Progressive Agriculture 31 (2): 74-80, 2020 **ISSN: 1017 - 8139**

Progressive Agriculture
Journal homepage:http://www.banglajol.info/index.php/PA

Severity of potato late blight under different weather conditions in Mymensingh region of Bangladesh

MS Monjil*, T Ulfat

Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh.

Abstract

An experiment has been conducted to observed the disease severity of late blight of potato in the different weather parameters viz., air temperature, soil temperature, dew points, percent relative humidity and period of sunshine. The experiment was conducted in the Net-house, Department of Plant Pathology, Bangladesh Agricultural University (BAU), Mymensingh during July 2016 to November 2017. Weather data were collected on daily basis from BAU weather station during the experimental period. A significant role of weather parameters was detected in disease development and disease progress. Temperature was strongly linked with the late blight infection in potato. From 15 December, 2016 to 12 January, 2017 air temperature was ranged from 21.00-23.50°C and soil temperature was ranged from 19.00-22.00°C, and this range late blight incidence was not detected in the potato plant. From 13-14 January air and soil temperature suddenly decreased 2°C and from next day again increased the temperature as well as starting late blight disease symptoms. It was observed that d*ew* point and percent relative humidity have a big role on late blight disease severity of potato. In 13-14 January, 2017 dew point decreased from 14°C to 8°C and Percent RH decreased from 80% to 51%. From 14 January, 2017, disease symptoms were observed in potato leaves and rapidly increased. Thus, late blight of potato disease may respond to the variation of temperature, dew point and relative humidity.

Key words: Weather, temperature, disease severity, late blight, potato

 ***Corresponding Author:** smonjil@yahoo.com

Introduction

Late blight, caused by the Oomycete pathogen *Phytophthora infestans* (Mont.) de Bary, is one of the most important, and major yield–limiting diseases in all potato–growing areas of the world (Fry and Goodwin, 1997). In developing countries, around two and three million hectares (Mha) out of 13 Mha of the world potato cultivated area are affected and the conservative estimates of 15% loss on actual yield and of 25% on attainable yield due to late blight exceed 6.7 to 15 billion dollar losses annually (Haverkort et al., 2009). In Bangladesh, annual potato yield losses due to late blight have been estimated at 25-57% (Ali and Dey, 1994). Due to differences in prevailing weather conditions, its severity varies from region to region.

The pathogen is highly variable and adapt to the newly bred varieties and fungicides. Region wise economic importance of late blight shows that the disease takes highest toll of potato in Sub-Saharan Africa (44% crop losses) followed by South-East Asia (35%) (CIP, 1997). Information on various aspects of late blight has been reviewed by different workers (Fry, 2008; Cooke et al., 2011; Monjil et al., 2015). Application of need-

based effective fungicides for the management of late blight of potato is the key activity in control of late blight of potato (Singh and Bhat, 2003). Outbreak of Late blight of potato appears suddenly within 2-3 days of prevailing favourable condition in Bangladesh and government advises preventive spray to farmers when a late blight infection period is predicted to occur.

Though there are several effective fungicides available in the market. For the management of this devastating disease Bangladesh farmers depend on regular application of fungicides at short intervals throughout the growing season resulting in health and environment hazards. But time of fungicide application is the key factor for late blight management. Farmers indiscriminately apply fungicides due to lack of proper spray schedule for management of the disease.

The degree of control primarily depends on the composition of the local *P. infestans* population, the timing of the fungicide applications, crop development and disease pressure. The efficiency of late blight control can therefore significantly improve by informing farmers, in time, on predicted future infection events (Kessel et al., 2019). Timely forecasting of the disease may result in lesser application of fungicides with effective management of the disease. Due to differences in prevailing weather conditions, its severity varies from region to region. Temperature, relative humidity (%) and precipitation are the key input parameters for developing forecast model (Singh et al., 2000). In Bangladesh, many researchers were worked on climatic variability on major crops and adaptation in agriculture, impact of wind speed, temperature extreme, precipitation on major crop cultivation etc. rather than the link of disease infestation with environmental factors (Rokonuzzaman *et al.*, 2018; Rahman *et al.*, 2019; Haque *et al.*, 2019; Afrin *et al.*, 2018). Forecasting of the disease can greatly help in managing this disease thereby lowering crop losses. Thus, the efficiency of late blight control can be improved considerably by informing farmers in time about predicted infection periods of the potato crop and the effectiveness of past spray applications. Keeping these views in mind, the present study was designed to know the relationship between different weather parameters and the severity of late blight disease of potato.

