

**UTILIZATION OF SEWAGE WATER IN THE  
PRODUCTION OF INDUSTRIAL OIL AND FIBERS FROM  
SOME PLANTS**

**Submitted By**

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Diploma in Environmental Sciences, Institute of Environmental Studies & Research,

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M. Sc. in Environmental Sciences, Institute of Environmental Studies & Research,

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A thesis submitted in Partial Fulfillment  
Of  
The Requirement for the Doctor of Philosophy Degree  
In  
Environmental Sciences

Department of Environmental Agricultural Sciences  
Institute of Environmental Studies and Research  
Ain Shams University

**2016**

APPROVAL SHEET  
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## ACKNOWLEDGMENT

The author would like first to thank GOD

The author would like to express his sincerest appreciation and gratitude to **Prof. Dr. Hesham Ibrahim Elkasass** Professor of Soil and Water Environment, Dean of Institute of Environmental Research and Studies, Ain Shams University, for his patience, guidance and advising, I appreciate the many chances he offered me to learn and benefit,

The author is grateful to **Prof. Dr. Taha Abdel Azim Mohamed Abdel-Razek** Professor of Basic Sciences - Institute of Environmental Research and Studies, Ain Shams University. For his great efforts, the valuable assistance, support and continuous encouragement that led to the successful completion of this study.

Special thanks are due to **Prof. Dr. Ahmed Mahmoud Essa** Professor of Soil, Water and Environment Science Research Institute of Agricultural Research center, Giza

Egypt for this valuable helping, supporting and encouraging to finish this study. In addition, I would like to present gratitude to **Prof. Dr. Saber Hussein Ahmed** Professor of Fibber Crops Research Department, Field Crops Research Institute of Agricultural Research center, Giza Egypt for his great efforts, the valuable assistance, support and continuous encouragement.

Special gratitude and dedication for this work is due to my wife and my children for their support, patience and encouragement through this research.

## ABSTRACT

The current work aims at gaining more information about, the suitability of primary treated sewage water alone or mixed with different rates of Nile water in product Sakha2 and multi function plants such as flax (*Linum usitatissimum* L.) class variety for use their oils products and it kenaf (*Hibiscus cannabinus* L.) class variety Giza 3 fibbers.

The use of primary treated sewage water in this study achieve high environmental values, achieve the economic returns of provision traditional irrigation water to irrigate food crops. Also, it studied their effect on both soils and plants. The morphological study characters included plant length (cm), Active plant length (cm), fiber length (cm), No. of capsule/plant, No. of seeds/capsule, No. of benches/plant and Iodine values(IV) were increased by irrigating with sewage water than freshwater. All the values of yield components of both studied crops such as weight of plant yields (ton/fed,) weight of straw yield (ton/fed.) and weight of fiber yield (ton/fed.) increased with increasing sewage water rates, due to irrigate with 100% sewage water (T<sub>5</sub>), comparing with those irrigated with freshwater (T<sub>1</sub>). In the same context of the increases of weight of 1000 (ton/fed.), oil yield (ton/fed.), fiber % and seed oil % increased with irrigated with sewage water. Nutrient contents in flax and kenaf seeds were affected by irrigation water quality, N, P and K concentration and uptake by flax and kenaf seeds plants show increase with increasing rate of sewage water, while decrease with increasing freshwater rates. The relative increase of heavy metal concentrations and uptake in flax and kenaf seeds irrigated with 100% waste water (t<sub>5</sub>), higher than the same seeds irrigated with freshwater (T<sub>1</sub>).

From the distribution of micro-micronutrients and heavy metal concentrations in all investigated plants. There is no doubt that the irrigation of flax and kenaf plants with wastewater, within safe or permissible limits and therefore possible to use such sources of this water for irrigation purposes in Egyptian territory under the codified standards and studies.

