THE RELATIONSHIP BETWEEN WATER REQUIRMENTS And NITROGEN FERTILIZERS SOURCE APPLICATED WITH DIFFERENT RATES And ITS EFFECT ON SUGAR BEET YIELD AS WILL AS SOIL And PLANT POLLUTION

By Shadia Ahmed M. Ibrahim

B.Sc. of (Agricultural Production), Faculty of Agriculture, Mansoura University, 1981
Diploma of Environmental Sciences, Institute of Environmental Studies &Research
Ain Shams University, 1998
Master of Environmental Sciences, Institute of Environmental Studies &Research
Ain Shams University, 2007

A Thesis Submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
In
Environmental Science

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

APPROVAL SHEET

THE RELATIONSHIP BETWEEN WATER REQUIRMENTS AND NITROGEN FERTILIZERS SOURCE APPLICATED WITH DIFFERENT RATES AND ITS EFFECT ON SUGAR BEET YIELD AS WILL AS SOIL AND PLANT POLLUTION

By

Shadia Ahmed M. Ibrahim

B.Sc. of (Agricultural Production), Faculty of Agriculture, Mansoura University, 1981 Diploma of Environmental Sciences, Institute of Environmental Studies & Research Ain Shams University, 1998

Master of Environmental Sciences, Institute of Environmental Studies & Research Ain Shams University, 2007

This thesis Towards a Doctor of Philosphy Degree in Environmental Science Has been Approved by :

Name Signature

1- Prof. Dr. Ezzat Mohamed Soliman

Prof.of Soil & Water, in Department of Environmental Agricultural Science, Institute of Environmental Studies & Research Ain Shams University.

2- Prof .Dr. Mohamed Al-Asmar El-Hawary

Prof. of Agronomy, Department of Agronomy Faculty of Agriculture Al-Azhar University

3- Prof. Dr. Naver Ebraheim Mahmoud Hassan Darwish

Prof. of Agronomy, Department of Agronomy Faculty of Agriculture Al-Azhar University

4- Prof. Dr. Ahmed Abdel Kader Taha

Prof.& Head of Department of Soil Science Faculty of Agriculture Mansoura University

THE RELATIONSHIP BETWEEN WATER REQUIRMENTS AND NITROGEN FERTILIZERS SOURCE APPLICATED WITH DIFFERENT RATES AND ITS EFFECT ON SUGAR BEET YIELD AS WILL AS SOIL AND PLANT POLLUTION

By

Shadia Ahmed M. Ibrahim

B.Sc. of (Agricultural Production), Faculty of Agriculture, Mansoura University, 1981
 Diploma of Environmental Sciences, Institute of Environmental Studies & Research
 Ain Shams University, 1998

Master of Environmental Sciences, Institute of Environmental Studies & Research
Ain Shams University, 2007

A Thesis Submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
In

Environmental Science
Department of Environmental Agricultural Science
Institute of Environmental Sciences & Research Ain Shams University

Under The Supervision of:

1- Prof. Dr. Ezzat Mohamed Soliman

Prof. of Soil & Water, in Department of Environmental Agricultural Science, Institute of Environmental Studies & Research Ain Shams University.

2- Prof .Dr. Mohamed Al-Asmar El-Hawary

Prof.of Agronomy, Department of Agronomy Faculty of Agriculture Al-Azhar University

3-Prof. Dr. Ibrahim M. A. Abdel-Aziz

Head of Research, Soil & Water & Environment Research Institute Agricultural Research Center

2013

ACKNOWLEDGEMENT

The writer wishes to express her sincere thanks and deep gratitude to *Prof. Dr. Ezzat M. Soliman*, Professor of Soil Science, Department of Environmental Agricultural Science, Institute of Environmental Studies and Research, Ain Shams University, for suggesting the problem, continuous help during the progress of this work and preparation of this thesis to its final form.

