EVALUATION OF CHICKEN MANURE APPLICATION UNDER DIFFERENT IRRIGATION WATER SOURCES FOR WHEAT PLANTS GROWN ON ALLUVIAL SOIL

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ABSTRACT

In a trial to investigate the possibility of using ground and sewage waters as substitutes for the Nile fresh water on one hand, and organic manuring to overcome shortage in the mineral fertilizers on the other hand, two field experiments were carried out on a clayey soil during two successive winter seasons (2006/2007 and 2007/2008) at Shibin Al-Qanater, Qalubia governorate. The effect of ground and sewage water was compared with that of the Nile fresh water for irrigation of wheat. Chicken manure also was tested for substituting partially the mineral fertilizers NPK. Growth parameters, yield components and the contents of N, P and K as ground as the micronutrients (Mn, Zn, Fe and Cu) were aimed to fulfill the purpose of the current investigation.

The obtained results revealed that the growth parameters expressed as plant height, number of spikes/m^2 as ground as yield components recorded higher values due to applying chicken manure upon using the Nile fresh water for irrigation as compared with the other two sources of water. However, higher N, P, K and micronutrient uptake by wheat grain and straw were recorded due to chicken manure under sewage irrigation. The lowest values of all growth parameters as well as yield components were recorded when the ground water was used.

Thus, this study highlights the usage of sewage water to overcome the shortage in the Nile fresh water on one hand and imposes the importance of organic manuring as an integrating factor for fertilization that can be used for substitution of the mineral fertilizer. Such factor might be of economical effect due to the pronounced increase in prices of the mineral fertilizers. Also, such a practice may minimize the hazardous effect of the used mineral fertilizers on soil and water environments.

Key words: Ground water, Nile water, sewage water, chicken manure, wheat plant.

INTRODUCTION

Wheat is the main winter cereal crop and considered as strategic crop in Egypt. The annual Egyptian production of wheat grains is about 7.4 million tons. Fertilization is one of the key factors contributing to grain yield increase.

Wheat is normally fertilized with mineral fertilizers, which may have hazardous effect on the environment and may induce poor quality when used in excessive amounts. Minimizing these adverse effects renewed the interest about organic manures to supply part or all of plant nutrients needed by crops **(Salah and Abd El-Fattah, 1997).** Moreover, the organic manures play an important role in nutrient solubility as they activate physiological and biochemical processes in plant and improve both physical and chemical properties of soils leading to increase in plant growth and nutrient uptake **(Florensa *et al.*, 1985 and Hegab, 1997).**

In this regard, using manure fertilizers such as chicken manure improved soil biological and chemical properties and consequently plant growth, yield and quality **(Tashkodzaer, 1985).**

Water is another factor affecting grain production. Thus, for sustainable agriculture it is necessary to develop an appropriate water management strategy. Ground water and sewage water are commonly used nowadays to overcome the shortage in amount of water required for irrigation.

Rattan *et al.* (2005) indicated that sewage effluent contained much higher amounts of P, K, S, Zn, Cu, Fe, Mn and Ni compared to ground water and metal contents were within the permissible limits for using such water for irrigation purpose. There was an increase in organic carbon content ranging from 38 to 79% in sewage- irrigated soils as compared to ground water irrigated ones. These waste waters contain appreciable amounts of plant nutrients but at the same time, carry appreciable amount of trace toxic metals **(Feign *et al.*, 1991; Bara *et al.*, 2000; Yadave *et al.*, 2002).** Although the concentration of heavy metals in sewage effluents are low, yet long-term use of this waste water on agricultural lands often results in the build-up of the elevated levels of these metals in soils **(Rattan *et al.*, 2002).**

Since the available ground water is saline and/or sodic in nature, its way of utilization to meet the crop demand greatly affects the land and water productivity. Also, the ground water has problems of residual sodium carbonate as ground as of soluble salts of chloride and sulphate **(Sakthivadivel *et al.*, 1999).**

Mostafa (2001) reported that irrigation with Nile water gave wheat grain yield of 2.29 t/fed compared to 2.26 t/fed and 2.21 t/fed of drainage and sewage water, respectively.

