STUDIES ON TOMATO VIRAL DISEASES IN EGYPT

BY

MEDHAT KAMAL NAKHLA

B. Sc., Agric., 1970

THESIS

Submitted in Partial Fulfilment of the
Requirements for the Degree of
Master of Science
in
Plant Pathology

Plant Pathology Department
Faculty of Agriculture
Ain Shams University

1977

The author is greatly indebted to Dr. M.A. Ashour, Professor of Plant Pathology, and Dr. M. El-Hammady, associate Professor of plant virus diseases, Plant Pathology Department, Faculty of Agriculture, Ain Shams University , for their fruitful supervision, guidance and valuable suggestions.

The author wishes to express his deepest gratitude to Dr. H.M. Mazyad, Plant Virologist, Plant Virus Research Section, Ministry of Agriculture, for his sincere help and progressive criticism.

Thanks to all members of Plant Pathology, Department, Faculty of Agriculture, Ain Shams University and all members of Plant Virus Research Section, Ministry of Agriculture, specially Mr. M.A. Tolba, Head of the Section for supplying with all facilities during the investigations.

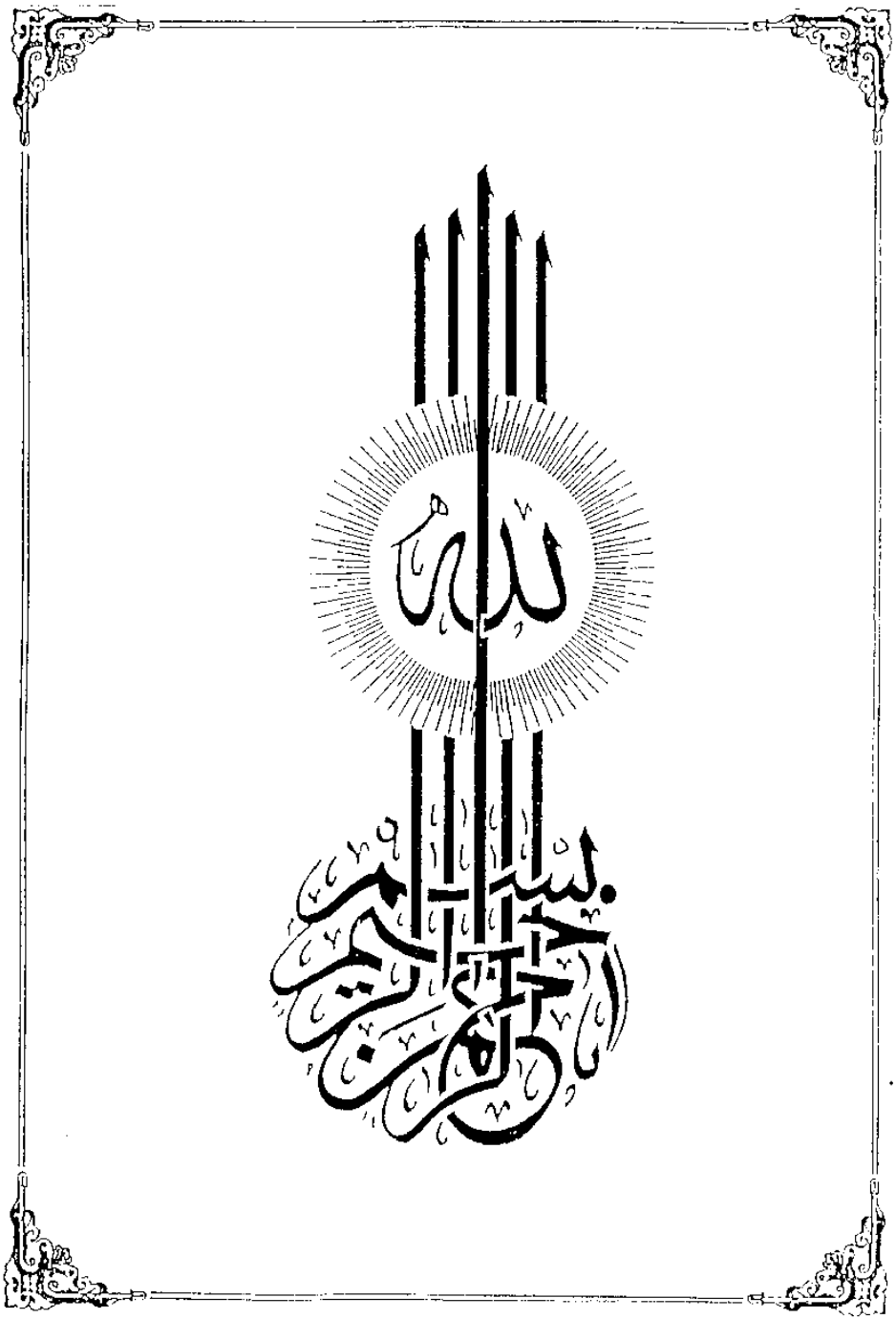

TABLE OF CONTENTS

INTRODUCTION

Tomato (Lycopersicon esculentum Mill., is one of the most important vegetable crops in Egypt. During the last years, the acreage of this crop has rapidly increased with the increasing of local consumption and exportation. It was about 33.000, 73.000 and 247.000 fiddans for the years 1929, 1950 and 1971 respectively.