Sincere thanks and appreciation to *Prof. Dr. Mohamed Al-Asmar El-Hawary*, Professor or Agronomy, Department of Fac. Agric., Al-Azhar Univ. for his encouragement and help during the preparation of the manuscript.

Deeply grateful is given to *Prof. Dr. Ibrahim M.A. Abdel-Aziz*, Head of Research, Soils & Water and Environment Research Institute, Agricultural Research Center for supervising, guidance and valuable advice.

Sincere thanks are also extended to all staff members of Agricultural Science Department, Environmental Studies and Research Institute, Ain Shams University and to all the staff members of Anhydrous Ammonia project, Soil Nutrition Research Department, Soils & Water and Environment Research Institute, Agricultural Research Center for morale support and encouragement and to my family for their endurance patience and kind help.

Thanks are also due to *Dr. Osman Mazen*, Soils & Water and Environment Research Institute, Agricultural Research Center for his effective help during the progress of this work.

ABSTRACT

Two field experiments were carried out to study the effect of irrigation quantity i.e. 2000- 2500- 3000m^{3/}fed., nitrogen fertilizer sources i.e. anhydrous ammonia, urea, ammonium sulfate and ammonium nitrate at rates i.e. 70, 80 and 90kg N/fed. on growth, juice quality, yield and its component as well as plant content of sugar beet plants under Kafr El-Sheikh Governorate conditions during 2010/2011 and 2011/2012 seasons.

Results reveal the following findings:

Decreasing amount of irrigation water caused reduction in crop growth rate, root volume, root fresh weight per plant, alpha amino nitrogen%, top yield/fed., root yield/fed., sugar yield/fed., water requirement, nitrite and nitrate, percentage in leaves, potassium percentage in roots as well as nitrite, and nitrate, and ammonium and available N in soil, in both seasons. On the other hand, reduction of irrigation water amount increased root length, sucrose%, purity%, sodium percentage, nitrogen percentage in leaves and water use efficiency, in both seasons. Relative growth rate and net assimilation rate were not significantly affected by irrigation water quantity in both seasons.

All studied traits were significantly affected by nitrogen fertilizer sources in both seasons. Sugar beet plant received anhydrous ammonia gave the highest values of root length and volume, root fresh weight, K%, purity%, sucrose%, root and sugar yield/fed., water use efficiency. Also increased crop growth rates nitrite, nitrate, ammonium and available N in soil, but anhydrous ammonia gave the lowest values of alpha amino nitrogen, Na%, water requirement, nitrite and nitrate in leaves and relative growth rate. Ammonium nitrate gave the highest values of alpha amino nitrogen, Na% and nitrate in leaves. Ammonium sulfate gave the highest values of water

requirements and N% in leaves. Applied urea gave highest values in top yield, relative growth rate and net assimilation rate.

Sugar beet plants fertilized at the rate of 90kg N/fed. gave the highest values of root length and volume and fresh weight and yield, K%, alpha amino nitrogen, root and sugar yield/fed., nitrite and nitrate and ammonium and available nitrogen in soil, and/or N% in leaves at harvest top yield and water use efficiency while, using the rate of 70kg N/fed. gave the highest values of Na%, purity%, water requirements and sucrose%.

The interaction effects between irrigation water quantities, nitrogen sources and nitrogen rates were found to be significant using 2000m³ water/fed. and anhydrous ammonia at 90kg N fed. gave the highest values of root length, water requirement, water use efficiency and N% in leaves in both seasons While, using 2000m³ water/fed and anhydrous ammonia at 70kg N/fed. gave the highest values of Na%, purity% and sucrose% in both seasons. Using 2000m³ water/fed. with ammonium sulphate at the rate of 90kg N/fed. gave highest value of N% in leaves. On the other hand, using 3000m³ water/fed with anhydrous ammonia at 90kg N/fed. produced the highest values of root fresh weight yield, K%, sugar yield, top yield as well as nitrite, nitrate, ammonium and available N in soil in both seasons While, using 3000m³ water/fed with ammonium nitrate gave the highest alpha amino nitrogen in both seasons.