Materials and Methods

The experiment was conducted in the Net-house and Microbiology and Bio-control Laboratory, Department of Plant Pathology, Bangladesh Agricultural University (BAU), Mymensingh. The experiment was carried out during the period July 2016 to November 2017 following Completely Randomized Design (CRD). Potato Variety, Diamont was selected for the experiment. Apparently good looking, healthy and large potato tubers were collected from market for planting in pot soil.

The soil of the experiment was collected and then sun dried for two days. After that the soil was grounded and large particles and plant debris were removed. Soil was mixed with formalin solution @ 200 ml/cft soil. Then the formaldehyde added soil was covered with polyethylene sheets and kept for 2-3 days. After two days the soil was uncovered to release the gas of formalin. The soil was prepared and poured into perforated plastic pot (22 cm height and 18 cm diameter) at the rate of 3 kg soil per pot.

Disease severity was determined by observing disease symptoms on leaf of potato. The mean values of rating (blight %) were determined to get rating score of the material (Table 1) with some modification of Henfling (1987). Disease severity was calculated by the following formula (Yaganza et al., 2004):

$$\text{Disease severity (\%)} = \frac{\text{Sum of no.of total rating}}{\text{Sum of total ratings} \times \text{maximum grade}} \times 100$$

Disease severity data ware recorded from 15 December, 2016 to 15 February, 2017. Data were collected daily basis, but data were placed in graph for alternate days.

Table 1. The rating score of the material was determined under the following scale.

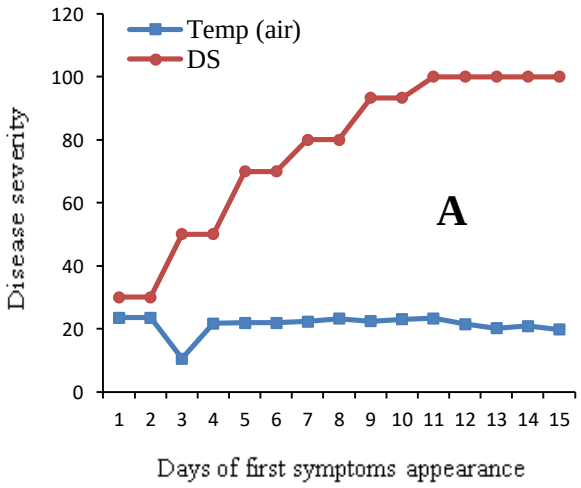
Grade	Description
0	No late blight observable
1	Late blight present. Maximum 10 lesions per plant
2	Foliage affected, not more than 15 leaves are affected
3	Plant looks healthy, but lesions are easily seen at closer distance. Maximum foliage area affected by lesions or destroyed corresponds to more than 20 leaflets
4	Plant looks diseased.15-20% of foliage covered with late blight
5	Late blight easily seen on most plants. About 25% of the foliage is covered with lesions or destroyed
6	All plants are affected. Lower leaves are dead. About half the foliage area is destroyed
7	About 75% of each plant is affected. Leaves of the lower half of plants are destroyed
8	Only top leaves are green. Many stems have large lesions.
9	A few top leaves still have some green areas. Most stem have lesions or are dead
10	All leaves and stems dead

Weather Parameters: Five parameters of weather were considered for this experiment, such as Air Temperature, Soil Temperature, Dew Point, Relative Humidity and Sunshine. Weather data of all parameters were collected from Bangladesh Meteorological Department, Mymensingh Centre.

Results

Effect of weather parameters viz., temperature, dew point, relative humidity and sunshine on disease severity of late blight of potato was estimated by plotting weather data and disease severity data on to the same graph (Figure 1).

***Effect of temperature parameters on disease severity of late blight of potato*:** Daily basis monitoring from tuber sowing to plant maturing stage revealed that temperature had a great effect on late blight disease severity of potato (Figure 1 A & B). A line graph was prepared for observing the relationship between late blight severity and temperature. From 15 December, 2016 to 12 January, 2017 air temperature was ranged from 21.00-23.50°C and this range late blight severity was not detected in the plant. From 13-14 January air temperature suddenly decreased 2°C and from next day again increased the temperature as well as starting late blight disease symptoms. In the similar time period soil temperature was ranged from 19.00-22.00°C and this range no late blight severity was observed in the plant. From 13-14 January soil temperature suddenly decreased 2-3°C and from next day again increased the soil temperature as well as starting late blight disease symptoms. Disease severity rapidly increase afterward and reach 50% by 10 days (by 25 January) and reached to maximum 100% by next 10 days. Therefore, it can be said that temperature fluctuation was one of the important parameter for the late blight disease appearance.



