



**UNIVERSITI PUTRA MALAYSIA**

**ETIOLOGY AND CONTROL OF PHYTOPHTHORA  
INFESTANS (MONT. ) DE BARY  
IN MALAYSIA**

**AHMAD KAMIL BIN MOHD YUNUS**

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**ETIOLOGY AND CONTROL OF *PHYTOPHTHORA*  
*INFESTANS* (MONT.) DE BARY  
IN MALAYSIA**

By

**AHMAD KAMIL BIN MOHD YUNUS**

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**AHMAD KAMIL BIN MOHD YUNUS**

**May 1994**

Chairman : Assoc. Prof. Dr. Sariah Meon

Faculty : Agriculture

*Phytophthora infestans* (Mont.) De Bary is the causal agent of late blight disease of tomato, a major destructive disease of tomato in Cameron Highlands. The study undertaken was to isolate the pathogen on artificial media. The morphology and cultural characteristics were described. Disease development of *P. infestans* isolates on tomato was also studied. In-vivo sensitivity of the isolates towards metalaxyl was tested. Disease epidemiology studies were conducted during the two tomato planting periods in Cameron Highlands.



Three isolates of *P. infestans* from Cameron Highlands were isolated on Rye Grain Agar (RGrA), V-8 Juice Agar (V8JA) and Rye wholemeal Agar (RWMA) all amended with antibiotics with percentage recovery of 2%, 0.1% and 0.4% respectively. The *P. infestans* isolates were designated as PIB/01, PIH/01 and PIKR/01. No growth was observed on the two other media viz. Pea Agar and Difco LBA. Successful isolation were aided by baiting using potato tuber slices.

Morphological studies of the *P. infestans* isolate showed that the mean zoosporangia size was  $37.25\mu\text{m} \times 19.71\mu\text{m}$ , mean L/B ratio of 1.91 and mean short pedicel length of  $1.60\mu\text{m}$ . Mean zoospores diameter measured  $9.99\mu\text{m}$ . No chlamydospores was produced in culture.

The isolates required a compatible isolate to form oospores. Direct contact method of pairing the isolates with the known A1 (*P. palmivora* durian isolate) and A2 (*P. palmivora* cocoa isolate) compatible types confirmed that all three *P. infestans* isolates belonged to A1 compatible type.

Cultural studies showed no definite growth pattern of *P. infestans* isolates on all media tested viz. V8JA, LBA,



RGrA and Potato tomato Rye Dextrose Agar (PTRDA). Mycelial growth was optimum between 18 - 22°C. No growth was observed at 30°C. Indirect germination of zoosporangia occurred at low temperature (6° - 15°C), while direct germination by germ tube occurred at 20° - 25°C. Disease development on tomato leaves was highest at relative humidity (RH) in the order 99 > 95 > 90 > 85 > 80 and 75%. Leaf wetness for the duration of 1 hour was needed for isolates to cause tomato late blight infections.

Resistance towards metalaxyl was detected among nine isolates tested. Two isolates were sensitive toward metalaxyl while seven other isolates showed high resistance toward the fungicide. Germination of zoosporangia for resistant isolates were not inhibited by dosages up to 100 ppm of the test fungicide.

Field studies showed that the mean disease severity value for tomato late blight in the second planting period was 44.41% while the first planting period recorded 21.98%. Rainfall distribution was found to be the major factor influencing the tomato late blight disease in Cameron Highlands. Temperature and humidity did not influence the disease progress curve during the two planting periods as both these factors were constant and did not fluctuate



tremendously to cause significant difference in disease severity. Pruning of diseased plant parts and prophylactic spraying of mancozeb significantly reduced the severity of the tomato late blight disease during the two planting periods.





**ETIOLOGI DAN PENGAWALAN *PHYTOPHTHORA*  
*INFESTANS* (MONT.) DE BARY  
DI MALAYSIA**

Oleh

**AHMAD KAMIL BIN MOHD YUNUS**

**May 1994**

Pengerusi : Prof. Madya Dr. Sariah Meon  
Fakulti : Pertanian

*Phytophthora infestans* (Mont.) De Bary adalah penyebab penyakit hawar lewat tomato, penyakit utama tanaman tomato di Cameron Highlands. Kajian dijalankan untuk mengasingkan patogen pada media tiruan. Sifat-sifat morfologi dan kultur telah diterangkan. Perkembangan penyakit oleh isolat pada tanaman tomato seterusnya telah dikaji. Keberkesanan in-vivo isolat-isolat terhadap racun kulat metalaxyl telah diuji. Kajian epidemiologi penyakit hawar telah dijalankan selama 2 tempoh penanaman tomato di ladang, di Cameron Highlands.