CONTENTS

Title		Page
I.	INTRODUCTION	1
II.	REVIEW OF LITERATURE	3
III.	MATERIALS AND METHODS	26
IV.	RESULTS AND DISCUSSION	34
IV.1	Growth attributes characters:-	34
IV. 1-1	Relative growth rate	34
IV. 1-2	Net assimilation rate	37
IV. 1-3	Crop growth rate	40
IV. 2	Yield components characters:-	44
IV. 2-1	Root length	44
IV. 2-2	Root volume	47
IV. 2-3	Root fresh weight per plant	51
IV. 3	Yield quality characters:-	55
IV. 3-1	Sucrose percentage	55
IV. 3-2	Purity percentage	58
IV. 3-3	Alpha amino nitrogen percentage	62
IV. 3-4	Potassium percentage	66
IV. 3-5	Sodium percentage	70
IV. 4	Yield characters:-	73

Title		Page
IV. 4-1	Top yield per feddan	73
IV. 4-2	Root yield per feddan	77
IV. 4-3	Sugar yield per feddan	82
IV. 5	Water relationship	86
IV. 5-1	Water use efficiency	86
IV. 5-2	Water requirement	90
IV. 6	Plant analysis:-	94
IV. 6-1	Nitrogen percentage in leaves	94
IV. 6-2	Nitrite percentage in leaves	96
IV. 6-3	Nitrate percentage in leaves	100
IV. 7	Soil analysis	106
IV. 7-1	Available nitrogen in soil	106
IV. 7-2	Nitrite content in soil	109
IV. 7-3	Nitrate content in soil	112
IV. 7-4	Ammonium content in soil	116
V.	SUMMARY	120
VI.	REFERENCES	124
	ARARIC SIIMMARV	

LIST OF TABLES

Table	TO LA	
No.	Titles	Page
1.	Physical and chemical properties of the experimental Soil.	27
2.	Meteorological date for Kafr El-Sheikh during 2010/2011	28
	and 2011/2012 seasons.	
3.	Quantity of seasonal irrigation water (IW) and rainfall	29
	water (R) applied to sugar beet in both seasons.	
4.	Average relative growth rate (RGR) of sugar beet as	36
	affected by irrigation levels, nitrogen sources, nitrogen	
	rates and interactions in 2010/2011 and 2011/2012 seasons.	
5.	Average net assimilation rate (NAR) (mg/m²/day) of sugar	39
	beet as affected by irrigation levels, nitrogen sources,	
	nitrogen rates and interactions in 2010/2011 and 2011/2012	
	seasons.	
6.	Average crop growth rate (CGR) (mg/day) of sugar beet as	43
	affected by irrigation levels, nitrogen sources, nitrogen	
	rates and interactions in 2010/2011 and 2011/2012 seasons.	
7.	Average root length (cm) of sugar beet as affected by	45
	irrigation levels, nitrogen sources, nitrogen rates and their	
	interactions in 2010/2011 and 2011/2012 seasons.	
8.	Average root volume (cm ³) of sugar beet as affected by	49
	irrigation levels, nitrogen sources, nitrogen rates and their	
	interactions in 2010/2011 and 2011/2012 seasons.	
9.	Average root fresh weight (g) at harvest of sugar beet as	53
	affected by irrigation levels, nitrogen sources, nitrogen	
	rates and their interactions in 2010/2011 and 2011/2012	
	seasons.	

