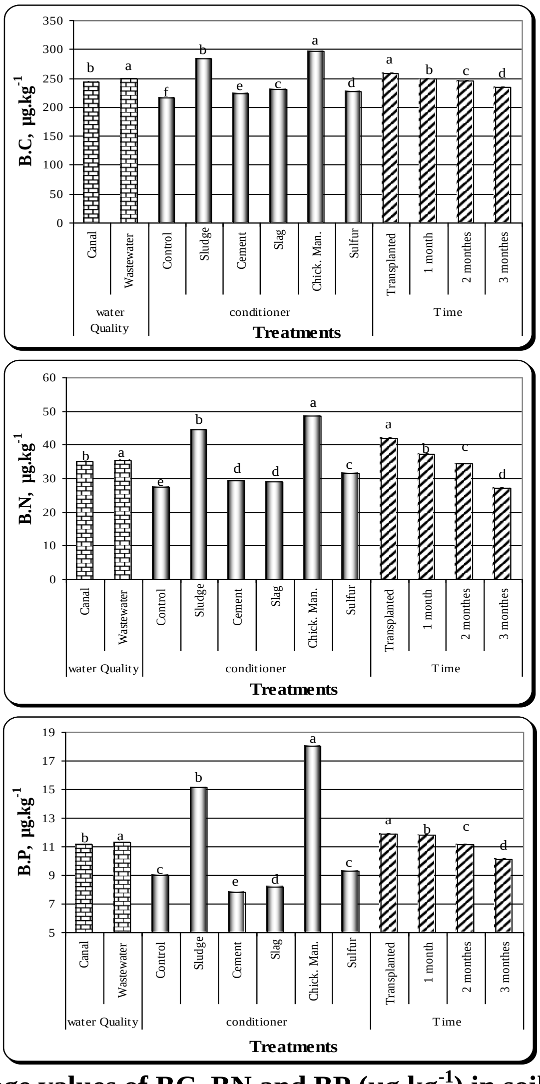



**Fig. (4): Average values of BC, BN and BP (µg kg$^{-1}$) in soils due to water quality, conditioners and time treatments.**

**5- Basal soil respiration (BSR):**

Irrigation with wastewater significantly decreased the BSR by 0.15% as compared with that of canal water. Application of soil conditioners increased BSR when compared to the control treatment. Chicken manure treatment produced the highest BSR with relative increase of 63.59%, followed by sulfur then sludge with relative increase of 26.38% and 13.03%. This agrees with the conclusion suggested by Quemada and Menacho (2001). On the other side, the BSR lowest values were found under cement and slag with relative decreases of 33.01% and 32.61% to control treatments. BSR was also increased from time of transplanting to harvest by 12.36 to 16.59 mg $CO_2$-C/g.

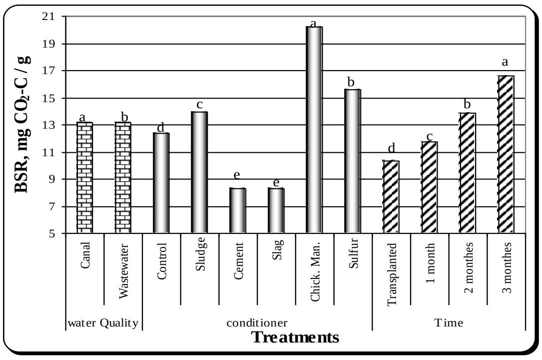



**Fig. (5): Average values of BSR (mg $CO_2$-C/g) for water quality, conditioners and time treatments.**

**Plant Quality:**

**1- Fruit yield:**

Table (6) showed that irrigation with wastewater increased significantly total eggplant yield by 1.07% when compared with canal water. Significant differences were obtained by all conditioner treatments where the highest total fresh yield was found with chicken manure followed by sludge treatment with relative increase 50.7% and 20.1% compared to control treatment (Fig. 5). This increase could be attributed to the higher decomposition rate of chicken manure than the sludge. On the other side, the lowest total fresh yield was observed under the cement treatment with 20.7% decrease relative to control treatment. This can be due to that cement material increases the soil pH which reflected on the availability of nutrients to plant, and consequently, a yield reduction. The same trend of data was observed in 1st and 2nd cut fresh yield.