Tiga isolat *P. infestans* dari Cameron Highlands telah diasingkan di atas media 'Rye Grain Agar' (RGrA), 'V8-Juice



Agar' (V8JA) dan 'Rye wholemeal Agar' (RWMA), kesemuanya telah diubahsuai dengan antibiotik dengan peratus kejayaan masing-masing 2%, 0.1% dan 0.4%. Isolat-isolat ini telah diberi panggilan PIB/01, PIH/01 dan PIKR/01. Pertumbuhan tidak didapati di atas dua media lain iaitu 'Pea Agar' dan Difco LBA. Kaedah pengumpanan menggunakan kepingan kentang telah berjaya membantu dalam proses pengasingan.

Kajian morfologi isolat *P. infestans* telah menunjukkan purata saiz zoosporangia adalah  $37.25 \mu\text{m} \times 19.71 \mu\text{m}$ , purata nisbah P/L adalah  $19.1 \mu\text{m}$  dan purata panjang pedisel pendek adalah  $1.60 \mu\text{m}$ . Zoospora berdiameter purata  $9.99 \mu\text{m}$ . Tiada klamidospora terbentuk di dalam kultur..

Isolat-isolat memerlukan isolat yang serasi untuk pembentukan oospora. Percantuman isolat *P. infestans* secara sentuhan terus dengan isolat A1 (*P. palmivora* isolat durian) dan A2 (*P. palmivora* isolat koko) telah membuktikan bahawa ketiga-tiga asingan *P. infestans* yang diuji adalah terdiri dari jenis A1.

Kajian kultur menunjukkan bahawa isolat *P. infestans* tidak mempunyai corak pertumbuhan tertentu di atas semua media iaitu V8JA, LBA, RGrA dan Potato Tomato Rye Dextrose Agar (PTRDA). Pertumbuhan miselium adalah optima pada suhu



di antara 18 - 22°C. Tiada pertumbuhan dilihat pada suhu 30°C. Percambahan zoosporangia secara tidak langsung berlaku pada suhu rendah (6 - 15°C), manakala percambahan zoosporangia cara langsung melalui tiub percambahan berlaku pada suhu di antara 20 - 25°C. Perkembangan penyakit paling tinggi pada daun tomato pada kelembapan perbandingan (RH) mengikut aturan 99 > 95 > 90 > 85 > 80 > 75%. Kebasahan daun untuk tempoh selama 1 jam adalah diperlukan untuk isolat *P. infestans* menyebabkan hawar lewat tomato.

Keresistanan terhadap metalaxyl telah dikesan di antara sembilan isolat yang diuji. Dua isolat menunjukkan kepekaan terhadap metalaxyl manakala tujuh isolat menunjukkan keresistanan yang tinggi terhadap racun kulat tersebut. Pada isolat yang resistan percambahan zoosporangium tidak direncatkan oleh racun sehingga kepekatan 100 ppm.

Kajian di ladang menunjukkan purata nilai keterukan penyakit hawar lewat tomato pada tempoh penanaman kedua adalah 44.41% iaitu lebih tinggi berbanding dengan 21.98% yang dicatatkan dalam tempoh penanaman pertama. Taburan hujan didapati faktor utama mempengaruhi jangkitan penyakit hawar lewat tomato di Cameron Highlands. Suhu dan kelembapan tidak mempengaruhi keluk perkembangan penyakit



pada kedua-dua tempoh penanaman kerana faktor-faktor ini adalah tetap dan tidak berubah dengan ketara untuk menyebabkan perbezaan yang bermakna pada keterukan penyakit. Mencantas bahagian pokok yang berpenyakit dan semburan profilaktik dengan racun mancozeb ke atas pokok tomato dapat mengurangkan keterukan penyakit hawar lewat tomato pada kedua-dua tempoh penanaman.

