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Research Article

Impact of Environmental Variables on Late Blight Pathogen against Potato Cultivars under Rawalakot Conditions Azad Jammu and Kashmir

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Abstract
Study was designed to evaluate the effect of weather parameters on late blight of potato. Four potato varieties, Lady Rosetta, Hermis, Racco and Kuroda were grown in the first week of April. Experiment was laid in pot experiment in open air with RCBD with four replications. Disease incidence and severity were recorded. Maximum 100% disease incidence was recorded on Racco and Kuroda while Lady Rosetta and Hermis showed 50 and 85% respectively. Maximum disease severity was found on Kuroda with 80.5% foliage covering while minimum 37% disease severity was shown by Lady Rosetta. Temperature, relative humidity and rainfall averages determined the disease severity which influenced the late blight dispersal and disease progress with average temperature (21.45 ˚C), relative humidity (43.45%) and a total rainfall of 126 mm in the whole experimental period.

Keywords: Late blight; Potato; Severity; Incidence.

Introduction
Potato (*Solanum tuberosum* L.) is one of the most important crops grown throughout the world. It is a good source of carbohydrates and provides essential vitaminsand minerals to human body. It is third most important crop in term of production and consumption after rice and wheat throughout the world (Anwar *et al*., 2015). Worldwide the production of potato was 381.7 million tons in an area of 19.1 million hectares during 2014 while in Pakistan the production in the same period was 2.9 million tons in an area of 0.15 million hectares (FAOSTAT, 2017). There are numerous biotic and abiotic factors that affect the yield of potato in the country. The prevailing abiotic factors limiting potato production in Pakistan includes climatic change in terms of temperature, humidity, costly fertilizers, lack of irrigation facility, rain fall, and drought while the biotic factors include fungal, bacterial, viral and nematode diseases that affect potato growth and production (Majeed *et al.*, 2017). Among them biotic challenges like soil borne root-knot nematodes which are found frequently in Azad Jammu and Kashmir (Tariq Khan, 2018; Tariq-Khan *et al.*, 2020c; Tariq-Khan *et al.*, 2020b; Tariq-Khan *et al.*, 2017; Tariq-Khan *et al.*,

2020a), cyst and other free living nematodes are of prime importance. Foliar diseases are late (Mahmood *et al.*, 2022) and early blight (Bashir *et al.*, 2020).

Phytophthora infestans (Mont.) de Barry is one highly destructive pathogen as cause late blight on potato and tomato causing 16% yield losses globally (Haverkort *et al.*, 2009). In Pakistan the losses in yield were 50-70% due to unfavorable conditions (Haq *et al.*, 2008). High relative humidity and low temperature favoring late blight which leads to the high infectivity to entire foliage (Iglesias *et al.*, 2010). Temperature range of 10-24 ˚C and 80% relative humidity (RH) above with cloudy days are favorable conditions for appearance of the disease (Bhat and Singh, 2008). Present study was designed and conducted in farm area of Faculty of Agriculture, University of Poonch, Rawalakot Azad Jammu and Kashmir during spring 2017 to evaluate infection pressure of *P. infestans* on leading varieties of potato under natural Rawalakot conditions.

Methodology

Potato leading cultivars/varieties Lady Rosetta, Hermis, Racco and kuroda were evaluated for their reaction and performance against late blight in natural conditions. Germplasm was sown in field with four replications. Standard procedure for land cultivation was opted with fertilizer recommendations. No any preventive fungicidal spray was done to allow the pathogen for its maximum potential to flourish. The disease progress was continuously monitored till the crop maturity up to 110 days from the date of sowing. Disease severity and disease incidence were documented at weekly basis after three weeks sowing. Meteorological data were collected on daily basis from Rawalakot meteorological station. Data on disease incidence and disease severity were determined by the following formulas (Singha *et al.*, 2014).

$$\text{Per cent disease incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \times 100$$

$$\text{Per cent disease severity} = \frac{\text{Sum of all disease ratings}}{\text{Total number of ratings} \times \text{Maximum disease grade}} \times 100$$

The disease severity was recorded on weekly basis using 0-9 scale after prevalence of disease to end of season (Henfling, 1987). Where 0 indicated no disease and 9 indicate all leaves and stem were dead due to infection.

