

WATER BALANCE FOR SOME VEGETABLE CROPS UNDER SOUTH NILE DELTA CONDITIONS

BY

MANAL MAHMOUD MOUSA EL-TANTAWY

A thesis submitted in partial fulfillment

of

the requirements for the degree of

MASTER OF SCIENCE

in
Agriculture

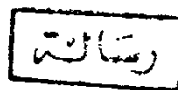
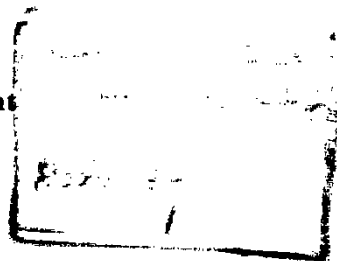
(Vegetable Crops)

Department of Horticulture

Faculty of Agriculture

Ain Shams University

1993



44814

635. 6
M. M

Approval Sheet

**WATER BALANCE FOR SOME VEGETABLE CROPS
UNDER SOUTH NILE DELTA CONDITIONS**

By

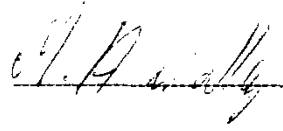
MANAL MAHMOUD MOUSA EL-TANTAWY

**B.Sc. In Agriculture, Horticulture, 1988
Ain Shams University**

This thesis for M.Sc. degree has been approved by :

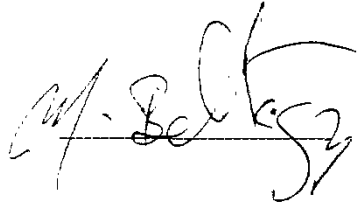
1- Prof. Dr. MAHER WALLY

Prof. of Vegetable Crops, Faculty of Agriculture,
Al-Azhar University.



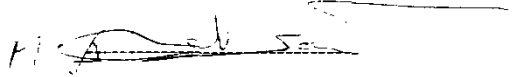
2- Prof. Dr. MOHAMED S. EL-BELTAGY

Prof. of Vegetable Crops, National Research Center.

