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# PRESENT STATUS AND PROSPECTS FOR MANAGEMENT OF LATE BLIGHT IN SRI LANKA

D.B.KELANIYANGODA
*National Plant Quarantine Service, Canada Friendship Road, Katunayake*
and
K.P.SOMACHANDRA
*Regional Agricultural Research and Development Centre, Bandarawela*

## ABSTRACT

**Eleven pathotypes (races) of *Phytophthora infestans* were identified in the up country of Sri Lanka. Distribution pattern of the pathotypes differed with the locations. Results also revealed that the distribution pattern of the pathotypes changed over time. Field survey clearly indicated, that the late blight $A_1$ type was found to be the most prevalent type in the up country of Sri Lanka. $A_2$ type was not very common and was found only on two imported potato varieties cultivated at Regional Agricultural Research and Development Centre, Bandarawela. Cultural practices, such as use of clean seeds, high ridging and removal of ground creepers were found useful in the management of the disease. Fungicide screening was conducted to study the efficacy of recommended fungicides, resistance development and suitable new chemicals. Two resistant varieties, Krushi and Sita have been released for cultivation. Promising lines 34-8 and CIP line 246 with high degree of resistance have been identified and are currently under cultivation.**

**KEYWORDS:** Disease management, Mating types, *Phytophthora infestans*, Potato, Races

## INTRODUCTION

Late blight, caused by *Phytophthora infestans*, is the most important fungal disease of potato. This pathogen originated in Central Mexico, and has spread throughout potato production areas in North and South America, Europe, Africa and Asia. Late blight became important for the first time in the 1840's, when it caused severe epidemics in North America and Europe and resulted in a million people starving to death during the Irish potato famine.

Potato (*Solanum tuberosum*) is a high value crop grown all over the world. World Potato extent in 1996 was estimated at 18.3 million ha. The total area under potato production in CE Europe occupies 43.9% (8 million ha) of the world production area. Asia, with 33.7% of total world production area, is the second. Western Europe follows Asia with 1.6 million hectares. North and Central America are collectively the fourth highest potato producing regions in the world, with 28 million tons on 4.5% of area. The potato area in South America is 0.9 million ha with the production of 12 million tons. Late blight (LB) is one of the major limiting factors in potato production particularly in the cool and moist

climates. In India, losses due to the disease have been recorded by several workers in different parts of the country (Dutt, 1979) as 19-65% in Eastern hills; 11-74% in North -Western hills, 10-75% in Eastern Plains, 20-40% in North-Western plains and 31-39% in Southern hills. In developing countries, yield reduction accounted as about 30% while expenditures for fungicides to control late blight exceeded US$ 600 million per year (Anonymous, 1992). In Sri Lanka, farmers spend about US$ 300-400 during rainy season on fungicides per ha for controlling late blight (Kelaniyangoda, 1996).

The potato varieties commonly grown in Sri Lanka are of European origin. These include Desiree, Kondor, Lyra, Cardinal, Raja, Granola, Sante, *etc.* The local varieties recommended for cultivation are LB resistant Sita and Krushi. About 70% of the total extent is planted with Desiree in the Badulla district. Varieties Desiree, Lyra, Granola Raja and Escort are the commonly cultivated varieties in the Nuwara Eliya district. Several diseases are prevalent in Sri Lanka namely late blight, early blight, bacterial wilt, black leg, soft rot and viral diseases, Potato Leaf Roll Virus (PLRV), Potato Virus Y (PVY), Potato Virus X (PVX) and Potato Virus S (PVS). In addition, there are about fifteen insect pests that are occurring in Sri Lanka.

The objective of this study was to select suitable environmentally friendly management practices to reduce the incidence of LB of potato as well as to identify the pathotype spectrum and mating types present in Sri Lanka.

## MATERIALS AND METHODS

In Sri Lanka, works on identification of races begun as early as 1996. Since then the races have been monitored regularly.

### Isolation of *Phytophthora infestans* races

Leaves from infected potato plants were collected from farmer fields at Sita Eliya, Piduruthalagala, Meepilimana, Uderadella, Boragas, Bandarawela, Rahangala, Liyangahawela, Ballaketuwa and Attampitiya. The collected samples were cultured on Rye Agar (Ribeiro, 1978) in the laboratory at Regional Agricultural Research and Development Centre (RARDC), Bandarawela and kept in the incubator (14 $^{0}$C) until the formation of sporangia. The sporangia were then transferred onto potato tuber slices. The pathotypes were identified on their differentiation according to the method of Black *et al.* (1953).

**Isolation of *Phytophthora infestans* mating types**

Mating types were tested by combining the isolates with the known A1 and A2 types on Rye Agar (Ribeiro, 1978).

