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Late Blight of Potato and Tomato-Most Weather Dependent Disease and its Rapid Management

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SUMMARY

Potato (*Solanum tuberosum*) and Tomato (*Lycopersicon esculentum* L.) belongs to solanaceous family, are most popular & widely cultivated vegetable crops in the world. The most important and wide spread pathogen of both the crops is *Phytophthora infestans* (Mont.) de Bary causing late blight disease of potato and tomato having capability of highest destruction by infecting the leaves, stems, fruits of tomato and tubers of potato. The disease causes the huge economic losses by destroying economic yield by degradating the quality and quantity. The key factor for this disease development is the weather parameters like humidity, rainfall and temperature. On the edge of disease prevalence the spraying of fungicides becomes the most affective and immediate action as the intensity and severity of this disease is very high.

INTRODUCTION

Potato and tomato having with their great popularity and high nutritive value has become an integral part of daily food intake by every Indian. Although potato is most popular in Asia as well as India, it is not indigenous in Asia mainly introduced in India by Portuguese in 17th century (Mehi L, *et al.*, 2016). The late blight disease was recorded in India for the first time between 1870 and 1880 in the Nilgiri hills (Butler E.J, 1918). Afterwards, appearance of late blight disease is regular feature with high disease severity in hill areas while in plains disease severity is moderate to high level. The reason behind the high severity of late blight disease in India is the favourable weather condition in this country. Maximum and minimum temperatures in the range of 16-20°C and 1-6°C. Similarly, high relative humidity, rainfall 1.5-3.75 mm and wind speed 1-5.5 Km/h, respectively were found advantageous for late blight disease. (Ahmed N, *et al.* 2015). Cloudy weather is favourable for late blight. The cool (12–15°C) and high humidity (>90%) weather with heavy dews or rains alternating with warm (18–20°C) moist period favour for rapid development of disease. Infection and disease development is observed a range of 7.2–26.6°C (Lal M, 2016). It spreads through seed and soil residual material. Seed and soil are important factors in primary inoculums of LB disease. LB disease can induce 100% yield losses under epidemic condition.

Symptoms

In case of potato late bight creates blackish/brown lesions on leaves and stems primarily very small and water soaked but rapidly expand and entire leaf become necrotic. Potato tuber tissue becomes copper brown, reddish or purplish in colour. Sporulation may occur on the surface of infected tubers in storage or on discarded cull piles. Like potato, infected tomato plants may be rapidly infected and destroyed by *P. infestans* and cause similar symptoms on leaves and sometimes attack stems also. Dark brown, firm lesions occur that enlarge and destroy the entire tomato fruit and cause soft rot also (Schumann and Arcy 2000).

Crop Losses Estimation

This disease can spread rapidly during cool, rainy weather, killing plants within a few days and causing total crop loss. Effects on the plant include extensive defoliation, reduced photosynthetic leaf area, loss of plant vigour, plant death, loss of fruits and reproductive capacity, and loss of seeds. As far as Indian scenario is concerned, reduction in potato production due to late blight ranged between 5 and 90% depending upon climatic conditions, with an average of 15% across the country (Collins WW, 2000). However, recently yield loss was reported, overall basis a range of 10–20% due to late blight in the year 2013–2014 major potato growing sites of the India viz., Utar Pradesh, West Bengal, Punjab, Karnataka and Utarakhand (Lal M, Arora RK, 2016).

Weather Factor Responsible for Late Blight Disease Occurrence and Disease Spread

Phytophthora infestans is an oomycete, water mold lower fungus that infects major important vegetables crop like potato and tomato during cool and wet weather preferred by moderate temperatures and high humidity. Temperature and leaf wetness duration periods affect different stages of the life cycle of *P. infestans*. Temperature affects sporulation, infection, lesion expansion rate, inoculum survival, and sporangia germination (Becktell, M. C. *et al*., 2005). Temperature also affects the survival of both sporangia and oospores (Mayton, H et al., 2000). Sporangia germination is also a temperature-driven process: below 15°C, zoospores are formed (indirect germination); whereas above 18°C. Once inside the plant, host colonization and pathogen sporulation are also affected by temperature, and more sporangia form optimally in the range of 18 to 22°C. Not only temperature but also Water, either as vapour or as well as rainfall or fog, plays an important role on late blight development by affecting germination, sporulation, and inoculum survival. Prolonged periods with leaf wetness and/or high relative humidity are required for sporangia germination and infection establishment. Humidity can also affect sporulation and sporangia survival (Minogue and Fry, 1981). Late blight initiation either from sporangia (in dry and high temperature) or from zoospores (in humid and low temperature). Sporangia are formed wide range of temperature (3 to 26°C) and optimum is 18–22°C. The sporangia are germinated by two ways process i.e. indirect and direct germination. It depends mainly on temperature. Indirect germination generally occurs at temperatures of 6 to 15°C (optimum 12°C) by means of sporangia produces zoospores. Direct germination takes place under warm temperature and a range of 4 to 30°C (optimum 25°C). High relative humidity (>90%) is required for spore formation, germination and infection; whereas >80% RH is essential for lesions expansion. Cloudy weather is favourable for late blight. The cool (12–15°C) and high humidity (>90%) weather with heavy dews or rains alternating with warm (18–20°C) moist period favour for rapid development of disease. Infection and disease development is observed a range of 7.2–26.6°C temperature. (Lal M, 2016). Disease development (growth and reproduction of the pathogen) is favoured by moderate temperatures (15°-27°C) and wet conditions. It can develop in very warm daytime temperatures (35°C) if conditions are extremely wet and night temperatures are moderate (15°-24°C). Mycelium of *P. infestans* can tolerate considerable variation of humidity and temperature within the crop host but sporangia are unable to survive temperatures above 25°C for more than 84 hrs (Rotem and Cohen, 1974).