Table	Titles	Page
10.	Average sucrose% of sugar beet as affected by irrigation	56
	levels, nitrogen sources, nitrogen rates and their	
	interactions in 2010/2011 and 2011/2012 seasons.	
11.	Average purity% in root juice of sugar beet as affected by	60
	irrigation levels, nitrogen sources, nitrogen rates and their	
	interactions in 2010/2011 and 2011/2012 seasons.	
12.	Average α amino nitrogen% in root juice of sugar beet as	63
	affected by irrigation levels, nitrogen sources, nitrogen	
	rates and their interactions in 2010/2011 and 2011/2012	
	seasons.	
13.	Average K% in roots of sugar beet as affected by irrigation	68
	levels, nitrogen sources, nitrogen rates and their	
	interactions in 2010/2011 and 2011/2012 seasons.	
14.	Average Na % in roots of sugar beet as affected by	71
	irrigation levels, nitrogen sources, nitrogen rates and their	
	interactions in 2010/2011 and 2011/2012 seasons.	
15.	Average Top yield (ton/fed.) of sugar beet as affected by	75
	irrigation levels, nitrogen sources, nitrogen rates and their	
	interactions in 2010/2011 and 2011/2012 seasons.	
16.	Average root yield/fed. (ton) of sugar beet as affected by	80
	irrigation levels, nitrogen sources, nitrogen rates and their	
	interactions in 2010/2011 and 2011/2012 seasons.	
17.	Average sugar yield/fed. (ton) of sugar beet as affected by	84
	irrigation levels, nitrogen sources, nitrogen rates and their	
	interactions in 2010/2011 and 2011/2012 seasons.	

Table No.	Titles	Page
18.	Average water use efficiency (kg sugar/m³ water) of sugar	88
	beet as affected by irrigation levels, nitrogen sources,	
	nitrogen rates and their interactions in 2010/2011 and	
	2011/2012 seasons.	
19.	Average water requirement (m³ water/kg sugar) of sugar	92
	beet as affected by irrigation levels, nitrogen sources,	
	nitrogen rates and their interactions in 2010/2011 and	
	2011/2012 seasons.	
20.	Average N% in leaves at harvest of sugar beet as affected	95
	by irrigation levels, nitrogen sources, nitrogen rates and	
	their interactions in 2010/2011 and 2011/2012 seasons.	
21.	Average nitrite% in leaves at harvest of sugar beet as	99
	affected by irrigation levels, nitrogen sources, nitrogen	
	rates and their interactions in 2010/2011 and 2011/2012	
	seasons.	
22.	Average nitrate% in leaves at harvest of sugar beet as	103
	affected by irrigation levels, nitrogen sources, nitrogen	
	rates and their interactions in 2010/2011 and 2011/2012	
	seasons.	
23.	Average available N in soil (mg/kg) of sugar beet as	108
	affected by irrigation levels, nitrogen sources, nitrogen	
	rates and their interactions at harvest from sawing in	
	2010/2011 and 2011/2012 seasons.	
24.	Average Nitrite content in soil (mg/kg) of sugar beet as	111
	affected by irrigation levels, nitrogen sources, nitrogen	
	rates and their interactions at harvest from sawing in	
	2010/2011 and 2011/2012 seasons.	

Table	Titles	Page
25.	Average Nitrate content in soil (mg/kg) of sugar beet as	114
	affected by irrigation levels, nitrogen sources, nitrogen	
	rates and their interactions mean at harvest from sawing in	
	2010/2011 and 2011/2012 seasons.	
26.	Average Ammonium content in soil (mg/kg) of sugar beet	117
	as affected by irrigation levels, nitrogen sources, nitrogen	
	rates and their interactions at harvest from sawing in	
	2010/2011 and 2011/2012 seasons.	

