UNIVERSITI PUTRA MALAYSIA

INFECTION AND SOME ASPECTS OF RESISTANCE MECHANISM OF CAPSICUM ANNUUM TO RALSTONIA SOLANACEARUM

MUHAMMED ABDUR RAHMAN

INFECTION AND SOME ASPECTS OF RESISTANCE MECHANISM OF *CAPSICUM ANNUUM* TO *RALSTONIA SOLANACEARUM*

By

MUHAMMED ABDUR RAHMAN

Thesis Submitted in Fulfillment of the Requirements for the Degree of Doctor of Philosophy in the Faculty of Agriculture, Universiti Pertanian Malaysia

March 1997

DEDICATION

To my wife Nasima,

my true friend and companion,

To my aunt Mrs. Khodeza and uncle

Mr. Afzal who brought me up and to

whom I owe everything

I dedicated this work

AKNOWLEDGEMENTS

I wish to acknowledge my sincere appreciation to my chairperson, Associate Professor Dr. Hiryati Abdullah for her guidance and encouragement throughout the period of my graduate studies. Thanks are also extended to Dr. Kamaruzaman Sijam and Dr. Matthieu Abdullah for their critical reading of this manuscript and for serving in my supervisory committee. To Dr. Ithnin Bujang, Department of Biology, UPM, I wish to thank him for providing me the germplasm of chilli collected from AVRDC.

I want to express my sincere gratitude to the Malaysian people for the opportunity to accomplish this goal and the Universiti Pertanian Malaysia for the financial support to carry on my doctoral programme.

Thanks also extended to the laboratory staff and technicians, Mr. Ho Q Kuan and Mrs. Aminah Jusoh, electron microscopy unit, UPM, Mrs. Salmi from Biometry, Mr. Bahrain, photographer of the Faculty of Agriculture and Mr. M. Hamdan Ali and others of the Department of Plant Protection; Faculty of Agriculture.

My special thanks to my wife, Nasima Akhter, and our children, Zerin, Tauhid and Farzana, whose patience, understanding and sacrifice make this study possible.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF ABBREVIATIONS

FAA = Formalin-acetic acid

DPX= Mixture of distrene, tricresyl phosphate & xylene

rpm = Revolution per minute

cfu = Colony forming unit

ml = Milliliter

g = Gram

LSD= Least Significant Difference

FM = Fresh Matter

SEM = Scanning Electron Microscope

TEM = Transmission Electron Microscope

cv. = Cultivar

LC 455 = Long Chilli 455

TZC = Tetrazolium Chloride

CPG = Casamino acid-Peptone Glucose

RCBD = Randomized Complete Block Design

CRD = Complete Randomized Design

MS = Murashige and Skoog

w = Weight

EDAX = Energy Dispersive Analysis of X-rays

Abstract of dissertation submitted to the Senate of Universiti Pertanian Malaysia in fulfillment of the requirements for the degree of Doctor of Philosophy.

INFECTION AND SOME ASPECTS OF RESISTANCE MECHANISM OF *CAPSICUM ANNUUM* TO *RALSTONIA SOLANACEARUM*

by

MUHAMMED ABDUR RAHMAN

March 1997

Chairman: **Assoc. Prof. Hiryati Abdullah, Ph. D.**

Faculty: **Agriculture**

Bacterial wilt of chilli (*Capsicum annuum* L.) caused by *Ralstonia solanacearum* is a major constraint to the production of the crop in Malaysia. To-date very few resistant germplasm of chilli to the pathogen is known. Information on the mechanism of infection and resistance, and multiplication of the pathogen in chilli are lacking. There is also no information on the anatomical characters of the hosts which might be related to resistance. The present study was, therefore, undertaken to obtain this information which would provide an understanding of the disease. It could be useful in formulating wilt-resistance breeding programme in chilli and an effective control measures for the disease.

Greenhouse evaluation of the susceptibility of accessions/cultivars of *Capsicum* spp. to *R. solanacearum* revealed that the cultivar 'Kulai' was highly resistant. Three accessions were moderately resistant while all others were susceptible to highly susceptible.

Anatomical study of resistant and susceptible cultivars showed significant differences in several anatomical characters which may contribute to the limitation of the infection process, movement and multiplication of the pathogen.

Population dynamics of the pathogen in susceptible and resistant cultivars revealed that in susceptible cultivar bacterial population did not differ after inoculation, at all sites tested, regardless of inoculation techniques used. Bacterial population differed significantly between cultivars at similar sites tested and for all the techniques used. Bacterial population in stem, root and soil-inoculated resistant plants decreased significantly at all sites. However, when soil-inoculated, the pathogen was not detected from the mid stem only. Thus, the infection was not limited but the resistance may be due to the lower rate of multiplication of the pathogen in resistant plants.

Root infection and colonization of susceptible chilli cultivar by *R. solanacearum* showed that the pathogen partially degraded the outermost tissues of the longitudinal grooves on root elongation sites and infected the inner cortex, vascular parenchyma and xylem vessels. Simultaneously, bacterial penetration through emerging lateral roots also occurred. Degradation and rupturing of the wall of the xylem vessels was observed

when 75% of the plants showed signs of wilting. Thus, in susceptible chilli, natural openings may cause early infection. Morphological barriers to limit the pathogen spread were absent.

Histopathological investigation of vascular colonization of both cultivars showed several induced responses in resistant cultivar. Cell wall coating material was developed together with swelling of the primary wall of the xylem vessels; formation of various types of vesicles in the xylem cells and the distortion and lysis of the bacteria in the xylem vessels were observed. These reactions were not observed in the susceptible cultivar where bacterial spread was not limited.

Greenhouse and field experiments showed that Ca-containing fertilizers effectively reduced the incidence of bacterial wilt in chilli. Ca nutrition also influenced the growth and multiplication of the pathogen by increasing pH of the growth medium and soil.

Abstrak dissertation yang dikemukan kepada Senat Universiti Pertanian bagi memenuhi keperluan untuk ijazah Doktor falsafah

JANGKITAN DAN BEBERAPA ASPEK MEKANISME RESISTAN *CAPSICUM ANNUUM* KEPADA *RALSTONIA SOLANACEARUM*

by

MOHAMMED ABDUR RAHMAN

Mac 1997

Pengerusi : Prof. Madya Hiryati Abdullah, Ph. D.

Fakulti: Pertanian

Penyakit layu bakteria pada cili (*Capsicum annuum* L.) yang disebabakan oleh *Ralstonia solanacearum*, adalah sekatan utama kepada pengeluaran tanaman ini di Malaysia. Hingga kini, hanya segelintir janaplasma cili yang resistan kepada patogen telah diketahui. Maklumat mengenai mekanisme jangkitan dan keresistanan, dan pembiakan patogen dalam cili sangat berkurangan. Maklumat mengenai ciri-ciri anatomi perumah yang mungkin berkaitan dengan keresistanan juga tiada kedapatan. Kajian ini bertujuan untuk mendapatkan maklumat yang boleh memberi kefahaman mengenai penyakit ini. Ianya berguna dalam program pembiakbakaan untuk keresistanan penyakit layu bakteria pada cili dan suatu cara kawalan yang berkesan bagi penyakit ini.

Penilaian rumah hijau untuk menilai kerentanan jenis/kultivar *Capsicum* spp. kepada *R. solanacearum* menunjukkan bahawa kultivar 'Kulai' adalah