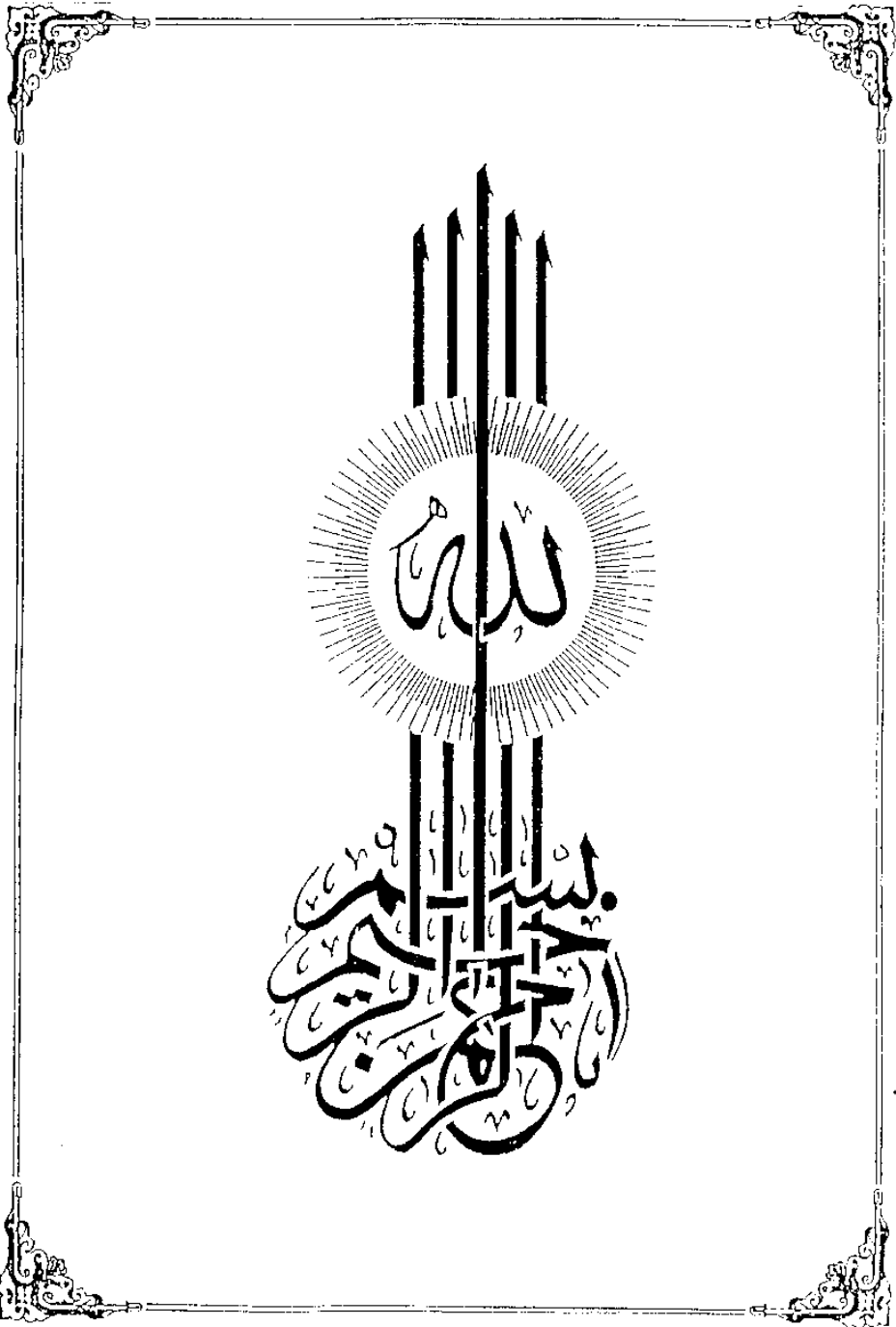


3- Prof. Dr. MOHAMED ABDEL-MAKSoud

Prof. of Vegetables, Faculty of Agriculture,
Ain Shams University



Date of examination : 20 / 2 / 1993



WATER BALANCE FOR SOME VEGETABLE CROPS UNDER SOUTH NILE DELTA CONDITIONS

BY

MANAL MAHMOUD MOUSA EL-TANTAWY

B.Sc. (Agric.) in Horticulture, 1988

Under the supervision of :

Prof. Dr. MOHAMED ABDEL-MAKSOUR

Prof. of Vegetables, Fac. Agric. Ain Shams University

Prof. Dr. ADEL S. EL-BELTAGY

Prof. of Vegetables, Fac. Agric. Ain Shams University

Prof. Dr. AYMAN F. ABOU-HADID

Assco. Prof. of vegetables, Fac. Agric. Ain Shams University

Abstract

Experiments were carried out during the two successive season (1990/91 and 1991/92) using tomato, lettuce and squash planted in sand and clay lysimeters. The aim of the work was to study the actual water consumption of those crops in comparison with the calculated value based on evaporation data. The crop coefficient (Kc) was re-estimated in order to meet the actual water consumption.

ACKNOWLEDGMENT

I wish to express deep sense of gratitude to Prof. Dr. M. A. Maksoud, Prof. of vegetables, Fac. of Agric., Ain Shams, Univ., and Prof. Dr. Adel S. El-beltagy, Prof. of vegetables Fac. of Agric., Ain Shams, Univ. for their continuous help and encouragement.

Sincerely thanks Dr. Ayman Farid Abou-Hadid, Associate professor of vegetable crops, who was always available for valuable and helpful guidance and for planning this work.

This work has been supported by the protected cultivation project, FAO, EGY 86 014.

Great thanks to colleagues in arid land laboratory and vegetable Research Department.

Lastly, my deep thanks to my family, for their patient during this work, and I would like also to express my deep thanks to my husband who offered many helps and encouragement during this work