**Screening varieties/lines under natural infestation**

Two resistant varieties Krushi and Sita have been released for cultivation about 12 years ago. These varieties are not popular, as they are long aged varieties. Therefore, different potato clones obtained from the International Potato Centre (CIP) have been evaluated against late blight at RARDC, Bandarawela and Agriculture Research Station (ARS), Sita Eliya over 8 seasons (*maha*, 1990 to *maha* 1998) using variety Desiree as susceptible check. The experiment unit was single line of 20 plants/treatment with four replicates. Fertilizer application and pest/diseases control was done as recommended by the Department of Agriculture. The varieties/lines were kept under weed free condition, supplementary irrigation was provided when necessary. Late blight diseases severity was made at weekly intervals starting from the appearance of 1$^{st}$ symptoms using measurement of potato late blight scale (Anonymous, 1984).

**Chemical screening for the control of late blight disease**

Fungicide screening have been conducted for the last 12 years starting from 1988 to 1999/2000 *maha*, to study the efficacy of recommended fungicides, resistance development and suitable new chemicals. Experiments were conducted using different chemicals acquired from chemical companies. Experiments were laid out as 6.5 $m^2$ plots replicated 3 times using the potato variety Desiree (Kelaniyangoda *et.al.*, 1988-1999/2000). Cultural practices and late blight disease assessment were done as described under "Screening varieties/lines under natural infestation".

## RESULTS AND DISCUSSION

**Occurrence of *P. infestans* races**

*Phytophthora infestans* pathotypes (races) were identified in the up country of Sri Lanka. Distribution pattern of pathotypes was different with the locations. The distribution of *Phytophthora infestans* pathotypes spectrum in up country of Sri Lanka is given in table 1.

The most effective method of late blight control lies in developing and cultivation of blight resistant cultivars. However, resistance to LB is not stable. In due course of time the pathogen develop new races, which overcome the host resistance. Therefore the success of resistance breeding programme is essentially dependent on the monitoring of the races.

Increase in race flora and their complexity has been ascribed to;

(I) cultivation of blight resistant cultivars and,
(II) prevalence of congenial weather condition for the late blight over a long period in the crop season.

**Incidence of $A_2$ mating type**

In 1997, a survey was conducted in fields to monitor the presence of metalaxyl resistant genotypes and the $A_2$ mating type, which had not been found previously in the up country of Sri Lanka. Up to now only the old Sri Lankan genotype ($A_1$, metalaxyl sensitive), have been found in the up country of Sri Lanka (table 2). In the same year (1997) imported seed potato varieties cultivated at Regional Agriculture Research Centre showed the presence of both $A_1$ and $A_2$ mating types (table 3). This result revealed the danger of getting seed material from other countries. It may carry $A_2$ types through the seed tuber also. Every country is aware of the risk of importing exotic pest with the introduction of any plant materials. The most dramatic examples are, of course, late blight in Europe during the last century and the $A_2$ mating type more recently (Lozoya, 1999). $A_2$ Type was not very common and was found only in two imported potato varieties cultivated at Regional Agricultural Research and Development Centre, Bandarawela.

**Screening potato varieties/lines for late blight disease**

Different potato clones obtained from CIP has been evaluated at RARDC, Bandarawela and a promising line (CIP 390353.11) with high degree of resistance have been identified from these studies. Babu *et.al* (1999) have tested 18 commercial varieties and 30 CIP lines and 34-8 a progeny from a single tubers family under sprayed and un-sprayed conditions to LB disease at Agricultural Research Station, Sita Eliya during six wet seasons. It was found that the potato

line 34-8 maintained a high level of resistance to LB in both wet and dry weather conditions. Additionally, CIP lines 246, 245 and 251 were selected for further studies.

**Table 1. Occurrence of *Phytophthora infestans* pathotypes spectrum in upcountry of Sri Lanka.**

| *Location* | *Year* | *Pathotypes* |
|---|---|---|
| Sita Eliya | 1996 | 1,2,3,10 |
| | 1998 | 1,2,3,6,7,10,11 |
| Piduruthalagala | 1996 | 3,9 |
| | 1998 | 3,9,10,11 |
| Meepilimana | 1996 | 1,3,6,11 |
| | 1998 | 1.3.6.7.10.11 |
| Uderadella | 1996 | 4,6,9,10,11 |
| | 1998 | 1,3,4,5,9,10,11 |
| Boragas | 1996 | 3,6,7,9,11. |
| | 1998 | 1,2,3,6,7,9,11 |
| Bandarawela | 1996 | 3,6,9 |
| | 1998 | 2,3,4,7,8,9,10,11 |
| Rahangala | 1996 | 1,2,3,4,6,7,9,10,11 |
| | 1998 | 1,2,3,4,5,6,7,8,9,10,11 |
| Liyangahawela | 1996 | 9 |
| | 1998 | 1,2,3,4,6,7,9,11 |
| Ballaketuwa | 1996 | 1, |
| | 1998 | 1,7,11 |
| Attampitiya | 1996 | 2,3 |
| | 1998 | 2,3,10,11 |

**Table 2. Identification of mating types of potato late blight in the up country of Sri Lanka.**

| | *Number of* | | | |
|---|---|---|---|---|
| *Location* | *Fields* | *Samples* | $A_1$ | $A_2$ |
| Liyangahawela | 8 | 25 | + | - |
| Neluwa | 5 | 15 | + | - |
| Attampitiya | 2 | 7 | + | - |
| Halpe | 2 | 8 | + | - |
| Ballaketuwa | 3 | 17 | + | - |
| Boragas | 1 | 5 | + | - |
| Sita Eliya | 2 | 10 | + | - |
| Black Pool | 2 | 7 | + | - |
| Meepilimana | 3 | 12 | + | - |