The current investigation aims at studying to what extent the organic manure, sewage water and ground water can be used as substitutes to compensate shortage of mineral fertilizers and fresh water under wheat grown on a clayey soil.

MATERIALS AND METHODS

The present field study was carried out at Shibin El-Kanater, Kalubia governorate, Egypt, during the two successive growing seasons of 2006/2007 and 2007/2008 to study the implication of using sewage and ground waters (as substitutes of the Nile fresh water) and organic manure (as a substitute of NPK mineral fertilizers) on wheat plants grown on a clayey soil. Table (1) reveals the most important properties of the waters used in this investigation.

The experimental work:

Wheat (*Triticum aestivum* L.), Sakha 93 cv. was grown on the studied soil under the following treatments:

1. Irrigation with ground water.
2. Irrigation with Nile water.
3. Irrigation with sewage water.

4. Chicken manure 5 m^3/fed+ irrigation with ground water.
5. Chicken manure 5 m^3/fed+ irrigation with Nile water.
6. Chicken manure 5 m^3/fed+ irrigation with sewage water.
7. Chicken manure 10 m^3/fed+ irrigation with ground water.
8. Chicken manure 10 m^3/fed+ irrigation with Nile water.
9. Chicken manure 10 m^3/fed+ irrigation with sewage water.

Table (1): Chemical analysis of the used waters.

Properties	Water sources		
	The Nile Water	**Ground water**	**Sewage water**
pH (1:2.5, soil:water extr.)	7.67	7.69	7.71
EC (dS/m)	1.16	0.76	1.37
Anions and cations ($mmol_c$/l)			
Cl^-	5.83	7.74	9.85
HCO_3^-	3.50	3.65	3..71
CO_3^{2-}	---	---	---
SO_4^{2-}	3.44	0.64	1.38
Ca^{2+}	4.70	4.63	5.97
Mg^{2+}	0.27	1.44	0.42
Na^+	3.90	2.85	6.10
K^+	2.90	3.11	2.45
Macro and micronutrients (mg/kg soil)			
N	3.51	0.97	3.51
P	0.41	0.13	0.41
K	13.80	8.15	13.80
Fe	0.630	0.07	0.63
Mn	0.070	0.019	0.070
Zn	0.095	0.020	0.095
Cu	0.066	0.016	0.066

All the experimental plots received the half of the recommended N, P and K rates, i.e. 37.5 kg N/fed as P_2O_5/fed as superphosphate and 12.0 kg K_2O/fed as potassium sulphate.

Nitrogen fertilizer was applied at two doses, the first one just before cultivation and the second one 45 days after cultivation. The organic manure, calcium superphosphate and potassium sulphate fertilizers were applied just before cultivation.

The experimental plots were statistically arranged in a complete randomized block design with three replicates. The obtained data were statistically analyzed according to **Snedecor and Cochran (1980).**

At the maturity stage, i.e. 120 days after cultivation, wheat growth parameters, i.e. plant height (cm), number of spikes/m^2, grain yield (ardeb fed^{-1}), straw yield (ton fed^{-1}) and 1000-grain weight (g) were estimated. Plants of the different treatments were sampled, dried at 70 °C, grained and sub-samples were digested using H_2SO_4 and $HClO_4$ acid mixture. The macronutrients N, P, K as ground as the micronutrients Mn, Zn, Cu and Fe were determined in the digests according to **Soltanpour and Schwab (1977).**

Soil analyses:

Soil surface samples (0-30 cm) were collected from the experimental plots and prepared for the laboratory analyses and determined as follow:

Table (2): Some physical and chemical properties of the experimental soil

Properties	2006/2007	2007/2008
Particle size distribution (%)		
Sand	24.72	23.25
Silt	13.11	12.07
Clay	62.17	64.68
Textural class	Clay	Clay
$CaCO_3$ (%)	3.08	2.96
O.M (%)	2.74	2.90
PH (1: 2.5 soil:water suspension)	7.7	8.0
EC dS m^{-1} (soil paste extract)	1.4	1.4
Soluble cations (m mol_c L^{-1})		
Ca^{++}	4.9	4.97
Mg^{++}	1.6	1.55
Na^{+}	6.5	7.07
K^{+}	0.5	0.63
Soluble anions (m mol_c L^{-1})		
$CO_3^{=}$	-	-
HCO_3^{-}	2.31	3.12
Cl^{-}	6.98	7.10
$SO_4^{=}$	4.21	4.10
Available macronutrients (mg kg^{-1})		
N	73.20	76.36
P	12.74	11.25
K	584	539
Micronutrients (DTPA extractable, mg kg^{-1})		
Fe	11.47	11.85
Mn	3.70	3.77
Zn	2.03	1.79

Particle size distribution was determined according to **FAO (1970).** Total soluble salts (EC), soil pH and calcium carbonate according to the standard methods outlined by **Page *et al.* (1982).** Soluble cations (Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}) and anions (Cl^{-}, CO_3^{2-}, HCO_3^{-} and SO_4^{2-}), organic matter content and available NPK nutrients according to the methods ascribed in **Page *et al.* (1982).**

In addition, some chemical properties of chicken manure were determined using the standard method outlined in **Page *et al.* (1982)** and results of determinations are presented in Table (3).

Table (3): Some properties of the chicken manure used in the experimental soil

Properties	Value
PH (1: 5, Ch.M:water)	6.97
EC (dS/m)	8.51
Total C (%)	25.20
O.M (%)	48.50
C/N ratio	10:1
Total N (%)	2.46
Total P (%)	0.92
Total K (%)	1.68
Available N (mg kg^{-1})	1080
Available P (mg kg^{-1})	1570
Available K (mg kg^{-1})	1780

RESULTS AND DISCUSSION

Growth parameters and yield components:

Data presented in Table (4) reveal values of plant height, number of spikes/m^2, for wheat plant as affected by the aforementioned treatments.

It is obvious that usage of ground or sewage water resulted in insignificant decrease in plant height as compared with that attained due to usage of the Nile fresh water. Application of the chicken manure at a rate of 5 m^3 fed^{-1} increased values of plant height, however its application at a rate of 10 m^3 fed^{-1} caused more obvious increases but insignificant. Such findings were true for the plants grown within the two growing seasons. Significant differences in number of spikes/m^2 could be observed due to the sources of irrigation water and rate of the organic manure.

In this concern, it could be noticed that upon application of half the recommended doses of NPK only i.e. without organic manure application, the sewage water resulted in the highest number of spikes/m^2 whereas the ground water resulted in the lowest ones. Upon application of the organic manure of the recommended dose, the following descending order could be observed for the number of spikes/m^2 during 2007 and 2008 seasons: the Nile fresh water> ground water> the sewage water.

Upon application of half the recommended dose of the organic manure, although the Nile fresh water was superior over the two sources of water, yet the sewage water was superior over the ground water in season of 2006/2007 whereas the latter source was superior over the former one in season 2007/2008.In addition, applying Ch.M plus NPK to plants increased plant growth expressed as plant height and number of spikes. This may be due to that the Ch.M improves soil fertility and 90% of N in Ch.M becomes available **(Mathers and Gross, 1979).** Also, Ch.M has much higher nitrogen which considerably enhanced growth and yield .Similar results were reported by **Abdel Ati (1998).**

Table (4): Effect of different sources of water irrigation on growth parameter for wheat plant of both tested seasons

Treatments	Growth parameters			
	Plant height (cm)		No. of spikes /m^2	
	2006/2007	2007/2008	2006/2007	2007/2008
Nile water	101.10	108.14	351	349
Ground water	94.78	98.15	308	316
Sewage water	97.71	93.80	377	387
Nile water +1/2 O.M	113.17	121.00	384	369
Ground water +1/2 O.M	96.65	103.30	364	362
Sewage water +1/2 O.M	110.80	115.30	380	361
Nile water + O.M	129.30	122.25	390	389
Ground water + O.M	117.50	110.90	350	352
Sewage water + O.M	175.14	123.14	316	334
LSD 5% O.M	n.s		2.01	
LSD 5% Water source	n.s		17.3	

Table (5) shows that grain yield, straw yield and 1000 grain weight were significantly affected by source of irrigation water as ground as rate of the applied organic manure.