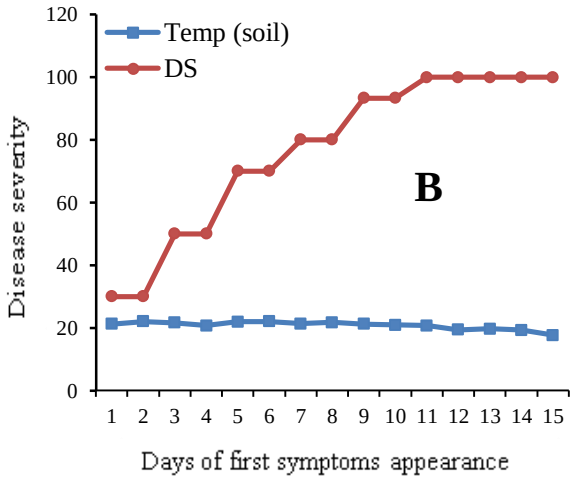
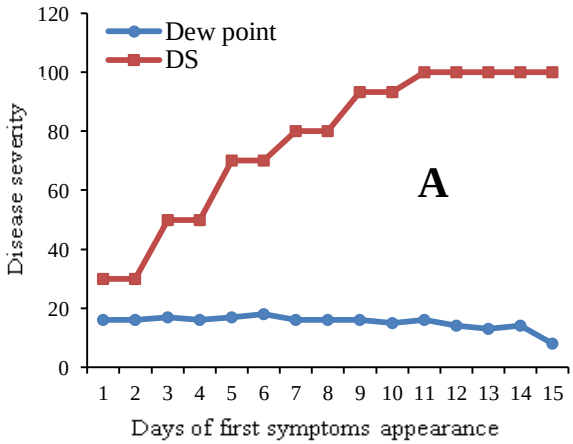


Figure 1. Effect of temperature (air and soil) on disease severity of late blight of potato. In X-axis, data were plotted alternate day like 1 (15 January), 3 (17 January), 5th (19 January) day from 15 January to 14 February, 2017. **A**= Air temperature, **B**=Soil temperature, Temp=Temperature, DS=Disease severity.

***Effect of dew point and Relative humidity on disease severity of late blight of potato*:** In case of dew point, Disease severity was increased while dew point was dropping (Figure 2A). Before 13 January, 2016 late blight symptoms were not appeared in potato plants. From 17 December, 2016 to 12 January, 2017 dew point was ranged from 14-16°C but in 13 January, it decreased to 8°C.



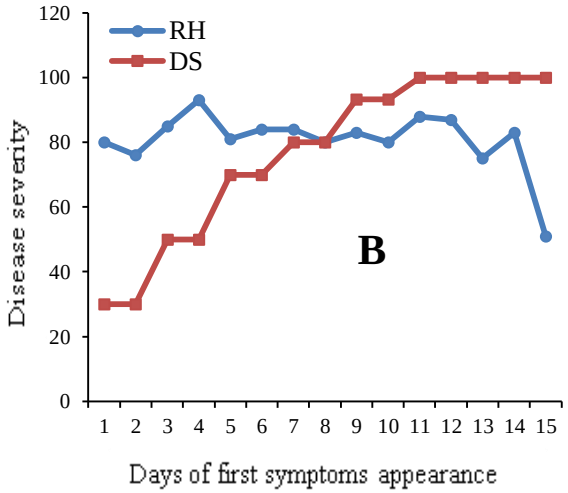


Figure 2. Effect of dew point and relative humidity on disease severity of late blight of potato. In X-axis, data were plotted alternate day like 1 (15 January), 3 (17 January), 5th (19 January) day from 15 January to 14 February, 2017. **A**=Dew point, **B**=Relative humidity, RH=Relative humidity, DS=Disease severity.

From the time late blight disease severity was increased up to maximum at 100% in 4 February, 2017. Relative humidity had a great effect on late blight disease severity of potato (Figure 2B). In case of relative humidity (% RH), most prominent fluctuation was observed. Percent RH was decrease from 80% to 51% in 13 January, 2017. From 14 January, 2017, Disease severity rapidly increased and reached to maximum 100% by next 20 days.