+ = Presence; - = Absence

**Table 3. *Phytophthora infestans* races found in RARDC, Bandarawela.**

| *Varieties* | *No. of samples* | $A_1$ | $A_2$ |
|---|---|---|---|
| Desiree | 5 | + | - |
| Vineta | 5 | + | - |
| Maranka | 5 | - | + |
| Proventa | 5 | + | - |
| Agria | 4 | - | + |
| Romano | 5 | - | - |
| Collete | 5 | - | - |
| Raja | 5 | - | - |

+ = Presence; - = Absence

Host genetic resistance however, after somewhat underestimated in presently the most significant alternative to help diminish the effect of increasing attention in most breeding programmes. However, the type of resistance in view horizontal resistance is to be perceived as the major component that can be used best within the concept of an integrated approach of disease management.

## Management through chemicals

Fungicides screening have been conducted for the last 12 years (1988-2000) to study the efficacy of recommended fungicides. Fungicides that have been recommended for the controlling LB in Sri Lanka are given in table 4.

Identification of potent fungicides alone will not help unless specific schedules are developed for important potato growing regions keeping in view the level of resistance in a given cultivar. Fungicides spraying schedules were developed based on the seasonal reports of RARDC, Bandarawela (1988-2000) for both susceptible and resistance cultivars. Time of appearance of the disease was taken into account while developing the schedules. In the Badulla district where blight favorable period (*maha* season) is generally limited to 1-2 months, two spray each of systemic fungicides like metalaxyl, oxidixyl or cymoxanil based and, three sprays of contact fungicides as mancozeb, clorothalonil, propineb or maneb based (table 4) are required for controlling the disease on susceptible varieties. However, one spray of both systemic and contact fungicides could manage the disease on resistance cultivars (table 5).

**Table 4. Recommended fungicides to control of LB.**

| *Common name* | *Trade name* | *Mode of action* | *Application rate (g/l)* |
|---|---|---|---|
| Propineb | Antracol | P | 2.5 |
| Clorothalonil | Daconil | P | 1.75 ml/l |
| Maneb | Trimangol | P | 2.5 |
| Maneb | Polyram M | P | 2.5 |
| Mancozeb | Dithane M | P | 2.5 |
| Metiram | Polyram DF | P | 2.5 |
| Metalaxyl +Mancozeb | Ridomil MZ | S*P**E*** | 2.0 |
| Benalaxyl | Galbane | SPE | 2.0 |
| Oxidixyl + Propineb | Fruvit WP | SPE | 2.0 |
| Metiram + Cymoxanil | Aviso DF | SPE | 2.0 |

S* - Systemic; P** - Protective; E*** - Eradicate

**Table 5. Fungicide schedule for late blight management.**

| *Treatment* | *Disease severity %*[1] | | | |
|---|---|---|---|---|
| | *Badulla district* | | *Nuwara Eliya district* | |
| | *Susceptible** | *Resistant*** | *Susceptible* | *Resistant* |
| Control | 100 | 10-20 | 100 | 20-30 |
| Contact fungicides | | | | |
| 1 spray | 60 | 5-10 | 100 | 10-15 |
| 2 sprays | 30-40 | 2-5 | 85 | 5-10 |
| 3 sprays | 10-15 | 0-2 | 60 | 0-5 |
| 4 sprays | 5 | - | 40 | - |
| Systemic + contact fungicides | | | | |
| 1 spray + 1 spray | 50 | 5 | 50-60 | 10 |
| 2 sprays + 3 sprays | 5 | - | 10 | - |

*susceptible cultivar – Desiree; [1]- Disease severity % (Anonymous, 1984); ** resistant cultivar – Sita

Requirement of fungicides for controlling late blight in the Nuwara Eliya where crop is grown under rainfed and irrigated conditions, are substantially high. Susceptible cultivars required a minimum of two sprays of systemic based fungicides with three or more sprays of contact fungicides. In spite of using resistant varieties and chemicals, use of cultural practices plays a major role in reducing the diseases level in the field. Bhattacharya *et al.* (1990) have established that infected tubers are the only source of the disease. Number of infection foci developed in the field was also dependent on the amount of late blight infection in the seed tubers. Tubers at the top of ridge develop more infection than those placed in deep (Arora, 1985). High ridging is therefore advised to avoid tuber infection. Destruction of infected crop residues, crop rotation and avoidance of staggered cultivation are the common cultural practices used to control of LB.

## CONCLUSIONS

Pathotype distribution pattern is dependent on the location and changed over time. Mating type of Phytophthora *infestans* $A_1$ is found to be most distributed type in the up country and $A_2$ type was not common and found on two imported potato varieties cultivated at RARDC, Bandarawela. Late blight disease in potato can be managed effectively through integrating the components such as, cultural practices, application of proper fungicides using appropriate spraying schedules, breeding varieties for disease resistance and use of clean healthy seeds.

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