Table (5): Effect of different sources of irrigation water under chicken manure application on yield and yield component for wheat plant during 2006/2007 and 2007/2008

Treatments	Grain yield (ardab / fed)		Straw yield (ton / fed)		1000 – grain weight (g)	
	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
Nile water	16.75	17.39	3.96	4.49	35.10	34.07
Ground water	18.81	19.32	5.06	5.39	39.76	38.85
Sewage water	19.84	19.74	4.83	5.18	39.81	40.15
Nile water + 1/2 O.M	19.43	19.50	5.05	4.76	39.14	38.90
Ground water + 1/2 O.M	20.81	20.35	5.41	5.95	40.75	41.43
Sewage water +1/2 O.M	20.67	20.47	5.10	4.70	40.50	41.34
Nile water + O.M	19.73	19.69	5.17	5.43	40.00	40.62
Ground water + O.M	22.55	21.93	5.98	6.33	42.15	41.62
Sewage water + O.M	19.14	20.05	5.44	5.78	40.30	41.00
LSD 5% O.M	0.57		0.32		n.s	
LSD 5% Water source	0.73		0.36		n.s	

*** ardab =150 kg.**

Sewage water seemed to be of the most pronounced effect on grain yield and 1000 grain weight in both growing seasons in the absence of the organic manure. However, application of chicken manure whether at half the recommended rate or at 100% of this rate caused the Nile water to be superior effective over the other two sources of irrigation water on grain yield, straw yield and 1000 grain weight. Increasing rate of the organic manure was associated with the corresponding increases in magnitude of each of grain yield, straw yield and weight of 1000 grain.

Nutrients uptake:

Data presented in Table (6) illustrate that N uptake by wheat grain and straw was generally affected by source of irrigation water and application of the organic manure. The N uptake by grains was higher due to application of the sewage water than the corresponding uptake attained due to irrigation with the Nile water. On the contrary, the ground water resulted in the lowest N uptake value. This trend was true regardless of the applied organic manure or its rate of application, yet, application of the organic manure seemed to have an obvious effect on the magnitudes of N uptake especially at its higher rate of application. Concerning the effect of NPK, **Hassan and Mohey El-Din (2002)** reported that N uptake in grains was increased due to the application of organic manures. **Abd El-Malak (1971)** noted that release of nitrogen during the degradation of

organic manure increased soil micro flora activity, which could in turn encourage fixed-air-nitrogen used by the plant roots.

P-uptake values were also significantly affected by the source of irrigation water and application of the organic manure. The effect of these variables on P uptake followed that of N-uptake which was previously shown. The increase in the uptake of P is due to the ability of wheat plants to absorb P not only as a mineral form but also the part released from the organic matters .Also , the carbon dioxide produced during the decomposition of organic matter had a role in increasing phosphorus availability **(Tissdale and Nelson, 1979).**

Likewise, K-uptake values were significantly affected by both source of irrigation water and application of the organic manure, however it is of importance to indicate that the Nile water was of more superior effect on K-uptake value than the sewage water whereas the ground water resulted in the lowest K-uptake values. Such results are in accordance with those obtained by **Hofman (1988), Sharma and Mittra (1991) and Abdel-Sabour *et al*., (1999)** who found that Ch.M application to wheat significantly increased potassium content in peanut plants when followed wheat cultivation due to the increase in the dry matter production caused by residual influence of organic manures. In addition, the increase in K content in wheat plants may be attributed to the function of the organic manures in reducing the bounding strength of exchangeable potassium. Available k moved to the root by the movement of soil moisture and diffusion of the nutrient to the root surface **(Tissdale and Nelson, 1979).**

Concerning the effect of the studied treatments on values of N-uptake by straw of wheat, the obtained results showed that only the applied organic manure was of a significant effect on these values whereas insignificant effect could be observed among the different used irrigation water sources.