Pathogen Survival

Epidemics can be rapid and devastating because of the high reproductive potential of this pathogen. Individual lesions can produce 100,000 to 300,000 sporangia per day. Each sporangium is capable of initiating a new infection that will become visible within three to four days and produce sporangia within another day or two under optimal conditions. Thus rapid reproduction of the pathogen and destruction of leaflets can defoliate potatoes or tomatoes and completely destroy healthy fields in a short time (Fry, W E., and S. B. Goodwin. 1997). In case of potato the pathogen generally survives on volunteer potato that remains left over in the field

after harvesting and the potato tubers in storage. In the next season the pathogen spreads over through infected seed tuber. In case of tomato pathogen survives through crop debris.

Infection Process

Both sporangia and zoospores can start fresh infection on host plants. Infection by direct germination of sporangia takes longer time as compared to the infection through zoospores. Zoospores remain motile up to 22 h at 5-6°C, whereas at higher temperature (24-25°C), motility decreases to 19 min only (Melhus, 1915). As soon as the zoospores become non-motile, they encyst and adhere firmly to the leaf surface, germinate and infect the host tissues. Germination of zoospores takes place at 3 to 28°C and germ tube elongation occurs most rapidly at about 21°C (Crosier, 1934). Infection usually occurs within 2.5h of inoculation with the zoospores and small necrotic flecks appear within the next 24-48 h.

Connection of Weather Factor and Development of An Epidemic

Temperature between 7 to 27°C is favourable for blight development. Humidity plays a major role in development of an epidemic. Prolonged survival of sporangia requires high RH (Martin, 1923). Development of late blight epidemic is greatly dependent on the presence of free water available from precipitation or dew. Infection cannot occur without free water on the leaf surface. Airborne sporangia rapidly lose their viability in the absence of high humidity and a surrounding film of water. Development of an epidemic is more closely associated with the timing of rain than with total rainfall. Overhead irrigation could also result in outbreaks of this disease (Van Everdingen, 1935).Wind has two opposing effects on the development of an epidemic. In the presence of high moisture the wind help in spreading the disease while at low moisture it retards the disease progress by accelerating the evaporation of surface moisture from the foliage and by drying out of the sporangia.

Management of Late Blight Disease By Using Chemicals

The most rapid and most effective management of late blight disease is use of fungicides as per need. A robust weather forecasting model can give a precautionary measure for using chemicals. A list of fungicide has been provided below:-

Fungicides name	**Common name of the disease**	**Dosage per ha (Formulation g/ml)**	**Dilution in water(Lit./ ha)**	**Waiting period from last application to harvest(in days)**
Azoxystrobin 23% SC	**Late blight**	500 ml	500	3
Mancozeb 75% WP	**Late blight**	1.5-2 kg	750	5-6
Mandipropamid 23.4% SC	**Late blight**	400 ml	500	5
Cyazafamid 34.5% SC	**Late blight**	200 ml	500	3-5
Metiram 55% + Pyraclostrobin 5% WG	**Late blight**	1500-1750 gm	500	5
Mancozeb 40% + Azoxystrobin 7% OS	**Late blight**	1500 gm	500	5
Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC	**Late blight**	0.1% or 1 ml / Litre water	500	5

Cymoxanil8%+ Mancozeb64%WP	**Late blight**	1500gm	500-750	10
Dimethomorph 50% WP		1g/litre	500	4
Dimethomorph 12% + Pyraclostrobin 6.7% WG	**Late blight**	1500 ml	750-1000	-
Metalaxyl 8% +mancozeb 64% WP	**Late blight**	(2g/litre) 1000-1500gm	500-750	14

(Shankar R, Harsha S, Bhandary R, 2014)

Fungicides sources: Directorate of Plant Protection, Quarantine & Storage Central Insecticide Board & Registration Committee N.H.-IV, Faridabad-121001 (UP TO 31.05.2018)

CONCLUSION

Although the history of this disease and its potential loss is very ancient but management of this disease is still a greater problem and thus this disease holds its own role of causing serious devastation in every year in every potato and tomato cultivating field. The reason behind this is the lack of knowledge of weather condition that is the key factor for disease development. Accuracy in weather forecasting and sharing the prediction with farmers can save the crop by applying the fungicides before infection starts in the situation of favourable weather condition.

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