**Table (6): Effect of irrigation water quality on fresh weight, leaf and fruit NPK contents of eggplant under different conditioner treatments.**

| Treatments | 1st Cut kg m-2 | 2nd Cut kg m-2 | Total yield kg m-2 | N leaf mg kg-1 | P leaf mg kg-1 | K leaf mg kg-1 | N fruits mg kg-1 | P fruits mg kg-1 | K fruits mg kg-1 |
|---|---|---|---|---|---|---|---|---|---|
| Canal | 5.50a | 5.09b | 10.58b | 27010b | 224.5b | 1764b | 13717b | 232.5b | 2056b |
| Wastewater | 5.14b | 5.56a | 10.70a | 27966a | 234.8a | 1770a | 14900a | 240.7a | 2075a |
| $LSD_{0.05}$ | 0.078 | 0.07 | 0.01 | 142.5 | 1.540 | 0.87 | 176.4 | 1.22 | 2.73 |
| $LSD_{0.01}$ | 0.181 | 0.12 | 0.02 | 328.9 | 3.553 | 2.01 | 406.8 | 2.81 | 6.30 |
| Control | 4.60d | 5.03e | 9.63e | 24900f | 173.0d | 1616e | 12300c | 194 d | 1877d |
| Sludge | 5.79b | 5.78b | 11.56b | 29050b | 296.0b | 1954b | 16800b | 329 b | 2375b |
| Cement | 3.76e | 3.88f | 7.64f | 26880d | 153.0f | 1648d | 11300e | 177 f | 1843e |
| Slag | 4.55d | 5.37c | 9.91d | 25650e | 162.0e | 1687c | 11850d | 184 e | 1812f |
| Chick Man | 7.83a | 6.68a | 14.51a | 31200a | 311.0a | 2043a | 21100a | 336 a | 2523a |
| Sulfur | 5.39c | 5.21d | 10.59c | 27250c | 282.5c | 1655d | 12500c | 201 c | 1962c |
| $LSD_{0.05}$ | 0.144 | 0.08 | 0.19 | 173.7 | 5.36 | 13.26 | 285.2 | 5.41 | 22.1 |
| $LSD_{0.01}$ | 0.197 | 0.12 | 0.23 | 236.9 | 7.31 | 18.08 | 389.0 | 7.38 | 30.1 |

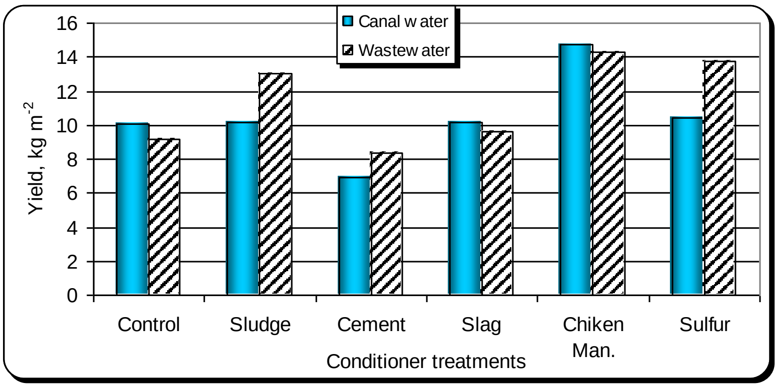



**Fig. (5): Effect of irrigation water quality on fresh weight of the eggplant fruits under different conditioner treatments.**

**2- Macronutrients content in plant leaves:**

Table (6) and Figure (6) showed that irrigation by wastewater significantly increase total N, P and K contents in the leaves of eggplant by 3.54%, 4.59% and 0.33%, respectively when compared to plants irrigated by canal water. Data also showed that plants grown on chicken manure treated soils had leaves containing the highest amount of N, P and K. The leaves contents of N, P and K were increased significantly by 25.3%, 79.77% and 26.46% compared to control treatment. Leaves N, P and K contents of plants grown in soil treated with sludge increased by 16.67%, 71.10% and 20.92% relative to control treatment (Table, 6). The lowest total N and K was observed in plant leaves grown under control treatment. While the lowest total P was noticed in leaves of plants grown under cement treatment which decreased significantly by 11.56% as compared with control which due to pH increase caused by cement application to the soil.