Virus diseases are considered to be one of the most important problems affecting tomato production in many countries. Tomato plants are known to be susceptible to infection with several viruses and according to Thornberry (1966), about 75 viruses infect this crop.

In the last few years, poor growth and low yield and quality of tomatoes were a common complaint of the growers in Egypt. Although these effects had been attributed by virologists to be due to virus diseases, only very few viruses were isolated and studied.

The present work was designed to : a) isolate and identify some viruses infecting tomato plants under field conditions at different parts in Egypt, b) to study the different

properties of the isolated viruses such as physical properties, host-range and mode of transmission and c. to study the effect of single and mixed infection with the isolated viruses on some morphological characters of infected tomato plants.

summarized as follows :-

Solanaceae :-

Tomato (Lycopersicon esculentum Mill.) .

Johnson (1926) stated that tomato and other solanaceous plants, are generally affected with mosaic disease, namely tobacco mosaic. Kunkell (1932) showed that the virus of aucuba or yellow mosaic (a strain of TMV)produced chlorotic local lesions on leaves of several tomato varieties. Aucuba mosaic virus differs from the ordinary tobacco mosaic in its capacity to produce local lesions in tomatoes. Stover and Vermillion (1933) mentioned that chlorotic areas in leaves of yellow mosaic diseased tomato plants are irregular in shape and much lighter in colour than in ordinary mosaic diseased leaves. Rast (1965) stated that tomato yellow ring spot symptoms were due to infection with a strain of TMV. Roberts (1966) mentioned that TMV is the causal of chlorotic spots and rings on tomato fruits. Sachchidananda (1966) isolated a strain of TMV causing enation and typical shoestring symptoms on tomato plants in the field. Cartia et al . (1969) found an isolate of TMV which caused internal browning of tomato fruits, and induced necrotic lesions on

tomato 4 weeks after sap inoculation. From naturally infected tomato plants, Tu-El Nasr (1970) isolated 4 strains which differed in the severity of symptoms incited on tomato plants. Casarous and Habib (1970) stated that tomato streak virus (a strain of TMV) isolated from tomato plants is characterized by mosaic, mottling, deformation and other abnormalities. Several workers reported on strains produced necrotic ring spots on tomato fruits (Cartia and Catara, 1971; Cristinzio and Ragozzino, 1973). However, Tewari et al. (1973) found that two wild species of tomato, Lycopersicon peruvianum(L.) Mill. and L. hirsutum Mill. were resistant to TMV infection.

Nicotiana species :-

Nicotiana tabacum L.

Tobacco mosaic virus occasionally produces mottling and later vein banding on tobacco (N. tabacum L.) plants (Johnson, 1926, Das and Raychaudhuri, 1952).

However, several necrotic strains were isolated from tobacco, tomato, and pepper plants by different workers (Kunkell, 1932; Komuro et al., 1966; Komuro and Iwaki, 1968; Cartia et al.,1969; Juretic, 1969; Rao and Reddy, 1972). These isolates produced only local necrotic reaction on tobacco.

Datura species :-

All strains of TMV were reported to cause local necrotic reaction or leaves of Datura stramonium (L.) Torr. and D. stromonium (L.) Torr. var. Tatula (Crawford, 1931, Caldwell, 1932, Li and Schmelzer, 1964; Carroll, 1966; Eskerous, 1968, Rao and Reddy, 1972).

Capsicum species :-

Lee and Smith (1966) and Rao and Reddy (1972) reported that TMV produced local necrotic lesions on Capsicum annuum L. and C. frutescence L.. Nazyad (1966) obtained similar result with C. annuum but not with C. frutescence on which mosaic symptoms were observed.

Petunia hybrida Vilm.

Mac Neill (1963) stated that the tomato form of TMV produced local lesions on P.hybrida leaves while the tobacco form caused systemic symptoms. This was in line with results obtained by Komuro et al (1966), Nazyad (1966) and Eskerous (1968).

Other solanaceous species :-

Systemic symptoms were produced on Nicandra physaloides

(L.) mnetn. and Solanum nigrum L. while local necrotic lesions were developed on leaves of Solanum melongena L. after inoculation with TMV (Crawford, 1941; Das and Mayeenuddin, 1962; Kapoor and Sharma, 1965). Potato plants (Solanum tuberosum L.) were found to be susceptible to TMV infection (Johnson, 1926, Boyle, 1964, Liu and Boyle, 1972). On the other hand Nazyad (1966) found that two isolates of TMV induced no reaction with S. tuberosum.

Chenopodiaceae :-

Chenopodium species :-

Several strains of TMV are known to produce local infection on inoculated leaves of C. amaranticolr Coste and Reyn. and C. quinoa L. (Brcak, 1965; Nazyad, 1966; Webb and Foster, 1966; Eskarous, 1968; Cartia et al., 1969; Tomaru et al, 1970 Rao and Reddy, 1972). Systemic infection was observed on C. murale L. Brcak (1965). Webb and Foster (1966) also reported that C. amaranticolor developed necrotic lesions followed by systemic mottle and leaf malformation after inoculation with a strain of TMV which was isolated from muskmelon plants and varied in some respects than the type strain

Spinacea oleracea L.

