PROPER MANAGEMENT OF SOIL AND WATER UNDER SALINE CONDITIONS

By

MOHAMMAD YAHIA HELMI

B.Sc. (Environ. Agric. Sci.), Fac. Environ. Agric. Sci., El-Arish, Suez Canal Univ., ٢٠٠١

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APPROVAL SHEET

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APPROVAL COMMITTEE

Dr. EID MORSY KHALED…………………..…………………………………
Professor of Soils, Fac. Agric., Ain Shams University

Dr. YOUSSIEF ALI ABDEL-AAL……………………………………………..
Professor of Soils, Fac. Agric., Cairo University

Dr. SAYED TAHA ABOU-ZEID ………..
Professor of Soils, Fac. Agric., Cairo University

Dr. ELSAID AHMED ELMORSY ……......................……………….............
Professor of Soils, Fac. Agric., Cairo University

Date: / / ٢٠١٢

SUPERVISION SHEET

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SUPERVISION COMMITTEE

Dr. ELSAID AHMED ELMORSY
Professor of Soils, Fac. Agric., Cairo University

Dr. SAYED TAHA ABOU-ZEID
Professor of Soils, Fac. Agric., Cairo University

Dr. ADEL MOHAMMED KHALEFA
Head Researcher of Soils, Agricultural Research Center, Giza

الإدارة الملائمة للأراضي والمياه تحت الظروف الملحية

رسالة مقدمة من

محمد يحيى حلمي
بكالوريوس في العلوم الزراعية البيئية – كلية العلوم الزراعية البيئية – العريش – جامعة قناة السويس، ٢٠٠١

للحصول على درجة

الماجستير

في

العلوم الزراعية

(أراضى)

قســـــم علوم الأراضى
كليـــــة الزراعـــــة
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لجنة الحكم

دكتور/ عيد مرسى خالد ....
أستاذ الأراضى، كلية الزراعة، جامعة عين شمس

دكتور/ يوسف على عبد العال ....
أستاذ الأراضى المتفرغ، كلية الزراعة، جامعة القاهرة

دكتور/ سيد طه أبو زيد ....
أستاذ الأراضى المتفرغ، كلية الزراعة، جامعة القاهرة

دكتور/ السعيد أحمد المرسى ....
أستاذ الأراضى المتفرغ، كلية الزراعة، جامعة القاهرة

التاريخ / / ٢٠١٢

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لجنة الإشراف

دكتور/ السعيد أحمد المرسى
أستاذ الأراضى، كلية الزراعة، جامعة القاهرة

دكتور/ سيد طه أبو زيد
أستاذ الأراضى، كلية الزراعة، جامعة القاهرة

دكتور/ عادل محمد خليفة
رئيس بحوث الأراضى، معهد بحوث الأراضى والمياه والبيئة، مركز البحوث الزراعية، الجيزة

DEDICATION

I dedicate this work to the spirit of ***my father's*** *precious, as well as to my mother, my sister and my brother for all the support they lovely offered along the period of my post graduation.*

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CONTENTS

INTRODUCTION

The shortage of the Nile fresh irrigation water in Egypt is one of the limiting factors for agricultural development in order to meet the growing demand for increasing population. Therefore, alternative water resources of low quality such as agricultural drainage water can be used for irrigation to partially satisfy the need of irrigation water. The use of low or marginal quality water for irrigation without proper management could produce negative effects on both soil quality and crop-production (Ould *et al.*, ٢٠٠٧).

The soil salinity and sodicity parameters increased as a result of the use of drainage and mixed water. Thus, proper management of irrigation water regardless of its quality, is essential for good crop production. It is even more important when saline water is used. In this context several management practices were recommended.

As a general policy in reusing drainage water for irrigation, it is agreeable to obtain satisfactory yields by selecting salt-tolerant crops and varieties and proper soil and water management, but reuse of these waters should not deteriorate the irrigated soils. The prime requirements of irrigation management for salinity control are timely irrigation, adequate leaching, adequate drainage and controlled water table (Zeidan *et al.*, ٢٠٠٩ and Feizi *et al.*, ٢٠١٠).The amount of water applied should be sufficient to meet both the water requirement of crops and satisfy the leaching requirement to maintain a favorable salt balance in the root zone, but not enough to overload the drainage system (Mostafazadeh-Fard *et al.*, ٢٠٠٩). Several physical, chemical and biological soil management help and facilitate the use of saline water in crop production. Brackish drainage water can be used for crop production provided that the soil is amended with certain chemical amendment, *i.e.*, gypsum (Rashid *et al.*, ٢٠٠٩), sulfur (El-Sharawy, ٢٠٠٨) and ammonium thiosulfate (ATS) (Yakout, ٢٠٠٣).

Timing and placement of proper fertilizers are important and unless properly applied, they may contribute to or cause a salinity problem. Esmaili *et al.* (٢٠٠٨) and Laboski (٢٠٠٨) recommended that the lower the salt index of the fertilizer, the less danger there is of salt burn and damage to seedling. A split application of small amount of fertilizers through saline irrigation water and increasing the NPK fertilizers rate more than those which are considered optimum under non saline condition, may overcome some of the inhibitory effects of water salinity (Yakout, ٢٠٠٣ and Esmaili *et al.*, ٢٠٠٨).

The current investigation aims to study and evaluate the following items;

١. different strategies of agricultural drainage water reuse as an alternative irrigation water resources,

٢. the effective role of some amendments application, *i.e.*, gypsum and ammonium thiosulfate $(NH_٤)_٢ S_٢O_٣$,

٣. adequate leaching requirement and drainage management, and

٤. small split application of NPK fertilizers through irrigation water, with increasing their applied rates higher than those recommended under non saline conditions; on alleviate the adverse effect of irrigation water salinity on soil properties, plant growth and yield.