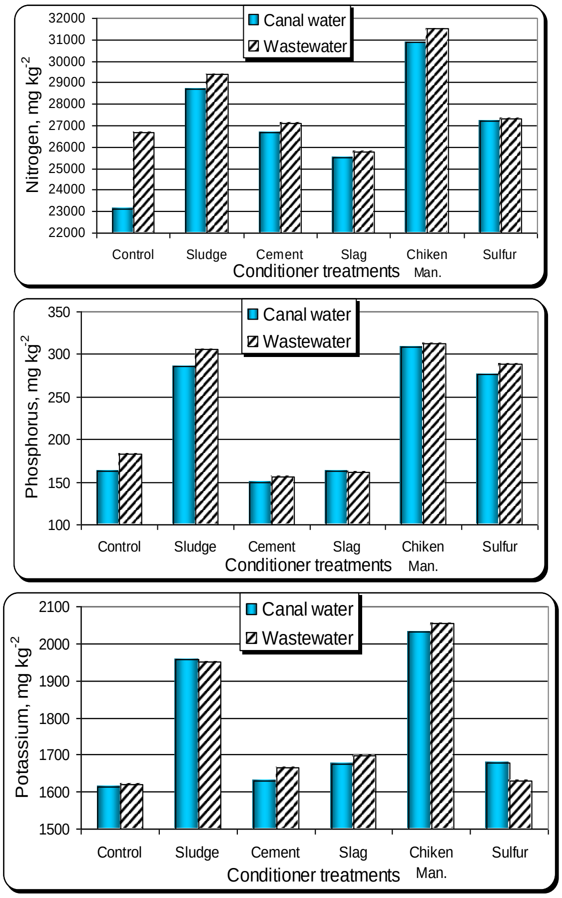
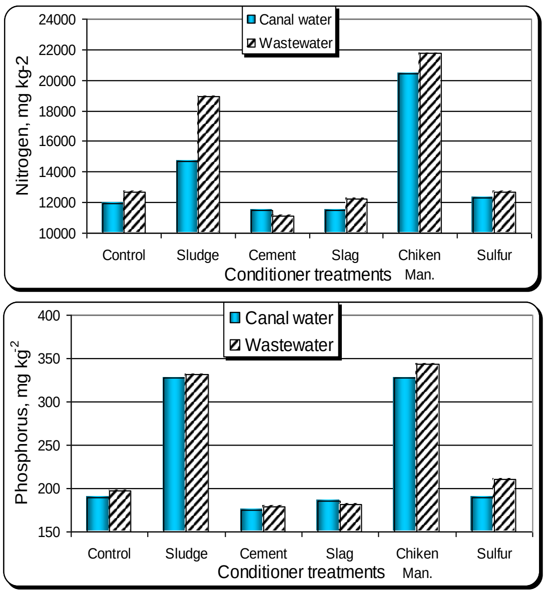



**Fig. (6): Effect of irrigation water quality on NPK of the eggplant leaves under different conditioner treatments.**

**3- Macronutrients content in fruits:**

Plants irrigated by wastewater had significantly higher fruit contents of N, P and K by 8.62%, 3.51% and 0.90%, respectively when compared to plants irrigated by canal water. The effect of soil conditioners on N, P and K in eggplant fruits are shown in Table (6) and Figure (7). Plants grown on chicken manure treated soils had fruits containing the highest amount of N, P and K. The fruits content of total N, P and K were increased significantly by 71.54%, 73.64% and 34.42% compared to the control treatment. Fruits N, P and K of plants grown in soil treated with sludge were increased by 36.59%, 70.02% and 26.53% relative to control treatment (Table, 6). The lowest total N and P was observed in fruits of plants grown under cement treatment which significantly decreased by 8.13% and 8.53% relative to control treatment which also refers to pH increase caused by cement application to the soil. Moreover the lowest total K was noticed in fruits of plants grown under slag treatment which significantly decreased by 3.46% with control (Table 6).



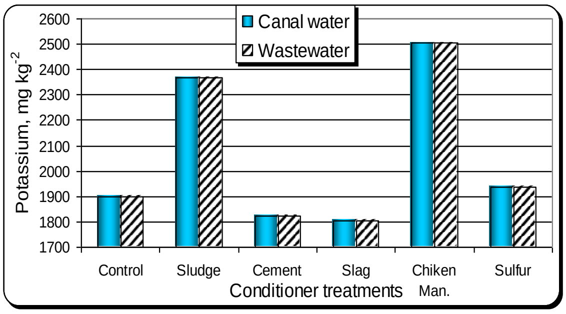



**Fig. (7): Effect of irrigation water quality on NPK of the eggplant fruits under different conditioner treatments.**

## CONCLUSION

According to the outcomes of this research, the following recommendations were reached (i) reuse of treated wastewater for irrigation can represent an additional, renewable, reliable source of water and N, P and K fertilizers as well and (ii) application of sewage sludge, chicken manure, cement, slag and sulfur as soil conditioner and fertilizer are considered a valuable resources to increase plant yield and improve soil chemical and biochemical properties.

