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Short Communication

Influence of weather parameters on development of leaf roll disease in potato (*Solanum tuberosum* L.)

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Potatoes are subject to plentiful abiotic (e.g. temperature and moisture) and biotic (plant diseases and pests) perils that affect the crop's production sustainability and yield. Besides direct yield reduction, pests indirectly affect yield by the transmission of viral diseases. Virus infection was recognized as the cause in the early twentieth century. Viral diseases such as *Potato virus Y* (PVY) (family *Potyviridae*, genus *Potyvirus*) and *Potato leafroll virus* (PLRV) (family *Luteoviridae*, genus *Polerovirus*) that infect cultivated potatoes and are both chief causes of low yield. PLRV has positive sense, ssRNA as its genome.

Potato leafroll virus is identified as one of the most notorious aphid-transmitted viruses. Aphids transmit PLRV to potatoes in a persistent circulative but non-propagative manner and mechanical transmission is not possible (Ragsdale *et al*., 2001). PLRV can be transmitted to potato plants by the common potato aphid (*Macrosiphum euphorbiae* Thomas) and eleven other species.

Weather conditions plays significant role in aphid population build up which further can elevate the virus transmission. Therefore, realizing the significance of plant virus epidemiology and subsequent losses caused by them, the present study reports the influence of weather parameters on the development and spread of potato leafroll disease.

Experimental details and observation

A field experiment was conducted during November to February of *rabi*, 2020-21 and *rabi*, 2021-22 at Plant Pathological Research Farm, B. A. College of Agriculture, Anand Agricultural University, Anand to reveal the impact of weather parameters on the progression of potato leafroll disease. Kufri Lauvkar, a highly susceptible variety was used in the experiment. The standard method was followed to raise the crop. No plant protection measures were applied against any disease. Plot area 10 × 10 m was equally divided into four quadrates and ten plants from each quadrate was selected randomly and labelled for recording the data.

The disease incidence in the field was recorded after germination of tubers at seven days interval following Standard Meteorological Week (SMW) up to harvest and correlated with weather parameters to determine the role of weather variables in the development of the potato leafroll disease. *Potato leafroll virus* is transmitted by many aphid species but *Aphis gossypii* was the vector in this study. Aphid population plays vital role in disease progression. The population of aphids in the field on the forty randomly selected plants was counted after germination of tubers at seven days interval following Standard Meteorological Week (SMW) up to harvest. The population of aphids (nymphs + adults) on plants was counted from three leaves (upper, middle and lower). Per cent disease incidence was calculated as per the following formula.

$$\text{Disease incidence (\%)} = \frac{\text{Number of diseased plants}}{\text{Total number of plants}} \times 100$$

The data on weather parameters from December, 2020 to February, 2021 and December, 2021 to February, 2022 were obtained from Department of Agricultural Meteorology, Anand Agricultural University, AAU, Anand.

The per cent disease incidence was correlated with (temperature, relative humidity, bright sunshine hour, rainfall, wind speed and evapotranspiration), to determine the role of weather variables in the development of PLRV epidemic. The disease incidence was also correlated with the aphid population.

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Table 1: Effect of weather parameters on PLRV disease incidence and aphid vectors in potato during *rabi*, 2020-21 and *rabi*, 2021-22

Rabi, 2020-21						*Rabi*, 2021-22					
SMW	PDI (%)	Increase in PDI	No. of aphids/3 leaves	Weather parameters	Correlation coefficient 'r' value	SMW	PDI (%)	Increase in PDI	No. of aphids/3 leaves	Weather parameters	Correlation coefficient 'r' value
50	0.0	0.0	0.00	No. of aphids	0.76**	49	0.0	0.0	0.00	No. of aphids	0.88**
51	5.0	5.0	0.46	Max. temp.	0.79**	50	0.0	0.0	0.00	Max. temp.	0.43
52	17.5	12.5	1.36	Min. temp.	-0.35	51	7.5	7.5	0.64	Min. temp.	-0.45
1	25.0	7.5	2.68	RH_1	-0.30	52	15.0	7.5	1.10	RH_1	0.12
2	37.5	12.5	4.52	RH_2	-0.78**	1	25.0	10.0	5.16	RH_2	-0.73*
3	52.5	15.0	8.32	BSS	0.64*	2	42.5	17.5	3.50	BSS	0.75**
4	67.5	15.0	6.67	Rainfall	-0.47	3	55.0	12.5	9.22	Rainfall	-0.42
5	85.0	17.5	8.92	Evaporation	0.88**	4	70.0	15.0	7.53	Evaporation	0.69*
6	92.5	7.5	6.53	Wind Speed	-0.52	5	82.5	12.5	9.65	Wind Speed	-0.47
7	95.0	2.5	5.02			6	90.0	7.5	8.17		
8	95.0	0.0	4.23			7	90.0	0.0	6.16		