Meanwhile, increasing the rate of the applied organic manure was of more pronounced effect on values of K-uptake.

P-uptake by wheat straw was significantly affected by both source of irrigation water and application of the organic manure in a way did not differ from that previously mentioned for P-uptake by grain.

Although, the studied treatments were of significant effects on values of K-uptake, yet in most cases, the sewage water was of superior effect than the Nile water whereas the ground water resulted in the lowest K-uptake values. Also, increasing rate of the applied manure was associated with obvious increases in magnitudes of K-uptake especially at the growing season of 2008.

Micronutrient uptake:

Data presented in Table (7) reveal that Mn, Zn, Cu and Fe uptake amounts by both grains and straw of wheat plant were affected significantly by source of the water used for irrigation and application of the organic manure. However, this finding did not hold true for Mn and Cu-uptake by grains and Zn-uptake by straw which did not respond significantly to the source of the applied irrigation water.

It is of importance to indicate that irrigation with the sewage water resulted in the highest uptake values of all the micronutrients under study whether by grains or by straw of wheat plants. Also, application of the organic manure was associated with increase in magnitudes of metal ion uptake by both grains and straw of wheat plants, yet increasing rate of the applied organic manure seemed to be of more obvious effect on these metal ion-uptake. The high contents of Mn, Zn, Cu and Fe in the sewage water are relatively high. These contents of metal ions in the applied organic manure may account for such increases. **Moustafa (2001)** reported that Fe, Zn and Mn concentrations in seed of plants grown under soil irrigation with sewage water were greater than those irrigated with Nile or drainage water, in addition long term –irrigation of soil by sewage water markedly increased the amount of Zn in plant. **Amany *et al*. (2008)** reported that wheat seed micronutrients (Fe, Zn and Mn) were the highest using sewage water.

Table 6

Table 7

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تقييم تأثير استخدام سماد الدواجن تحت مصادر رى مختلفة على القمح النامى في أرض طينية

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أقيمت تجربتان حقليتان خلال موسمى ٢٠٠٦/٢٠٠٧ – ٢٠٠٧/ ٢٠٠٨ بمنطقة شبين القناطر بمحافظة القليوبية على نبات القمح وذلك لتقييم استخدام مصادر الرى المختلفة (مياه النيل– مياه آبار – مياه صرف صحى). مع استعمال معدلان من السماد العضوى، وتأثير ذلك على نمو نبات القمح، وقد تم تقدير طول النبات، وعدد السنابل/ متر مربع، ومحصولى الحبوب والقش، ووزن ١٠٠٠ حبة، بالإضافة إلى تقدير محتوى النبات من العناصر الكبرى والصغرى.

وقد كانت أهم النتائج المتحصل عليها ما يلي:

- زيادة محصول الحبوب وعدد السنابل/متر مربع ووزن ١٠٠٠ حبة عند الرى بمياه الصرف الصحي بينما أدى استخدام مياه النيل إلى زيادة طول النبات.
- إضافة جرعات السماد العضوى مع الرى بمياه النيل أدى إلى زيادة محصول الحبوب والقش وكذلك طول النبات وعدد السنابل/متر مربع ووزن ١٠٠٠ حبة.
- أدى استخدام الري بمياه الآبار إلى انخفاض قيم كل من طول النبات وعدد السنابل – محصول الحبوب والقش ووزن ١٠٠٠ حبة وذلك مقارنة باستخدام الرى بمياه النيل والصرف الصحى.
- زيادة محتوى الحبوب والقش من العناصر الكبرى والصغرى عند استخدام الرى مياه الصرف الصحى بمفردها وكذلك زيادة محتوى هذه العناصر عن استخدام السماد العضوى مع الرى بمياه الصرف الصحى ولكن كانت هذه الزيادة في الحدود المسموح بها والآمنة.