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## **1-INTRODUCTION**

Currently, Egypt produces an estimated 5.5 – 6.5 billion cubic meters of sewage water per year. of that amount, about 2.97 BCM<sup>3</sup>per year is treated, but only 0.7 BCM<sup>3</sup>per year is utilized for agriculture (0.26 BCM<sup>3</sup>is undergoing secondary treatment and 0.44 BCM<sup>3</sup> undergoing primary treatment), mainly in direct reuse in desert areas or indirect reuse through mixing with agricultural drainage water (**Abdel-Shafy and Abdel-Sabour, 2006**).

Treated domestic sewage is being reused for irrigation with or without blending with fresh water. The increasing demands for domestic water will increase the total amount of sewage available for reuse. It is estimated that the total quantity of reused treated waste water in Egypt in 2013 is about 0.3 BCM<sup>3</sup>. By the year 2020, water requirements will most likely increase by 20% as 15 BCM/yr, (**Ministry of Water Resources and Irrigation, Egypt ,2014**).

The current study was conducted on a sandy soil at Balaks in Mostord Potable Water and Sanitation Company, El-Qaliubia, Egypt. The irrigation water is sewage water alone or mixed with different rates of Nile water. Flax is the second important fiber crop after cotton in Egypt. It is grown for producing fibers only or seeds only, but in Egypt it is grown as dual purpose crop. Flax is the oldest fiber crop in Egypt. Flax is grown during winter season. In Egypt, the flax cultivated area was about 35700 feddans yearly (Ministry of Agriculture). Flax production still depends mainly on manual methods for planting and harvesting, consuming time, cost, non-uniformity of seeds which ultimately results in poor and moreover high percentage of crop losses. Water is often the primary limiting factor in any crop production. Therefore, irrigation management is very important nowadays in Egypt due to the shortage in water resources as well as the expansion of agriculture in newly reclaimed lands (**Hamada et al., 2009**).

Kenaf is a summer-season annual plant in the Malvaceae family closely related to cotton (*Gossypium hirsutum* L.). Kenaf fibers are used for paper pulp and cordage. The stems of kenaf have two principal components: bark with long fibres (2-6 mm), making up 35- 40 % of total stem weight; and core, with short fibres (0.6 mm), making up the remaining 60-65%.

Thus, the current work is identifying the suitability of primary treated sewage water alone or mixed with Nile water at different ratios and their effects on soils and plants grown thereon. So, the main objectives could be categorized into:

- 1- Evaluation of primary treated sewage water for irrigating sandy soil.
- 2- Effect of irrigation with sewage water alone or mixed with Nile water at different ratios on available and total macro and micronutrients and heavy metals contents in the studied soil.
- 3- Effect of primary treated waste water on plants growth and productivity.
- 4- Effect of primary treated waste water on macro and micronutrient concentrations and uptake in seeds of flax and kenaf.
- 5- Effect of primary treated waste water on heavy metals concentration and uptake in seeds of flax and kenaf.
- 6- Effect of primary treated waste water on oil and fiber productivity and quality.

## **2- REVIEW OF LITERATURE**

### **2.1 Water resources in Egypt**

**Oosterbaan (1999) stated that** because of the scarcity of fresh water resources that is limited to a portion amounting 55 billion m<sup>3</sup> annually from Nile water, Ministry of Public Works and Water Resources prepared a strategy for re-use of agricultural drainage water, in conjunction with the Nile water that is spilled in the sea (about 7.50 billion m<sup>3</sup> annually). The ministry started important steps to implement this strategy by expanding in new agricultural at the upstream countries of Egypt lands. In addition, all drainage water between Aswan and Cairo are returned to the Nile River; thereby reused in the Delta where several main drains discharge into Rosetta and Damietta branches.