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# الملخص العربى

## تأثير جودة المياه ومكيفات التربة على بعض خصائص التربة الكيميائية والبيوكيميائية

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تمت هذه الدراسة لتقويم تأثير كل من جودة المياه ومكيفات التربة على بعض خصائص التربة الكيمائية والبيوكيميائية والمحصول ومحتوى اوراق وثمار الباذنجان النامى فى ارض جيرية من العناصر الغذائية الكبرى. اقيمت تجربة حقلية لمدة عامين بمحطة التجارب بالبستان ، كلية الزراعة بدمنهور، جامعة الاسكندرية. تم تطبيق نوعين من المياه (مياه ترعة ومياه صرف صحى معالجة) وخمسة انواع من مكيفات التربة ( أسمنت ، خبث الحديد ، الحمأة ، سبلة كتكوت ، الكبريت). الرى يتم عند فقد 45% من الماء المتاح للنبات وحتى يصل المحتوى الرطوبى الى التشبع من خلال الرى الغمر. جمعت عينات تربة سطحية (صفر – 30 سم) على اربعة ازمنة (الشتل – بعد شهر - بعد شهرين - بعد ثلاثة اشهر من الشتل) كما جمعت عينات نباتية.

حدث نقص معنوى فى ملوحة تربة الاراضى التى تروى بمياه الترعة بالمقارنة بالتى تروى بمياه الصرف. الرى بمياه الصرف تحت كل معاملات مكيفات التربة والوقت يقلل معنويا كل من pH التربة وتنفس التربة، بينما يزيد كل من الكربون العضوى (OC) والكربون الحيوى (BC) والنيتروجين الحيوى (BN) وكذلك الفسفور الحيوى (BP) بالمقارنة بالتى تروى بمياه الترعة. التربة المعاملة بالاسمنت وخبث الحديد تزيد معنوياً pH التربة بينما الارض المعاملة بالحمأة وسبلة الكتكوت والكبريت تقلل معنوياً قيمة pH التربة.

وجد أن أعلى OC فى معاملة الحمأة متبوعة بمعاملة سبلة الكتكوت بزيادة نسبية قدرها 27.9% و 31.1% ، 19.8% و 26.0% لكل من معاملة مياه الترعة ومياه الصرف بالترتيب. قيم BC و BN و BP فى معاملة سبلة الكتكوت أزدادت بنسبة 38.6% و 76.67% و 100% نسبة للمعاملة المرجع ، بينما قلت قيمهم مع الزمن منذ الشتل وحتى الحصاد بنسبة 9.26% و 35.52% و 15.37% بالترتيب. وفى نفس الوقت معاملة سبلة الكتكوت أعطت أعلى قيمة فى تنفس الارض بزيادة نسبية مقدارها 63.59% متبوعة بمعاملة الكبريت ثم الحمأة بزيادة نسبية مقدارها 36.38% و 13.030% نسبة للمعاملة المرجع. الرى بمياه الصرف المعالجة زاد معنويا من المحصول الكلى الطازج وكذلك التركيز الكلى للنيتروجين والفوسفور والبوتاسيوم فى أوراق وثمار الباذنجان بالمقارنة بالرى بمياه الترعة. أعلى محصول كلى طازج تم ملاحظته تحت معاملة سبلة الكتكوت متبوعة بمعاملة الحمأة بينما كان أقل محصول كلى طازج تم ملاحظته فى معاملة الأسمنت. النباتات النامية فى الأرض المعاملة بسبلة الكتكوت احتوت على أعلى تركيز من النيتروجين والفوسفور والبوتاسيوم فى كل من الأوراق والثمار بينما كان أقل تركيز للفوسفور فى الأوراق والثمار لوحظ فى النباتات النامية فى معاملة الأسمنت والذى قل بنسبة معنوية.