***Effect of sunshine on disease severity of late blight of potato*:** Effect of sunshine on disease severity of late blight of potato were presented in Figure 3. There is no sunshine effect was appeared apparently in potato plants during the study period from December, 2016 to January, 2017. Relationship between sunshine and disease severity was not observed.

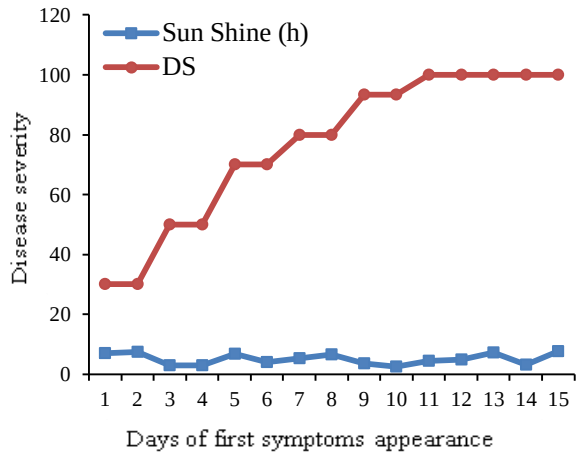


Figure 3. Effect of sunshine (h) on disease severity of late blight of potato. In X-axis, data were plotted alternate day like 1 (15 January), 3 (17 January), 5th (19 January) day from 15 January to 14 February, 2017. DS=Disease Severity.

Discussion

Late blight caused by *Phytophthora infestans* is one of the most dangerous diseases of potato in Bangladesh and cause significant loss in production. The pathogen is highly variable and adapt to the newly bred varieties and fungicides. Relationship between *P. infestans* and the weather is well understood and has been utilized for developing disease forecasting models and decision support systems across the globe. An increasing severity of late blight in many potato growing areas, a shift in pathogen population toward increased specific virulence and an increasing tolerance to the most effective late blight specific fungicides suggests a need to develop an appropriate alternate and eco-friendly disease management strategy.

Temperature had a great effect on late blight disease severity of potato. At the maturity of potato plant air temperature was lowest and disease severity was increased. In case of soil temperature, disease severity was increased rapidly soil temperature was dropping. On the other hand, dew point decreased but disease severity was increased. Relative humidity was started dropping suddenly and disease progress was increased. Sunshine fluctuated a lot and disease severity reached maximum.

Chumann and Arcy (2000) reported that temperature and moisture are the most important environmental factors affecting late blight development. Sporangia germinate directly via a germ tube at 21-26°C and below 18° C, sporangia produce 6 to 8 zoospores which require water for swimming. Although the effects of relative humidity on late blight are not well studied, Minogue and Fry (1981) concluded that there was no significant effect of altered humidity (in a range from 40–88%) on sporangial viability. However, many late blight prediction models, such as SIMCAST and its derivatives, presume a threshold of 90% relative humidity for late blight infection to occur and spread.

Since it has recently been shown that local populations of P. infestans exhibit a high level of adaptation to temperature (Mariette et al., 2016), it is highly likely that modern *P. infestans* isolates have adapted to a wider relative humidity range than the single clonal isolates used by (Minogue and Fry, 1981) and (Harrison and Lowe, 1989). Late blight infections derived from mixed infections influence the genotypes of the competing strains both positively and negatively (Clement et al., 2017) it is highly likely that some strains have adapted to higher or lower humidity conditions. Therefore, we can conclude that temperature, relative humidity and sunshine have combined effect for successful infection and existing temperature prediction might significantly improve their prediction capabilities.

References

Afrin N, Habiba U, Das RR, Auyon ST, Islam MA (2018). Impact and vulnerability assessment on climate change of Jessore and Mymensingh districts in Bangladesh. Progressive Agriculture, 29 (4): 320-335.

Ali MS, Dey TK (1994). Pathological research on tuber rops in Bangladesh. In. Proc. Workshop on Transfer Technology of CDP crops under Research. -Extension. Linkage Programme, held on October, 22-27, pp. 159-165.

Clement JAJ, Magalon H, Glais I, Jacquot E, Andrivon D (2012). To Be or Not to Be Solitary: *Phytophthora infestans* 'Dilemma for Optimizing its Reproductive Fitness in Multiple Infections. PLoS One.7: e37838. pmid: 22675493.

