ASSESSMENT OF CLIMATE CHANGE ON TOMATO PRODUCTION UNDER EGYPTIAN CONDITIONS

By

Asmaa Said Hafez Mohamed

B. Sc. Agric. Sc. (Soil Science), Cairo University, 2009

THESIS

Submitted in Partial Fulfillment of
the Requirements for the Degree of

MASTER OF SCIENCE

In

Agricultural Sciences

(Vegetable Crops)

Department of Vegetable crops
Faculty of Agriculture
Cairo University
EGYPT

2017

SUPERVISION SHEET

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Approval: 28 /11 /2017

ABSTRACT

The Egyptian processing tomato *(Solanum Lycopersicon*) has a major dominance in the global market but few studies have been conducted using a cropping systems analysis approach for this crop. The overall goal of this project was to evaluate the CropSyst (Cropping Systems Simulation) software with experiment data were taken from field experiment in summer season during two successive seasons (2014 and 2015) in Egypt, Giza, Dokki (Lat.: 29°:51':08.33 "N, Long.: 31°:14':24.11"E) The Experiment included two planting dates (April. 10 and April. 25) with three irrigation levels of waters (80% _ 100%_ 120%), in addition to two cultivars (superstrein B and Castle rock). The experiment included 36 experimental plots, 2 planting dates × 3 irrigation levels × 2 cultivars × 3 replicates. The experimental plot area was 75 m2 and consisted of 5 rows with 150 cm width and 10 m length; and the space between plants was 30 cm. The experiment was established as factorial with three factors. The planting date was in the main plot, whereas the irrigation levels was in sub-plot, the cultivar was distributed in sub-sub-plot. Data analysis was done by an IBM computer, using Excel program for statistical analysis. The LSD among means for all treatments was tested for significance at 5% level. A comparison of yield for the different transplanting dates showed that earlier transplanting dates increased yield for all varieties, while there was a significant higher yield for superstrein B variety than Castle rock variety. The two summer seasons in 2014 and 2015 gave a significant difference between two transplanting date, with higher plant growth with the first transplanting date and with level irrigation (120 %). the data of this experiment (2014/15 season) was used to validate the CropSyst model. The treatments of the validation experiment composed of two tomato cultivars and three irrigation treatments. climate change scenarios A1B were used to assess the consequences of climate change on tomato yield in 2040.. The results showed that CropSyst model was able to predict tomato yield with high degree of accuracy for both calibration and validation procedures. The results also indicated that, in general, the yield of both cultivars will be decrease under climate change; however the reduction was lower for Castle rock, as compared with superstrein B.

Keywords: *Solanum Lycopersicon*, cropsyst, crop simulation, calibration, validation, climate change scenario, A1B.

DEDICATION

I dedicate this work to my parents, my husband, my son Yassein and for all the support they lovely offered during my post-graduate studies.

ACKNOWLEDGMENT

I would be honored to convey my deepest thanks and true gratitude to ***Dr. Mohammed Mohammed Shahin****, Professor of Vegetable Crops Department, Cairo University, for his supervision, constructive guidance, encouragement's and continuous valuable help throughout the course of this investigation and preparation of the manuscript.*
Also, I wish to extend my deep gratitude and sincere thanks to ***Prof. Dr. Hassan Ahmed Khater*** *Prof. of Soil Science Department, Cairo University, for his kind supervision, valuable assistance, and faithful attitude during the preparation of this thesis. Moreover, I wish to extend my deep gratitude and sincere thanks to* ***Dr. Shaker Mohammed Abu El Maaty****, researcher of Central Laboratory for Agricultural climate, Agric research center for his kind supervision and sincere help.*

I wish to express my deep thanks and gratitude to ***Dr. Tahany Ahmed Noreldin****, researcher in Water Requirement and Field Irrigation Department, Soils, Water and Environment Research Institute, Agriculture Research Center (ARC) for his constructive guidance and valuable assistance during the preparation of this thesis.*

Also the author wishes to express his thanks to Vegetable Crops Department staff Faculty of Agriculture ,Cairo University for their help and encourage. Thanks are also due to all the staff in Central Laboratory for Agricultural Climate (CLAC) for help, support, and encourage and their concern on my work.

