# SOIL SOLARIZATION IN RELATION TO FUSARIUM WILT DISEASE OF TOMATO IN EGYPT



By

*MONA ABD EL-MONEM EL-SHAMI*

B. Sc. (Plant Pathology) Ain Shams University 1972

M. Sc. (Plant Pathology) Ain Shams University 1984

**THESIS**

Submitted in Partial Fulfilment of

the requirement for the degree

of

**DOCTOR OF PHILOSOPHY IN AGRICULTURAL SCIENCES**

IN

PLANT PATHOLOGY

Department of Agric. Botany and Plant Pathology

Faculty of Agriculture

Ain Shams University

**1987**

APPROVAL SHEET

Thesis for Ph. D. degree entitled " Soil Solarization in relation to Fusarium Wilt Disease of Tomato in Egypt ".

Approved by :

Prof. Dr. ....L. F. Gamal El Din

Prof. Dr. ...A. H. Yehia...

Prof. Dr. M. M. El Zayat

( Committee in charge )

Date 26 / 7 / 1987 .

بسم الله الرحمن الرحيم

## ACKNOWLEDGEMENT

The author wishes to express her appreciation and deepest gratitude to Prof. Dr. Mohamed Mahmoud El-Zayat, Prof. Dr. W. E. Ashour, Professors of Plant Pathology at the Agric. Botany and Plant Pathology Dept., Fac. of Agric., Ain Shams University and to Prof. Dr. F. A. Fadl, Prof. of Plant Pathology, Pl. Pathol. Institute, Agric. Res. Center for their supervision, valuable help, advice, guidance and encouragement throughout this investigation.

Deep gratitude and appreciations are due to his Excellency Prof. Dr. Y. A. Wally, Vice-Prime Minister and Minister of Agriculture and to Prof. Dr. A. Shehata, Director of the Agricultural Research Center for their great help and support during this investigation.

Sincere thanks are due to Prof. Dr. I. Darrag, Gen. Director of the Agric. Res. Stations, Prof. Dr. A. Arafa, Director of Bahtim Agric. Expt. Sta. and Dr. Dorrya Salem, Assist. Prof. of Pl. Pathol. at Bahtim Agric. Expt. Sta. for their help that made all field work possible.

I wish to thank also Prof. Dr. K. A. Okasha, Prof. of Hort. Crops at the Fac. of Agric., Ain Shams Univ. and Prof. Dr. M. Satour, Prof. of Plant Pathology and Vice Dir. of the Agric. Res. Center for Extension for their valuable discussions and facilities they provide. Thanks are also extended to Dr. T. Abdel Moity and Dr. S. El-Eraki, Assist. Profs. of Pl. Pathol., Pl. Pathology Inst. for the assistance given during the study of soil microflora and nematodes. I wish also to thank Prof. Dr. T. Kutbia, head of the Soil Dept., Fac. of Agric., Ain Shams Univ. for the help given in soil analyses.

Thanks are also extended to all staff members of the Vegetable Dis. Dept., Agric. Res. Center for their technical assistances.

CONTENTS

Page

INTRODUCTION .................................... 1

REVIEW OF LITERATURE .............................. 4

MATERIAL AND METHODS .............................. 42

EXPERIMENTAL RESULTS .............................. 67

I. Isolation and Identification of Tomato Wilt Pathogen .................................. 67

II. The Effect of Temperature on the Fusarium Wilt Pathogen in Vitro ..................... 68

II.a. The range of temperature for linear growth and sporulation of the tomato wilt fungus ............................ 68

II.b. Effect of exposing the Fusarium wilt fungus to high temperature on spore germination and mycelial growth ........ 69

III. The Monitoring of Soil Temperature at Different Depths ............................ 80

III.a. The pattern of soil temperatures at different depths at Bahtim Agric. Exp. Station Farm during the day and normal duration of sunshine ................. 80