Cooke LR, Schepers HTAM, Hermansen A, Bain RA, Bradshaw NJ, Ritchie F, Shaw DS, Evenhuis A, Kessel GJT, Wander JGN, Andersson B, Hansen JG, Hannukkala A, Naerstad R, Nielsen BJ (2011). Epidemiology and integrated control of potato late blight in Europe. Potato Research. 54: 183-22.

FAO (2015). FAO Statistical Pocketbook, ISBN 978-92-5-108802-9.

Fry W (2008). *Phytophthora infestans*: the plant (and R gene) destroyer. Mol Plant Pathol 9(3): 385-02.

Fry WE, Goodwin SB (1997). R-emergence of potato and tomato late blight in the United States. Plant Disease. 81(12):1349-1357.

Haque MM, Islam MA, Auyon ST, Rahman MA, Marzia S (2019). Adaptation practices of climate change in agriculture by the farmers of Phulbari upazila of Kurigram district in Bangladesh. Progressive Agriculture, 30 (3): 253-262.

Harrison JG, Lowe R (1989). Effects of humidity and air speed on sporulation of *Phytophthora infestans* on potato leaves. Plant Pathol. 38: 585-591.

Hashem M, Abo-Elyousr KA (2011). Management of the root-knot nematode *Meloidogyne incognita* on tomato with combinations of different biocontrol organisms. Crop Protection 30: 285-292.

Haverkort AJ, Struik PC, Visser RGF, Jacobsen E (2009). Applied biotechnology to combat late blight in potato caused by *Phytophthora infestans*. Potato Res. 52: 249-264.

Henfling JW (1987). Late Blight of potato *Phytopthora infestans*. International Potato Center (CIP), Lima, Peru. Technical information bulatin 4.

Kessel G, Islam M, Maroof M, Mukul M, Syed A, De Vries M, Moene A, Hengsdijk H (2019). Geodata for the control of potato late blight in Bangladesh Seventeenth Euroblight Workshop York-United Kingdom, WUR-Special Report No. 19; 57-62.

Mariette N, Mabon R, Corbière F, Boulard I, Glais B, Marquer B (2016). Phenotypic and genotypic changes in French populations of *Phytophthora infestans*: are invasive clones the most aggressive? Plant Pathol. 65: 577-586.

Mariette N, Mabon R, Corbière R, Boulard F, Glais I, Marquer B, Pasco C, Montarry J, Andrivon D (2016). Phenotypic and genotypic changes in French populations of *Phytophthora infestans*: are invasive clones the most aggressive? Plant Pathol, 65: 577-586. doi:10.1111/ppa.12441

Minogue KP, Fry WE (1981). Effect of temperature, relative humidity, and rehydration rate on germination of dried sporangia of *Phytophthora infestans*. Phytopathology. pp. 1181-1184.

Monjil MS, Nozawa T, Shibata Y, Takemoto D, Ojika M, Kawakita K (2015). Methanol extract of mycelia from *Phytophthora infestans*-induced resistance in potato. Comptes Rendus Biologies. C. R. Biologies 338: 185-196.

Rahim M, Anowar MM, Begum KS, Monjil MS (2016). Management of insect pest and diseases of vegetable crops in Bangladesh (Bengali). USAID/Agro-inputs project (AIP) and agro-input retailer's networks (AIRN).

Rahman MA, Yeasmin M, Islam MA, Farukh MA (2019). An Empirical Study on Predicting the Wind Speed after Landfall of Tropical Cyclones Over Bay of Bengal. *International* Journal of Scientific Research in Science and Technology (IJSRST), 5(4): 1-11

Rokonuzzaman M, Rahman MA, Yeasmin M, Islam MA (2018). Relationship between precipitation

and rice production in Rangpur district. Progressive Agriculture, 29(1): 10-21.

Singh BP, Ahamd I, Sharma VC, Shekhawat GS (2000). JHULSACAST: a computerized forecast of potato late blight in Western Uttar Pradesh. J Indian Potato Assoc., 27(1-2): 25-34.

Wardad Y (2018). Geopotato project to save potato from late blight disease. The Financial Express. Retrieved from https://www.thefinancialexpress.com.bd/trade/geopotato-project-to-save-potato-from-late-blight-disease-1517721202.

Yaganza ES, Arul J, Tweddell RJ (2004). Effect of pre-storage application of different organic and inorganic salts on stored potato quality. Potato Research 46: 167-178.