Result and Discussion

Average temperature for the whole study time was 22 ˚C and average RH was 29.14% after drizzle showers (44 mm and 1 mm in 1st week and 2nd week of June respectively) initial disease incidence was recorded 8.33 and 11.6 percent with disease severity 7.4 and 9.6percent for Racco and Kuroda varieties respectively, in 2nd week of June 2017 (Table 1). The maximum 100% disease incidence and 74.0% severity occurred in 3rd week of July 2017 (Kuroda). The Initial disease incidence was 6.66 with 3.7 disease severity was recorded on Hermis in 3rd week of June 2017 when average temperature was 19.75 ˚C and average 51.42% RH while for Lady-Rosetta it was 5% with 2.96% disease severity in 4th week of June 2017 at 22.25 ˚C and 49.71% average RH. The maximum 100% disease incidence with 77.8% and 80.5% disease severity were recorded for Racco and Kuroda varieties respectively in 4th week of July 2017 at 25 ˚C temperature on 66.7% average RH. The maximum disease incidence 50% and 85% and disease severity 37% and 67.4% were recorded for Lady Rosetta and Hermis respectively, in 4th week of July 2017 when average temperature was 25 ˚C and 66.7% average RH. The results indicated that Lady rosetta showed resistance against late blight of potato followed by Hermis variety while Kuroda variety showed least resistance against late blight of potato under field conditions of Rawalakot Azad Jammu and Kashmir.

Table 1. Effect of climatic parameters on disease incidence and severity of potato during season 2016.

Month	Week	Min-Max. Temp (0 ˚C)	Av. Temp (0 ˚C)	Av. RH (%)	Rainfall (mm)	Disease incidence (%)				Disease severity (%)			
						V1*	V2**	V3***	V4****	V1	V2	V3	4
MAY 17	1st week	13-20.5	16.75	38.3	7	0	0	0	0	0	0	0	0
	2nd week	19-21	20	35.1	0	0	0	0	0	0	0	0	0
	3rd week	17-20.5	18.75	37.5	13	0	0	0	0	0	0	0	0
	4th week	18-23	20.5	28.4	1	0	0	0	0	0	0	0	0
JUN 17	1st week	17-24	20.5	27.7	44	0	0	0	0	0	0	0	0
	2nd week	19-25	22	29.1	1	0	0	8.33	11.6	0	0	7.4	9.6
	3rd week	16-23.5	19.75	51.4	20	0	6.66	15	25	0	3.7	10.4	14.8
	4th week	19.5-25	22.25	49.7	2	5	13.3	26.7	41.7	2.96	9.6	16.3	29.6
JUL 17	1st week	21-25.5	23.25	43.1	1	15	30	46.7	63.3	10.3	22.2	35.5	50.2
	2nd week	22-26.5	24.25	57.5	23	23.33	43.3	66.67	83.3	18.5	37.0	55.5	62.9
	3rd week	23.5-25.5	24.5	56.5	7	36.7	70	91.7	100	25.9	56.2	66.7	74.0
	4th week	23-27	25	66.7	7	50	85	100	100	37.0	67.4	77.8	80.5

V1*= Lady rosetta, V2**= Hermis, V3***= Racco, V4****= kuroda

Late blight is important constraint to potato crop throughout the world, as crop destructor and yield reducer. Effective management is only possible to know the best time of its appearance and the circumstances prevailed during disease spread. Monitoring the epidemiological factor can enable us to find out the best strategy to control the disease and reduce yield losses. Present study was focused with two aspect, first to know the disease natural spread in the temperate hilly areas of Azad Jammu and Kashmir when there is active inoculum and second the evaluation of the germplasm for their ability to withstand with the pathogen virulence. Temperature, relative humidity (RH), and rain fall are key factors that determine the incidence of late blight on potato. In the present study the disease incidence increased with the higher humidity and rain fall (Table 1) which is normal process in the case of fungal like organisms like oomycetes. The first infection was noticed with started of drizzling showers in the first and second week of June resulting in increased humidity and increase in infection rate. These results are in line with studied effects of different weather parameter on late blight disease of potato (Singha *et al*., 2014). Their results showed that with the increase in relative humidity and rainfall influenced disease incidence and its severity by increase in fungal sporulation at temperature 16-22˚C and 90% RH. In present study, disease severity was higher at high rainfall and low temperature, clarifying that low temperature and high rainfall favored disease. Low temperature and high rain fall increase disease incidence and severity (Ahmed *et al.*, 2015). The two varieties Kuroda and Racco are highly susceptible to late blight as compared to Lady-Rosetta and Hermis. This showed that the Lady Rosetta and Hermis variety show some resistance towards late blight. The study concluded that the late blight pathogen is increasing changing in behaviour and now is aggressive even at high temperatures provided with high relative humidity as reported in this case. The selection of germplasm for resistance along with high yield can be an excellent part of work that can result in successful sustainable potato production.

Conflict of Interest

The authors have not declared any conflict of interest.

Authors Contributions

All the authors have contributed equally to the research and compiling the data as well as editing the manuscript.

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