Infection by TMV did not produce any reaction on this

host (Mazyad, 1966). However, in his book, Smith (1972) reported that S. oleracea is a systemic host to TMV.

Leguminosae :-

Two TMV strains were isolated from cowpea and sunn hemp (cf. Fraenkel-Conrat, 1974). However Vigna sinensis (Torner) Savi. and Pisum sativum L. induced no reaction with two TMV strains (Mazyad, 1966).

Some strains of TMV were reported to induce local lesions on the leaves of some varieties of bean (Phaseolus vulgaris L.) such as pinto bean (Li and Schmelzer, 1964; El-Hammady, 1967) and sudani bean (Mazyad, 1966).

Cucurbitaceae :-

Mc Kinney and Fulton (1949) presented that the capacity for infecting cucumber locally is a rather general property of TMV and its strains. Mazyad (1966) mentioned that Cucumis sativus L.and Cucurbita pepo(Tourn) L. produced no reaction with two strains of TMV. Webb and Foster (1966) found an isolate of TMV on muskmelons with necrotic leaf flecking.

Amaranthaceae, Compositae and Malvaceae :-

Gomphrena globosa L. was reported to be local lesion

host for TMV (Von der Pahlen, 1961; Mazyad, 1966).

In his studies on two strains of TMV, Mazyad (1966) found that Zinnia elegans Jacq. and Gossypium barbadense L. produced no reaction with the two strains while Z. elegans was found to be carier to one strain of them.

Physical properties :-

Thermal inactivation point (TIP):

Several conflicting reports concerning the thermal inactivation point of TMV are available in literature. Temperatures reported started from 50-55°C (Rao and Reddy, 1972) and reached 98°C (Das and Raychaudhuri, 1953; Abu-El Nasr, 1969). In between these two limits, several investigators have reported different temperature ranges at which the strains of TMV loose their infectivity. Thus, the following TIP were reported : 70-72°C(Miller and Thornberry, 1958; Webb and Foster, 1966) 80-90°C (Stover and Vermillion, 1933; Jensen, 1937; Goldin and Vostrova, 1959; Twardowiez - Jakuszowa, 1970), and 90-96°C (Price, 1933; Stover and Vermillion, 1933, Mazyad ,1966).

Dilution end-point (DEP):-

Several workers reported that TMV can still be infective in sap diluted up to 10^{-6} (Capoor, 1962; Webb and Foster, 1966; Eskarous, 1968; Mazyad , 1969; Abu-EL Nasr, 1969 ; Twardowicz-Jakuszowa, 1970). However, other workers found it to be between 10^{-3} and 10^{-4} (Price and Fenne,1951; Rao and Reddy, 1972) and 10^{-4}-10^{-5} (Abu-El Nasr, 1969).

Longevity in vitro (LIV):-

Longevity in vitro of TMV was found to be 2-3 months by Eskarous (1968); 6-12 months by Mazyad (1966) and Twardowicz-Jakuszowa (1970) and 17 months by Webb and Foster (1966) and Abu-El Nasr (1969). Interistinglly enough, Silber and Burk (1965) stated the infictivity of TMV stored for fifty years in extracted unpreserved plant juice.

Transmission :-

The virus is easily transmissible by mechanical means and is known to be one of the most infectious of the plant viruses (Johnson, 1926; Adsuar, 1964; Abu-El Nasr 1969).

The question of seed transmission of tobacco mosaic virus

has been the subject of controversy for many years. TMV was reported to be carried internally in seeds of some plants such as pear and apple (Gilmer and Wilks, 1960) and grape (Gilmer and Kelts, 1960). The occasional infection of young tomato seedlings is probably due to contamination by virus on the surface of freshly extracted seed rather than to virus inside the seed (Nitzany, 1960; Taylor et al., 1961; Nazyad, 1966). However, Broadbent (1965) found that about half the seeds from infected tomato fruits contained the tomato strain of TMV. The virus was carried externally in the testa and endosperm, whereas no virus was found in the embryo.

Another controversial question is that of possible vectors of tobacco mosaic virus. Hoggan (1931 & 1934) reported the transmissibility of TMV by aphids. Teakle and Sylvester (1962) showed that TMV can be transmitted only if the aphids allowed to feed on tobacco leaves sprayed with a concentrated virus suspension. They concluded that such transmission is actively mechanical one. In previous and parallel test with Mayzus persicae Sulz aphids no transmission of TMV to susceptible plants was obtained (Pirone, 1967; Abu-El Nasr, 1969; Rao and Reddy, 1972). However, contrary with this M. persicae was found to be capable to transmit TMV from tomato plants

infected with PVY only and not with PVY and cucumber mosaic virus (CMV) (Lojec and Orlob, 1974).

Serological test :-

Clear positive serological reactions can be detected with PVY strains (Nazyad, 1966; Abu-El Nasr, 1969)