III.b. Effect of mulching with transparent, yellow and black polyethylene sheets on soil temperatures throughout three seasons ............................ 84

Page

IV. The Effect of Soil Mulching in Comparison with Soil Fumigation on the Severity of Fusarium Wilt Disease .................... 99

V. Effect of Soil Mulching on Plant Growth .. 112

V.1. Effect on root and shoot length ...... 112

V.2. Effect on fresh weight of the roots and shoots .............................. 117

V.3. Effect on dry weight of roots and shoots 122

V.4. Effect on the yield of tomato fruits.. 125

VI. Effect of Mulching on the Numbers of Soil Microflora .............................. 133

VI.1. Effect on actinomycets ................. 133

VI.2. Effect on bacteria .................... 134

VI.3. Effect on fungi ....................... 134

VI.4. Effect on *Fusarium* spp. ............... 135

VI.5. Effect on nematode population ......... 136

VII. Effect of Mulching and MB Fumigation on the Mechanical and Chemical Structure of Soil.. 142

VIII. Soil Solarization by Focusing Solar collector 145

VIII.1. Effect on soil temperatures ........... 145

VIII.2. Effect on the population densities of *Fusarium* and on disease severity...... 147

DISCUSSION ....................................... 150

ENGLISH SUMMARY .................................. 168

REFERENCES ....................................... 178

ARABIC SUMMARY ...................................

# I N T R O D U C T I O N

# INTRODUCTION

Since the dawn of history, man has been seeking greater control over his environment. During early history, man's ability to manipulate the environment was so limited that poor shelter and unstable food supplies imposed severe constraints on human population. The gradual increase in man's capacity to control and manipulate his environment parallels the gradual rise of civilization. When man began to practice agriculture, he encountered increasingly severe attacks by pests and diseases against his crops. Thus, he lived with local food shortages throughout history. However, even before the causal nature of plant disease was understood, he was able to discover empirical cultural and physical control practices for crop protection. His needs for better methods was intensified during the nineteenth and twentieth centuries because of the appearance of many disease epidemics. Hence, the success in controlling plant diseases with host resistance and the use of chemicals distracted plant pathologists from cultural control (Stevens 1960; Apple, 1977).

However, the nontarget effects of pesticides used in disease control, both inside and outside the agroecosystem, became widely recognized. Also there are risks to humans, to other animals and to the environment generally which their costs are very difficult to evaluate (Fry, 1977). Thus, there seems to be general agreement that chemicals should be used on the basis of a risk-benefit analysis (Sbragia, 1975).

Egyptians learned by experience a long time ago, one important strategy of disease management by reducing the amount of inoculum in the soil from which the disease starts with, thousands of years before the causal organisms were known to man. They used to leave their land bare after the winter crops from mid-May to first of June till they plant the Nili crops at the end of July to mid-August annually when the over-flow of the River Nile was starting. This was known by the Sharaki period, where the land was dried up and its tempera-ture was increased to a maximum of 68 C at some places like Upper Egypt. Increasing soil temperature during the Sharaki period resulted in partial sterilization of soil, thus, redu-ced the inoculum of most soil pathogens. Hence, yield inc-rease of most Nili crops was observed (Prescott, 1919-1920; Shalaby *et al* , 1958, 1959). This situation had stopped after the regulation of irrigation water through the High Dam since 1965, where intensified agriculture has been managed by Egyp-tian farmers throughout the year around and hence, never leave the land bare any more. This was followed by the regulation of increasing of many soil-borne plant pathogens.

During the last few years, this has been taken by scie-ntists and was developed in the Mulching technique to gain the same pasteurizing effect that the Egyptians were having during the Sharaki period throughout their long history.

Solar energy research is now going rapidly in all directions. In the Field of Plant Pathology this could be utilized efficiently in disease management of soilborne plant pathogens especially in Egypt as well as in other Arabian countries. This part of the world is having the biggest amount of solarization reaching the soil throughout the year around. Hence, minimizing the use of chemicals and pollution of environment could be achieved.