I am particularly grateful to my family for their helps and continuous encouragement during my study period.

LIST OF ABBREVIATIONS AND INITIALS

Soil salinity of the saturated paste	: ECe
Saturation percentage	: SP
Total soluble solids	: TSS
Potential evapotranspiration in mm/day	: ET_o
A 0.75 pan coefficient value was used for the site	: K_p
Pan evaporation measurements in mm/day	: E_{Pan}
Crop evapotranspiration (mm/day)	:ET_{crop}
Application efficiency of the drip system	: Ea
Leaching requirement	: LR
Food and agriculture organization	: FAO
Electrical conductivity of irrigation water in dS/m	: E_{ciw}
Electrical conductivity of drainage water in dS/m	: E_{cdw}
International Panel for Climate Change	:IPCC
Abscisic acid	: ABA
Water use efficiency	:WUE

Percent difference between measured and predicted values.	:PD%
Willmott index of agreement	:WI
Root mean square error	:RMSE

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INTRODUCTION

Tomato (*Solanum lycopersicon*) is one of the most important vegetable crops grown under outdoor and indoor conditions. It has become an important commercial crop in Egypt so far as the cultivation area, production, industrial values and its contribution to human nutrition. The total cultivated area of tomato in 2014 was 507.6 thousands feddan, which produced about 8881.0 thousand Tons, While the total exported tomato was 5.7 thousand ton in 2010**.** (FAO, 2014).

Recent climatological studies have also found that the global surface air temperature has increased by 0.76°C from 1850 to 2005. Moreover, the trend for linear warming over the last 50 years has been recorded at 0.13°C per decade.

It is likely that the currently observed trend of global warming, which has been + 0.6°C since 1900, will continue and that the average global temperature will increase by between 1.4 and 5.8°C over the period 1990 to 2100 (Houghton et al., 2001). The impact of this type of climate change will probably lead to a decrease in crop productivity, but with important differences between regions (Rosenzweig and Liverman, 1992; McCarthy et al., 2001).

The effects of climate change on crop production can be complex. Depending on the temperature regime and the crop, high temperatures can lead to low yields due to increased development rates and higher respiration (Nonhebel, 1993).

Tomato can be growing under a wide range of temperature; however, fruit set is limited in narrow range, where relatively low or high temperature lead to poor fruit set. The critical factor in tomato fruit setting is the night temperature, the optimal range being 15-20° C (Went, 1945). Fruit set is also low when the average maximal day temperature is

above 32° C and the average minimal night temperature is above 21° C (Moore and Thomas, 1952). The Earth has warmed by 0.7°C on average since1900. Most of the warming since 1950 is due to human activities that have increased greenhouse gases (IPCC, 2001). There has been an increase in heat waves, fewer frosts, warming of the lower atmosphere and Upper Ocean, retreat of glaciers and sea-ice, an average rise in global sea-level of approximately 17cm and increased heavy rainfall in many regions. Many species of plants and animals have changed their location or behavior in ways that provide further evidence of global warming (IPCC, 2001).

Tomatoes are commonly used as a model crop for diverse physiological, cellular, biochemical, molecular and genetic studies because they are easily grown, have a short life cycle and are easy to manipulate (Kinet and Peet, 1997).

A comparison of yield for the different transplanting dates showed that earlier transplanting dates increased yield for all varieties, while there was a significant higher yield for NPT variety than the other three varieties. The moderate rainy season in 2009 gave a significant difference between mulched and non-mulched plots, with higher plant growth for mulched conditions. The rainy season in 2010 reduced the effect of both mulching the soil and irrigation on growth, development, and yield (Lofty, 2011).

The present investigation was imposed to study the impact of climate change on tomato productivity, and to find out the best suitable adaptation option to mitigate the negative impacts of climate change on tomato production.

And validating the Cropsyst model with the field experiment under Egyptian conditions, expect yield of tomato under climate change

conditions by CropSyst (Cropping Systems Simulation) and finally mitigate the negative impacts of climate change on tomato production.

The objectives in this study were: (1) to calibrate CropSyst model on tomato grown at El-Giza governorates using previous field data; (2) To validate CropSyst model for field data experiment on tomato in the same governorate; (3) to determine yield losses under climate change scenario.