SMW: Standard Meteorological Week; *Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed)

Progressive disease development

During crop season 2020-21 the disease was first appeared on 52nd SMW. The observations were recorded from the 53rd SMW. The first appearance of potato leafroll disease and its aphid vector was noticed at 25 DAS and it progressed from there (Table 1). The disease progressed slowly at first, but it reached its peak during the 7th SMW of 2021 (95%), which occurred in February month. The maximum increase in PDI was recorded during 5th SMW then after it was decreasing and completely halt at 8th SMW. During 2020-21, the disease was first observed at 51st SMW. Observations were recorded at weekly intervals from the 52nd SMW. The potato leafroll disease and its aphid vector was first spotted at 33 DAS and since then disease has progressed (Table 1). The disease incidence was modest at initially, but peaked in February of 2022, during the 6th SMW (90%). The maximum progress in PDI was recorded during the 2nd SMW and completely halt at 7th SMW.

During both the years highly significant positive correlation of aphid population and percent disease incidence (PDI). The PDI was positively correlated with maximum temperature, bright sunshine hours and evaporation. There was significant negative correlation with evening relative humidity in both the years (Table 1).

Iftikhar *et al.* (2020), observed significant association of disease severity with temperature (max and min) and relative humidity (RH) in susceptible varieties. The disease was most severe in the areas with the most aphids. They reported that aphid population was highly significant and positively correlated with PLRV incidence. According to Chung *et al.* (2016) within a temperature range of 10-20 °C, infection by PLRV increased with rising plant temperature in *Nicotiana benthamiana* L. and *P. floridana* L., respectively. When *P. floridana* L. plants were kept at 25 °C, the greatest number of them became infected with PLRV and the highest titer of PLRV was seen in *P. floridana* L. maintained at 20-25 °C. Chung *et al.* (2017) reported that increased PLRV RNA accumulation and higher numbers of PLRV-infected *S. tuberosum* L. plants under conditions of high temperature (30±2 °C) which was corroborated with results of this experiment as maximum temperature, bright sunshine hours and evaporation was positively correlated with PLRV incidence. Dar *et al.* (2021) had reported that the maximum and minimum temperature, relative humidity, rainfall and wind speed appeared to be most significant factors in the potato late blight disease development. Kumar and Gupta (2016) reported that the maximum and minimum temperatures had positive correlations with whitefly population causing potato apical leaf curl virus disease while RH2 had negative correlation.

In numerous plant species, the onset of viral disease symptoms was delayed at low temperatures. At a higher temperature, virus resistance was suppressed in plants. Increasing heat stress and mean temperature enhanced plant vulnerability to virus infection, reducing the efficiency of temperature-sensitive single-gene resistance. Individual viruses present in mixed infections vary their replication, seed transmission and systemic movement when the temperature rises. (Jones and Barbetti, 2012). The soft delicate leaves and lush plant development that develop under situations of high relative humidity aid virus dissemination in crops. In comparison to hard-leaved plants in low-humidity circumstances, these plants are more susceptible to viral infection. This is due to the fact that wounds form more easily when growth is soft and viruses must first enter a plant's protective cuticle through wounds before invading damaged cells. (Jones, 2016). The least and most extreme air temperature and wind speed had a strong link with extreme PVY, PLRV and PVX infection; however, relative humidity and precipitation had a negative relationship with disease incidence (Mubeen *et al*., 2020).

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