REVIEW OF LITERATURE

The increasing demand for water in the world, especially in the arid and semi arid regions, has forced farmers to use low quality water for irrigation, such as agricultural drainage water. Irrigation with high salinity drainage water during the whole growing season of the crops, even the tolerant ones, does not produce high yield most of the times.

Salinity is one of the most important problems which reduces agricultural production and gradually decreases the area under cultivation. Irrigation agriculture using saline water in the arid and semi-arid region can lead to salt accumulation in the soil profile, reduction in yield and deterioration in soil resource, if proper management practice are not adopted (Ould *et al.*, ٢٠٠٧).

Long-term use of brackish waters for irrigation can deteriorate soil properties and adversely affect yields of different crops. The excess of cations like sodium and of anions like carbonate, bicarbonate and chloride present in irrigation water increase soil pH, electrical conductivity (EC) and exchangeable sodium percentage (ESP) (Minhas and Bajwa, ٢٠٠١; Choudhary *et al.*, ٢٠٠٤).

Sustainable use of poor-quality drainage water for irrigation requires close monitoring and control of soil salinity at both regional (Kotb *et al.*, ٢٠٠٠) and field scales (Odeh *et al.*, ١٩٩٨) to minimize adverse effects of soil salinity on agricultural production.

Salinity is a significant factor in many irrigated, semi-arid lands. The potential effects of salinity are not only on crop yield but also on factors such as salinization of lands, degrading ground and surface waters. All of these factors should be considered in developing irrigation strategies (Feng *et al.*, ٢٠٠٣).

To overcome these problems, Abdel-Gawad and Ghaibeh (٢٠٠١), Yurtseven *et al.* (٢٠٠٥) recommended methods such as mixing agricultural drainage water with good quality irrigation water, plant breeding (selection of salt tolerant cultivars) and alternating good quality irrigation water with saline water. These practices are important for reducing salinity problems but they cannot prevent soil degradation due to salinity and sodicity. Therefore, the use of appropriate irrigation water for leaching with suitable drainage systems is one of the best methods for improvement of saline-sodic soils.

Rhoades (١٩٩٩a) reported that to facilitate adequate leaching of the salts added through saline irrigation water, soil and water management approaches should attempt to reduce unproductive water losses associated with evaporation from soil surfaces; increase soil moisture storage; maintain soil physical properties in root zone; enhance soil organic matter inputs and nutrient availability status; and maintain soil salinity and sodicity levels within acceptable crop production limits.

Under irrigation conditions in arid and semi-arid climates, the build-up of salinity in soils is inevitable. The severity and rapidity of build-up depends on a number of interacting factors such as the amount of dissolved salt in the irrigation water and the local climate. However, with proper management of soil moisture, irrigation system uniformity and efficiency, local drainage, and the right choice of crops, soil salinity can be managed to prolong field productivity (Cardon *et al.*, ٢٠٠٧).

Another effective method of reducing the salinity hazard is application of proper leaching and irrigation management. Also, Rashid *et al.* (٢٠٠٩) mentioned that there is different strategies including ploughing, leaching, using of chemical amendments and fertilization help plants growth in salt affected soils.

١. Irrigation management practices

a. Management of multi-quality water resources

The extent to which a saline water can be used for crop production depends upon its quality and availability and upon the availability of a good quality water source. Water availability is equal in importance to water quality, particularly if the water supply (either saline or non-saline) is not available or dependable at certain times of the year. The use of saline water is facilitated when an adequate supply of good quality water is available, at least during the early part of the season, and when saline water of suitable quality is available and accessible during the latter part of the season.

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Water resources might be managed to optimize yield by maintaining salt stress at acceptable levels depending on crop, soil type, and quality of irrigation water (Dalton *et al.*, ٢٠٠١).

Qadir and Oster (٢٠٠٤) mentioned that there are three major approaches that involve the use of saline and/or sodic drainage waters for crop production. These include cyclic, blending and sequential use and reuse of such waters through surface irrigation. The cyclic strategy involves the use of saline sodic drainage water and non saline irrigation water in crop rotations that include both moderately salt-sensitive and salt-tolerant crops. Typically, the non saline water is also used before planting and during initial growth stages of the salt-tolerant crop while saline water is usually used after seedling establishment. The cyclic strategy requires a crop rotation plan that can make best use of the available good-and poor-quality waters, and takes into account the different salt sensitivities among the crops grown in the region, including the changes in salt sensitivities of crops at different stages of growth. The advantages of cyclic strategy include: (١) steady-state salinity conditions in the soil profile are never reached because the quality of irrigation water changes over time, (٢) soil salinity is kept lower over time, especially in the topsoil during seedling establishment, (٣) a broad range of crops, including those with high economic-value and moderate salt sensitivity, can be grown in rotation with salt-tolerant crops and (٤) conventional irrigation systems can be used. A major disadvantage is that drainage water must be collected and kept separate from the primary water supply, *i.e.*, it requires storage when it cannot be used for irrigation.

Sharma and Tyagi (٢٠٠٤) showed that the cyclic use is favored over mixing of the multi-salinity waters due to its operational advantages as alternate use of canal water and saline water can be made to different fields, seasons and crop stages to keep the build-up of salts to the minimum. Also, Choudhary *et al.* (٢٠٠٦) reported that cyclic use keeps the average soil salinity lower than that under blending especially in the upper portion of the profile.

Abdel-Gawad *et al.* (٢٠٠٣) found that the tomato yield increased using alternating irrigation of fresh water (٠,٦ dSm$^{-١}$) and mixed drainage water (in ٣ ratios, *i.e.*, ٢,٣ , ٤,٠ and ٦,٠ dSm$^{-١}$ corresponded to