CONTENTS

	Page
1.INTRODUCTION.....	1
2.REVIEW OF LITERATURE.....	2
2.1 Methods of estimating evapotranspiration.....	2
2.1.1 Temperature, radiation based methods.....	4
2.2 Water application efficiency.....	7
2.3 Crop coefficient.....	11
2.4 Lysimeter Description.....	12
2.5 Types soil water content measurments.....	13
2.5.1 Field measurments of soil water.....	13
2.5.1.1.1 Gravimetical Methods.....	14
2.5.1.2.1 Tensiometers.....	14
2.5.1.2.2 Electrical Resistance Blocks.....	14
1.Gypsum Block.....	14
2. Stainless steel sensor.....	15
2.6 Leaching.....	15
2.7 Water Balance.....	17
3. MATERIALS AND METHODS.....	19
3.1 Plant material.....	19
3.2 The experimental design.....	19
3.3 Water mangament measurements.....	21
3.3.1 Soil water content.....	21
3.3.2 Water Balance	21
3.3.3 Evapotranspiration.....	22
3.3.4 Actual leaching measurment.....	22
3.3.5 Drained water.....	22
3.4 Growth Measurments.....	22
3.4.1 Winter experiments.....	22
3.4.2 Summer experiments.....	23
3.5 Statistical Analysis.....	24
4. RESULTS AND DISCUSSION.....	25
4.1 General.....	25
4.1.1 Correlation between measured Pan evaporation and Piche.....	25
4.1.2 Soil moisture.....	25
4.2 Tomato.....	28
4.2.1 Winter tomato.....	28
4.2.1.1 Water relation.....	33
4.2.2 Summer tomato.....	40
4.2.2.1 Water relation.....	40
4.2.2.2Growth measurments.....	44
4.3 Lettece.....	50
4.3.1 Water relation.....	50
4.3.1 Growth measurments.....	59
4.4 Squash.....	59
4.4.1 Water relation.....	59
4.4.2 Growth measurments.....	66
5. SUMMARY AND CONCLUSION.....	73
6. REFERENCES.....	77
ARABIC SUMMARY	

LIST OF FIGURES

Figure No.	Page
1. Correlation between estimated Pan evaporation and Piche for two seasons.....	26
2. Correlation between soil moisture content (%) and resistance (OHM) in sandy soil.....	27
3. Correlation between soil moisture content (%) and resistance (OHM) in clay soil.....	27
4. Actual evapotranspiration and measured Pan evaporation for winter tomato plants grown in sand and clay lysimeters.....	29
5. Correlation between Pan evaporation and calculated water consumptive use in sand and clay soils in winter tomato grown lysimeters.....	30
6. Percentage of leaching from actual water consumption for winter tomato plants grown in sand and clay lysimeters.....	34
7. Actual and calculated drainage water for winter tomato plants grown in sand and clay lysimeters.....	35
8. Plant height (cm) for winter tomato plants grown in sand and clay lysimeters.....	36
9. Number of leaves for winter tomato plants grown in sand and clay lysimeters.....	38
10. Actual evapotranspiration and measured Pan evaporation for summer tomato plants grown in sand and clay lysimeters.....	41
11. Correlation between Pan evaporation and calculated water consumptive use in sand and clay soils in summer tomato grown lysimeters.....	42
12. Percentage of leaching from actual water consumption for summer tomato plants grown in sand and clay lysimeters.....	45
13. Actual and calculated drainage water for summer tomato plants grown in sand and clay lysimeters.....	47
14. Plant height (cm) for summer tomato plants grown in sand and clay lysimeters.....	48
15. Number of leaves for summer tomato plants grown in sand and clay lysimeters.....	49
16. Actual evapotranspiration and measured Pan evaporation for lettuce plants grown in sand and clay lysimeters.....	52
17. Correlation between Pan evaporation and calculated water consumptive use in sand and clay soils in lettuce grown lysimeters.....	54
18. Percentage of leaching from actual water consumption for lettuce plants grown in sand and clay lysimeters.....	57

19. Actual and calculated drainage water for lettuce plants grown in sand and clay lysimeters.....	58
20. Actual evapotranspiration and measured Pan evaporation for squash plants grown in sand and clay lysimeters.....	61
21. Correlation between Pan evaporation and calculated water consumptive use in sand and clay soils in squash grown lysimeters.....	63
22. Percentage of leaching from actual water consumption for squash plants grown in sand and clay lysimeters.....	67
23. Actual and calculated drainage water for squash plants grown in sand and clay lysimeters.....	68
24. Plant height (cm) for squash plants grown in sand and clay lysimeters.....	69
25. Number of leaves for squash plants grown in sand and clay lysimeters.....	70

LIST OF TABLES

Table No.	Page
1. Dates of sowing and transplanting for different crops used in the trail during the two successive season 1990and1991.....	20
2. Relationship between normal Et, calculated and measured Et, in winter tomato plants.....	32
3. The measured Kc for winter tomato plants during two successive season.....	32
4. Growth parameters of winter tomato plants under sand and clay lysimeters.....	39
5. Relationship between normal Et, calculated and measured Et, in summer tomato plants.....	44
6. The measured Kc for summer tomato plants during two successive season.....	44
7. Growth parameters of summer tomato plants under sand and clay lysimeters.....	51
8. Relationship between normal Et, calculated and measured Et, in lettuce plants.....	55
9. The measured Kc for lettuce plants during two successive season.....	55
10. Growth parameters of lettuce plants under sand and clay lysimeters.....	60
11. Relationship between normal Et, calculated and measured Et, in squash plants.....	65
12. The measured Kc for squash plants during two successive season.....	65
13. Growth parameters of squash plants under sand and clay lysimeters.....	72

