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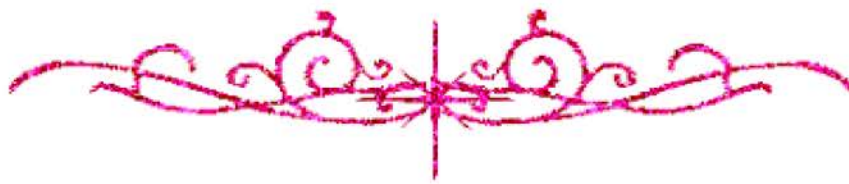
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**STUDIES ON FUNGICIDAL ACQUIRED RESISTANCE
OF ALTERNARIA SOLANI ON TOMATO**

BY

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B. Sc. Agric. SC. (Pesticides)

Cairo University, 1983

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Introduction

The signing of the General Agreement of Tariff and Trade (GATT), is a very good chance for many countries specially countries that have cheap manpower. Egypt is fortunate to be one of the countries that can get many benefits from the GATT.

Since tomatoes can be grown in Egypt the year- round, it can be considered one of the most important export vegetable crops. In 1995, the total area in Egypt cultivated with vegetable crops reached 1, 312, 231 feddans, which yielded 6,361,463, 800 £E (\$ 1,971,018,700). The total area cultivated with tomato in the same year reached 355433 feddans or 27.086 % of the total vegetable area and produced 5,034, 197 tons, which earned 2,517,098,500 £E (\$ 740,323,080) or 39,57 % of the total vegetable income (Anon., 1995).

Tomato is a subject to many diseases which lower the quantity and quality of the yield. Tomato early blight disease caused by *Alternaria solani* is considered one of the most destructive diseases (Hilaal, 1992).

Chemical control is considered the most effective way to control this disease, however, lately the constant use of fungicides has caused many problems. One of the most recent problems to attract attention is the development of strains of different plant pathogens resistant to different fungicides.

Since the fungicides are likely to continue to be the mainstay of the fungal disease management all over the world for the foreseeable future, effective control of plant disease requires effective management of fungicide resistance in the pathogen population (Delp, 1987).

This work aimed to focus the light on the situation of the problem of acquired resistance in the natural populations of *Alternaria solani*, the causal organism of early blight disease of tomato, in the different governorates in Egypt, and the effect of the acquisition of resistance on some of the biological characters of the resistant strains.

Review of Literature

Early blight disease and causal organism.

The first published description of the fungus was in the USA by Ellis and Martin (1882) under the name *Macrosporium solani*. After eight years the disease was recorded in Europe by Soraner (1896). Many years later it was established that *Alternaria solani* is distributed practically all over the world where potatoes and tomatoes are grown. It was the first record for Canada by Mc-Cubbin (1915). Two years later the disease was reported in South America under the name *Alternaria* leaf spot by Rands (1917). In 1923 the disease was reported in India by Paravicini (1923).

The disease was recorded in Egypt for the first time by Briton-Jones (1925). Later the disease attracted increasing attention in Europe and new reports on the fungus in potato and tomato have been published in all the European countries (Richter, 1946).

Chemical control of the disease.

For a long time, ever since the early blight disease was described, many attempts have been made to control this disease. Going through the literature shows, however, that the control of this disease formerly depended entirely upon the use of the copper and dithiocarbamate compounds, nowadays trials continue using newly developed fungicides in addition to conventional fungicides or combinations of them.

Ramakrishnon *et al.* (1971), evaluated different fungicides to control tomato leaf spot disease caused by *A. solani*, they found that 0.15 % Dithane Z.78 and 0.2 % Du-ter suspension were more effective against *A. solani* than 1.0 % Bordeaux mixture. In another study carried out by Farley and Cuero (1974), dithiocarbamate compounds were evaluated with other developed fungicides. Bravo, Difolatan and Dithane M-45 each applied at 1.5 Lb./acre for the first 2 sprays, and 3 Lb./acre for

the third at 7 days intervals controlled early blight in two seasons, however the best control was obtained by using Dithane M-45. This data was confirmed by Sharma *et al* (1976), who found that weekly application of Dithane Z-78, 12 times at 250-300 gal/hect., starting prior to the occurrence of the disease gave good results. Also Stevenson (1977), found that application of captafol and chlorothalonil (the active ingredient of Bravo) fortnightly successfully controlled the disease. Similar data was obtained by Fraire (1978). He found that Daconil (chlorothalonil), Du-ter (fentin hydroxide) and Difolatan (captafol) gave the best results in controlling early blight disease when applied at the beginning of flowering at intervals of 7, 10, or 13 days.