INTRODUCTION

Sugar beet (*Beta vulgaris*, L.) ranks the second important sugar crop after sugar cane, producing annually 45% of sugar production all over the world. Recently, sugar beet has an important position in Egyptian crop rotation as a winter crop not only in the fertile soils, but also in poor or saline or alkaline or calcareous soils. The great importance of sugar beet crop is not only from its ability to grow in the newly reclaimed areas as economic crop, but also for production higher of sugar under these conditions as compared with sugar cane. Moreover, sugar beet is specialized as a short duration crop, where it grows in a period of about half that of sugar cane. Furthermore, sugar beet requires less water requirement. Also, its productivity makes it a good cash crop at this situation. The Egyptian Government encourages sugar beet growers to increase the cultivated area for decreasing the gap between sugar production and consumption. This increase is likely to be obtained by growing sugar beet crop in newly reclaimed soils. Most of these areas face some stress problems, i.e. shortage of irrigation water, salinity and unbalance nutrient elements. Attempts are made for increasing sugar beet productivity in newly reclaimed soils.

Nowadays, Egypt face a problem in amount of irrigation water. The shortage of irrigation water is the most important factor constraining agricultural production in Egypt. Thus, the first important step of Egyptian strategy is increasing productivity from unit area with the lowest irrigation water quantity and saving the irrigation water.

Nitrogen is a major nutrient element and it's needed in large amount for high yield of sugar beet and it considered the most factor affecting the growth and productivity of sugar beet. Application the optimum rate from nitrogen fertilizer plays a fundamental role in plant growth and yield as well as yield quality.

Source of nitrogen application is important management tools in this respect because maximum nitrogen efficiency is obtained when nitrogen is applied in the form which is available for uptake by plant needed.

Anhydrous ammonia represents a cheaper N-source than the famous solid sources. The cost of transportation and handling is relatively low for anhydrous ammonia owing to its 82% N composition. Being a liquid when pressurized allows anhydrous ammonia to be transported and handled in more convenient and less expensive ways and with less labor that dry materials. These advantages carry over to the farmer in a very effective, less expensive N fertilizer and a source that requires less labor and handling to apply it in the field. When N was absorbed as NH⁺₄, action uptake exceeded anion uptake and H⁺ were released to balance the charge, conversely. When N was absorbed as No₃ anion uptake was changed and OH or HCO₃ ions were released to balance the excess anion absorption. The major advantages of anhydrous ammonia as a direct application fertilizer are its high N analysis and low cost. Recently, a great attention has been devoted to develop practices of application and technologies, which are offered by fertilizer producers, engineers, distributes, traders, policy makers and scientific communities.

The studies on fertilization sugar beet with new nitrogen source such as anhydrous ammonia under limited irrigation quantity are rare. Therefore the aim of the present investigation is to study the effect of irrigation quantity, nitrogen sources and rates on sugar beet growth, juice quality, yield and it's components under Kafr El-Sheikh Governorate conditions.

REVIEW OF LITERATURE

The literature of this study could be divided as follows:

A.1-Effect of irrigation on growth of sugar beet:

Carter *et al.* (1980) showed that reducing the irrigation level increased sucrose percentage. The reduction in water may increase percentage but may also reduce plant growth, root and sugar yield.

El-Hennaway and El-Hawary (1995) found that values of root length, root diameter and root fresh weight of sugar beet were significantly decreased as water depletion level increased.

Abd El-Wahab *et al.* (1996) studied the effect of different amounts of irrigation water (I_1 =2625, I_2 =2100 and I_3 =1575 m³/fed.), they found that root length was significantly increased as water amount decreased and decreased root diameter (cm).

Emara (1996) found that the highest increase for root length resulted from the irrigation volume of 1500m³/fed. values were 29.54cm, while the maximum irrigation water 2500m³/fed. resulted in the highest values of root diameter, root fresh weight and foliage weight of sugar beet.

Mohamed *et al.* (2000) showed the highest root length and root fresh weight/plant of sugar beet when irrigation was applied at 65% of the field capacity (F.C.).

Abd El-Wahab *et al.* (2002) found that root diameter was increased significantly as water amount increased. Root length was increased significantly as water amounts decreased.

Fadi *et al.* (2002) showed that the growth of sugar beet was much lower in soils irrigated at 60% field capacity than in soil irrigation at 100% field capacity. The rate of underground to aboveground dry matter increased