This was the goal of this investigation that aimed to investigate the utilization of solar energy in the control of soilborne plant pathogens in Egypt as indicated by the Fusarium wilt of tomato in comparison with soil fumigation.

## R E V I E W   O F   L I T E R A T U R E

# REVIEW OF LITERATURE

## The Causal Pathogen :

The Fusarium wilt of tomatoes (*Lycopersicon esculentum* Mill.) is one of the most important diseases affecting this crop in Egypt as well as in many other parts of the world. The causal pathogen is the soilborne fungus *Fusarium oxysporum* f.sp. *lycopersici* (Sacc.) Snyder & Hansen.

Jones *et al* (1926), and Haymaker (1928) reported that *Fusarium* spp. and *F. oxysporum* f. sp. *lycopersici* were favoured by relatively high soil temperature and the best temperature for growth on PDA was at 28 C.

Fahmi (1930, 1931), was the first to report that *F.lycopersici* is the causal fungus of tomato wilt in Egypt and screened several foreign and local tomato varieties for susceptibility to Fusarium wilt during the seedling and mature stages.

Gaumann and Naef-Roth (1950), found that the average degree of wilting in tomato rose steadily with increasing temperature, being 0.5 at 13 C, 2 at 18.5 C, and 3.5 at 30 C. This increase in toxicity with the rise of temperature was demonstrated to be due to activation of the transformation of lycomerasmin into a lycomerasmin-ion complex ten times more toxic.

Walker (1952), reported that the wilt disease was first recorded in Channel Island few years before 1845. It has been one of the most prevalent and damaging disease of tomato in the USA and many of the warm regions throughout the world. The disease has been extensively studied by many workers concerning etiology and disease symptoms, host-parasite interaction, epidemiology and methods of control.

Ashour (1956), found that the emergence of tomato seeds in soil inoculated by *F. oxysporum* was much lower at 30-33 C.

Oteifa and Ragab (1956) reported that Fusarium wilt disease of tomato was most severe when seedlings were inoculated with *Meloidogyne javanica* nematodes before fungal inoculation. They found that soil treatment with the nematocide DD controlled the wilt disease.

Mostafa and Harhash (1958) reported that the optimum temperature of Fusarium wilt fungus of tomato was 30 C.

El-Helaly *et al.* (1962), reported that the range of temperature for the mycelial growth of *F. oxysporum* was between 10-40 C.

El-Shehri, Nadia (1971), found that the optimum temperature for rate and amount of growth of *F. oxysporum* f.sp. *lycopersici* was 30 C where the maximum was around 40 C.

El-Shami, Mona (1984), found that the maximum mycelial growth and sporulation of the fungus *F. oxysporum* f. sp. *niveum* was at 25 and 30 C, respectively. No growth was recorded at 5 or 40 C.

Pathogenicity and Survival of Causal Pathogen in Soil :

Edgerton and Moreland (1920), Clayton (1923), Wellman (1939), Wellman and Blaisdell (1940, 1941) and Mahmoud, Fatma (1975) reported pathogenic variations among isolates of different origins of the Fusarium wilt fungus.

Gerdeman and Finely (1951), differentiated two races designated 1 and 2, among isolates obtained from naturally and artificially infected tomatoes.

According to Walker (1952), Elliott and Crawford in 1922 in Arkansas and Kendrick in 1944 in California described rare transmission of the wilt fungus of tomato in the seeds. Hence, the chief methods of wide distribution are by transplants, wind-borne soil, surface drainage water, and water-borne soil.

Walker (1952), indicated that in young plants in the greenhouse, two of the earliest symptoms are clearing of the veinlets and drooping of the petioles. In the field the disease may appear at any time that conditions are favourable. Yellowing of the lower leaves appears first, usually affecting the leaflets unilaterally. The affected leaves wilt and