#### **Water resources in Egypt as following:**

- 1 -The High Dam releases annually about 55 billion m<sup>3</sup> per year.
- 2 -Un-beneficial evaporation losses from Egypt's extensive river and irrigation canal system are about 3 billion m<sup>3</sup> per year.
- 3 -Industrial water use is around 8 billion m<sup>3</sup> per year, of which about 1 billion m<sup>3</sup> per year evaporates, 1 billion m<sup>3</sup> per year is pumped into the sea, and some 6 billion m<sup>3</sup> per year returns to the surface water and can be re-used for irrigation;
- 4 -Municipal water use is more or less 5 billion m<sup>3</sup> per year, of which about 2 billion m<sup>3</sup> per year evaporates and about 2 billion m<sup>3</sup> per year returns to the surface waters and can be re-used for irrigation;
- 5 -Escape losses from the Edfina barrage at the downstream end of the Rosetta branch of the river Nile into the sea, in relation to shipping requirements and the closure period of the irrigation for maintenance, are presently close to 1 billion m<sup>3</sup> per year;
- 7-The availability of irrigation water results from the balance of the above quantities: 46 billion m<sup>3</sup> per year.

**FAO (2010) illustrated that** Irrigated agriculture in Egypt consumes about 80% of the Nile's water and almost all available conventional water resources have been exhausted. The use of non-conventional water resources was reviewed, with special emphasis on the reuse of treated waste water Throughout the last decade; municipal

waste water reuse has emerged as an important and viable means of supplementing dwindling water supplies in a large number of regions throughout the world.

**Aquastat (2005) showed that** sewage water often untreated, is used to irrigate 10 percent of the world's crops, especially in urban areas, reveals the first global survey of the hidden practice of waste water irrigation. In many instances, reuse is also promoted as a mean of limiting waste water discharges to aquatic environments. River Nile is the main source of water for Egypt, with an annual allocated flow 55.5 billion m<sup>3</sup>/yr under the Nile Waters Agreement of 1959

**Capmas (2010) stated that** water issues are most important in Egypt and the danger of scarcity is increasing within future. Egypt is one of the poorest 35 countries in the world in the ownership of fresh water resources. Due to the limited available water resources for agriculture and the increasing demand of horizontal and vertical expansion of the cultivated area, as well as increasing population, it was necessary to use non-traditional sources of water in agricultural. Most of the water needs 57.8 Billion m<sup>3</sup> in 2002/2003 represents a rate of 86.8% and rose to 59.3 Billion m<sup>3</sup> in the year 2006/2007.

**Table (1): Egyptian water resources from the period (2006- 2010) by Billion m<sup>3</sup>/ Year (Capmas, 2010).**

<b>Water resource</b>	<b>2006 / 2007</b>	<b>2007/ 2008</b>	<b>2008 / 2009</b>	<b>2009 / 2010</b>
<b>Water River Nile</b>	<b>55.5</b>	<b>55.5</b>	<b>55.5</b>	<b>55.5</b>
<b>Under ground water in Valley &amp; Delta</b>	<b>6.1</b>	<b>6.2</b>	<b>6.2</b>	<b>6.2</b>
<b>Agricultural waste recycling</b>	<b>5.7</b>	<b>9.9</b>	<b>8.07</b>	<b>--</b>
<b>sewage water recycling</b>	<b>1.3</b>	<b>1.3</b>	<b>--</b>	<b>--</b>
<b>Rains &amp; Floods</b>	<b>1.3</b>	<b>1.3</b>	<b>1.3</b>	<b>1.3</b>
<b>Seawater desalination</b>	<b>0.06</b>	<b>0.06</b>	<b>--</b>	<b>--</b>
<b>Total</b>	<b>70.0</b>	<b>74.3</b>	<b>--</b>	<b>--</b>

## **2. 2. Waste water effects and its criteria:**

The reuse of treated waste water in agriculture is an option that is increasingly being investigated and taken up in regions with water scarcity, growing urban populations and growing demand for irrigation water.

**Hussein et al., (2006)** found that the use of waste water can save up to 50% application of inorganic nitrogen fertilizer if the waste water contains 40 mg N/L.