INTRODUCTION

1. INTRODUCTION

The Egyptian national supply of water from the Nile is around 55.5 billions cubic meter of water per year. In addition, around two billion cubic meters are available from the artisan wells. Meanwhile, The population is increasing already at the rate of 2.6% annually. Now, the population is around 57 million. The expected population after 25 years is 100 millions.

Accordingly, It is advised to evaluate new possible approaches to reduce the plant water requirement through the implementation of proper irrigation systems and agromanagement techniques. The other possible approach is to cultivate the crops in areas where potential evapotranspiration is lower, i.e., in north coast of the country .The corner stone for such policies is to determines exactly the amount of actual evapotranspiration (Et) for each crop for different regions. This will help to reduce the losses of water to make it available to cultivate more lands.

Three important crops were selected for this study, namely, Lettuce, Squash and Tomato where the yearly cultivated areas for each are 13539, 60567 and 394320 Feddan respectively. Lettuce is a leafy Vegetables, squash is consumed as immature fruits and tomato is a full mature or ripe fruits. Hence, the these crops were selected to represent different types of economical vegetable groups.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The prevailing climate in Egypt indicates that water shortage is a real problem and serious yield limiting factor.

Different approaches were reported to handle the crop water requirements problem. One of the best reported methods in the use of water balance approach in which both the inputs and the outputs of water is calculated.

These studies were designed to first, estimate or measure the evaporation in the irrigation field, second, estimate the evapotranspiration in the said fields and accordingly estimate the water consumptive use, lastly, drainage have to be estimated before subtracting its value from the amount of irrigation water to establish the actual water use.

2.1. Methods of estimating evapotranspiration:

Evaporation has a major merit on consumptive use. Pruitt and Angus (1960) have determined evaporation by means of Class "A" pan evaporator (according to the United States Water Bureau) located in large grass field and they used lysimeter to determine Et. According to Young and Bloney (1942) the potted tanks were surrounded by natural growth of the same species, i.e., in their natural environment so that Et would presumably be the same as for similar growth outside the tank.

Israelson and Hansen (1962) stated that lysimeters have been proved successful in consumptive use measurements for water tables at various depths. Technical problems are encountered when lysimeter were used in the absence of water table. Pruitt and Angus (1960) have developed and used elaborate 20 Feet diameter weighing lysimeter for studying Et for ryegrass. Van Bavel and Meyers (1962) described an automatic weighing lysimeter utilizing strain gauges and electronic system for remote control.

McIlory and Angus (1963) Indicated that a lysimeter should consist of a block of soil together with vegetation, if such a device was enclosed in a suitable container and exposed in natural surroundings, it will permit determination of any term of the hydrological equation when the others are known.

Tanner (1967), referred to the lysimeter as a volume of soil, which may be planted to vegetation, was located in a container to isolate it hydrological from the surrounding soil in order to assess or control various terms of the water balance.

The world meteorological organization (1966) used the term evapotranspirometers or soil evapometer for containers of soil and vegetation from which the water loss was measured by weighing or accounting for all incoming water at the surface and all outflow from the

bottom of the container.

2.1.1 Temperature, radiation based methods:

2.1.1.1 Blaney Cradle Method :

$$E_t = C [P (0.46T + 8)] \dots\dots\dots \text{mm/day}$$

where

E_t = reference crop evapotranspiration in mm/day for the month considered.

T = mean daily temperature in °C over the month considered.

P = mean daily percentage of total annual daytime hours.

C = adjustment factor which depends on minimum relative humidity, sunshine hours and daytime wind estimates.

A strong correlation existed for a given climate between E_t and Blarney Cradle factor (Tanner, 1967).

2.1.1.2 Radiation Method :

$$E_t = C (W.R_s) \dots\dots\dots \text{mm/day}$$

where

E_t = reference crop evapotranspiration in mm/day for the period considered.

R_s = solar radiation in equivalent evaporation in mm/day

W = weighting factor which depends on temperature and