## CHAPTER I

### INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) is cultivated in Cameron Highlands as a vegetable crop. In 1988, 268.8 ha of farms were planted with tomato, with production of 15,170.09 mt (FAMA, 1992). The crop is grown as the sole crop or mixed with other crops. The fruits harvested are for fresh consumption and these highland tomatoes are marketed locally and exported to Singapore markets. In 1988, exports of local fresh tomatoes constitute 6,500 mt and this amounted to RM 1.1 million (FAO, 1988).

One of the major problems faced by tomato growers in Cameron Highlands, Malaysia is the incidence of late blight caused by *Phytophthora infestans* (Mont.) De Bary (Singh, 1980). Though no local records of damages and losses by the fungus on tomato were available, the disease has been accepted by growers to be extremely devastating and cause appreciable losses which vary from season to season. The disease kills the entire plant, if proper control measures were not carried out. The fungus also cause a destructive late blight disease of potato in Cameron Highlands. A survey carried out by the Department of Agriculture, Malaysia in March 1987 showed that tomato late blight was



detected in all the six tomato farms surveyed (Jabatan Pertanian, 1987). Prophylactic spraying of fungicide viz. maneb, mancozeb, benomyl and captafol was carried out to curb this disease. The report noted that the fungicide spraying was stopped one day prior to the harvesting and as such the preharvesting interval of at least fourteen days was not met. This gave rise to the problem of pesticide residue on the fruits harvested.

The enforcement of the Food Regulation under the Food Act, 1985 forced the farmers to be more aware of pesticide residue. However, the farmers claimed that the recommended preharvest interval of 14 days for ethylene-bis-dithiocarbamate (EBDC) fungicides viz. maneb and mancozeb cannot be met or observed. This is because harvesting is done daily for a period of 3 - 4 weeks and thus the Food Act of 1985 is not practical. Further more if they observed the 14 days pre-harvest interval their plants would be badly affected. In view of the seriousness of the situation, some other control measures need to be formulated immediately. However, due to the lack of knowledge on the etiology of the pathogen, pathogenesis and epidemiology, effective control measures of control have yet to be formulated.

Studies on this disease were therefore initiated with the following objectives:

- (1) to isolate and characterise *P. infestans* on artificial media.
- (2) to study the effect of environmental factors on disease development.
- (3) to study the effectiveness of metalaxyl on *P. infestans*.
- (4) to study disease epidemiology by examining the effect of environmental factors on the development of disease.
- (5) to study the effect of pruning of diseased materials and prophylactic fungicide treatments against late blight disease.

## CHAPTER II

### REVIEW OF LITERATURE

#### Occurrence and Economic Importance of Late Blight of Tomato

The late blight disease of potato and tomato caused by *Phytophthora infestans* (Mont.) De Bary is a destructive disease if left unattended. It is believed that the disease is widespread in all tomato and potato growing areas, occurring in cool humid regions, the semi-arid areas of the Mediterranean and the cooler tropical highlands (Walker, 1969; Rotem and Cohen, 1974). The disease distribution documented by CABI in 1982 showed that it was a world wide problem.

Walker (1969) reported that late blight on potato was first recorded at the beginning of 1830 almost simultaneously in Europe and the United States. In 1845 the disease epidemic was widespread throughout Europe and during the same period the disease caused famine in Ireland.





The disease continued to be a major problem in the cool, humid regions of temperate zones. In Europe, the countries surrounding the North Sea are the most frequently affected, while in the United States the areas were located in New England, New York, Pennsylvania and West Virginia. However the disease is not confined to temperate zones as the disease had been recorded in other regions such as semi-arid states of America (Walker, 1969) and Kenya (Cox and Large, 1960). Potato Late blight was also recorded in Malaysia (Shukor, 1989).

Late blight on tomato was first described by Payen in 1947 (Cited by Walker, 1969) and it was confirmed to be caused by the same fungus that attacked potato. The disease was first recorded on tomato in France by Tulasne in 1954 (Cited by Walker 1969). It is believed that the fungus that caused tomato late blight (the tomato strain) arises in nature as a result of serial passage of the strain through tomato foliage (Mills, 1940).

The disease epidemic on tomato caused heavy losses world wide and in United States in 1946 losses amounting to millions of dollars were reported (Walker, 1969). However late blight epidemic on tomato has not been found to coincide with the epidemics on potato.