When Khade and Joi (1980) tested 9 fungicides in field plot trials against early blight, he found that all the tested fungicides reduced the disease incidence. However the highest yield was obtained from plants treated with Dithane M-45, blue Cu 50, Cuman L., Dithane Z-78 and Difolatan.

Later Rajagopal and Vidhyarekaran (1986), stated that Difolatan and Dithane M-49 effectively controlled *A. solani*. Dater and Maye (1986) found that Du-ter 0.2 % (fentin hydroxide), and Dithane M-45 were superior to the recommended chemicals and also to ziram and zineb in reducing the severity of *A. solani*.

Other investigators tried to involve some systemic fungicides in early blight disease chemical control programs. As early as 1975, Bavistin and Vitavax captan were tested with other non-systemic fungicides (Polyram. compi and Dithane M-22.) However all the four fungicides showed good control of the disease, Polyram-compi showed slightly better control than the other fungicides (Abol-Wafa and Kamara, 1975). When Ramakishnon and Kendaswamy (1978) evaluated different non-systemic and systemic fungicides regarding control of early blight disease, they found that the most effective and economic control was obtained by Dithane M-45, followed by Benlate (benomyl) and Difolatan.

In a comparison of Copper oxychloride, Dithane M-45 and Benlate in controlling tomato early blight, only Dithane M-45 gave satisfactory results (Alexandri, *et al*, 1982).

In a study on the control of early blight disease carried out by Mohammed (1990), it was found that Polyram-combi at 1-5 g/l or Dithane M-45 at 2.5 g/l gave effective control, whereas Bavistin (carbendazim) at 0.5 g/l and Captan at 2-5 g/l were less effective.

Antibiotics were tested against early blight disease. In field trials, Dorzhkin and Ivanyuk (1982), found that the antibiotics Kasumin and Polymycin, zineb pyrocatechol, and hydroquinone gave best control of early blight disease.

Many investigators controlled early blight disease using mixtures consisting of two or more fungicides. Roding (1979) mixed Fundazol (benomyl) with zineb at the rate of 1:1. He found that a mixture of 3 % reduced infection of tomato with early blight disease to 0-1-5.0 % compared with 0.5-15 % when the fungicides were applied separately. Later in 1983 Potter found that a mixture of Dithane M-45 (mancozeb) + tribasic copper or Bravo 500 (chlorothalonil) reduced the incidence of the disease (c. f. Hilaal, 1992).

Cuprosan 311 super D (30% copper + 10% maneb +10% zineb) Trimiltox fort (20% mancozeb + 21% copper + 6% stimulant additives), Dithane M-45 and Antracol cuivre (5 % propineb) gave the best results in controlling early blight disease (Fadl, *et al.*, 1985). Moeso (1991 tested the same mixtures in addition to single fungicides. He found that Brema (fantin acetate + maneb), Cuprosan 311 super D (30%copper oxychloride + 10%maneb + 10%zineb), Trimelttox fort (21%copper salts +20% mancozeb), Mancozeb, Difolatan, Daconil and Brestan were the most effective fungicides in controlling the disease.

The fungicide resistance problem.

Acquired resistance in fungi to fungicides means, a decrease in the sensitivity of the fungus to one or more fungicides as a result of continuous exposure of the pathogen to the fungicide in question (Mayer, 1969 and Luc and Sung, 1971). Some phytopathologists use the term "tolerance" instead of acquired resistance (Fritzsche, 1967).

The acquired resistance phenomena did not attract the attention of plant pathologists for long time, however, in the last twenty years, the frequency of reports of cases has accelerated. When Moustafa (1980) surveyed the published records on acquired resistance, he found 252 reports of acquired resistance in 78 different pathogenic fungi belonging to different mycological classes i.e. 5 genera belonging to Phycomycetes, 25 genera belonging to Ascomycetes, 8 genera belonging to Basidiomycetes and 40 genera belonging to imperfect fungi.

Sisler (1987) referred this problem to the fact that all fungicides used for plant disease control before 1970, were multisite inhibitors of low biochemical specificity that were limited in their action to surface protection. Fungicides of these groups include inorganic sulfur and copper compounds and organic compounds such as dithiocarbamate, the captan group, chlorothalonil, and dichlone. The need for increased potency and for internal therapeutic action to eradicate established infections led to inhibitors usually characterized by a narrow antifungal spectrum, systemic action, and susceptibility to fungal resistance problems. At that time Eckert (1987) expressed the opinion that, although the resistance has developed at a slower pace in agricultural fungicides, due mainly to the predominant use of nonselective multisite fungicides until the mid-1960s; since then the frequency of fungicide resistance reports has accelerated, paralleling the introduction of new compounds that attack specific biochemical targets in the pathogen. Many of these are systemic fungicides, but the systemic property is not a requirement for resistance development, since