

JP- Plant Pathology

Relationship of Environmental Conditions with the Development of Viral Diseases on Two Genotypes of Potato

Rajesh Kumar*, L.P. Awasthi, N.K. Sharma and S.K. Singh

Department of Plant Pathology, N.D.U.A.T., Kumarganj, Faizabad

Article Info	Summary
Article History Received : 16-05-2011 Revised : 02-08-2011 Accepted : 02-08-2011 *Corresponding Author Tel : 05270262012 Email: lpawasthi@sifymail.com	Two genotypes viz. Kufri Ashoka and Kufri Chipsona-1 were selected to study the relationship of environmental conditions (maximum and minimum temperature, relative humidity and rainfall) with viral disease(s) of potato. Maximum disease intensity (80.5, 82.70% and 10.20,12.45%) was recorded in fourth week of January during 2008-09 and 2009-10 in Kufri Ashoka and Kufri Chipsona-1, respectively. Disease was favoured by minimum temperature from 7.3 to 10.3 °C and maximum temperature 27.1 to 23.3 °C along with minimum relative humidity 53.80 to 51.20% and maximum relative humidity 93.6 to 92.7% during 2008-09, while in the year 2009-10 minimum temperature ranged 4.8 to 7.6 °C, maximum temperature 23.42 to 17.0 °C along with minimum relative humidity 45.85 to 71.57% and maximum relative humidity from 87.71 to 90.71%, respectively, during the period of maximum disease development.
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Introduction

Potato (*Solanum tuberosum* L.) occupies a prominent position among the vegetable crops consumed by human beings due to high production, good nutritional value and better quality of the starch. In Uttar Pradesh, potato is cultivated in 0.42 mha with production of 11.09 m tons during 2007-08 (1). Several biotic and abiotic factors responsible for the low potato productivity of potato and viral diseases i.e. potato virus X(PVX), Potato virus Y(PVY), potato virus M(PVM) and potato leaf roll virus (PLRV) are most important. In order to manage the viral diseases, sowing of moderately resistant variety with enough knowledge of relationship of environmental conditions for these diseases is the valid option in viral diseases control strategy as environmental conditions play a crucial role in development of these viral diseases in epidemic form. Determination of conducive environmental conditions may help in forecasting of these viral diseases. The objective of these studies was to investigate the relationship of weekly environmental conditions with the severity of viral disease(s) recorded on two genotypes.

Materials and Methods

A trial consisting of two varieties (Kufri Ashoka and K. Chipsona-1) was conducted (December- 8th and 10th November) during 2008-09 and 2009-10 in *Rabi* season at Student's Instructional Farm of N.D. University of Agriculture and Technology, Kumarganj, Faizabad to record epidemiological data. Two varieties were sown at 60cm row to row and 20 cm plant to plant distance with two replication in augmented design. Observation of diseases and terminal severity were recorded at weekly interval.

Meteorological factors-Meteorological factors including maximum and minimum temperature, rain fall, clouds, relative humidity and wind speed were recorded from Meteorological station of Student's Instructional Farm of N.D. University of Agriculture and Technology, Kumarganj, Faizabad.

Recording and processing of recorded data on viral disease of potato:

Ten plants in each plot were randomly selected and tagged. Severity of viral disease (s) was measured visually by using 0-4 rating scale designed (2). Plant Disease Intensity (PDI) and infection rate ("r") (3) were calculated as per formula given below:

$$\text{Per cent disease intensity (PDI)} = \frac{\text{Sum of total numerical ratings}}{\text{Total no. of leaves examined} \times \text{maximum disease grade}} \times 100$$

$$\text{Infection rate (r)} = \frac{2.3}{t_2 - t_1} \log_e \frac{X_2 (1 - X_1)}{X_1 (1 - X_2)}$$

Where,

- t₁ = time (days) during 1st observation
- t₂ = time (days) during 2nd observation
- t₂-t₁ = time interval between two observations
- X₁ = per cent disease intensity value in decimal at corresponding t₁ time
- X₂ = per cent disease intensity value in decimal at corresponding t₂ time
- log_e = natural log

Severity of viral disease of potato was subjected to correlation and multiple regression analysis with weather

factors, for the specific periods of the same years, to determine their relationship. The prediction equation used was:

$$Y = a + b_1X_1 + b_2X_2 + \dots + b_nX_n$$

Where,

Y = per cent disease intensity

a = intercept

b_1 to b_n = partial regression coefficient (slop)

X_1 to X_n = Weather factors

Results and Discussion

Viral disease(s) were first observed in first and third week of December in year 2008-09 and 2009-10 in K. Ashoka and K. Chipsona-1 variety, respectively. Maximum disease intensities i.e. 80.5, 10.2% and 82.70, 12.45% was recorded in 4th week of January during both the years and favoured by minimum temperature from 7.3-10.3 °C, maximum temperature 27.1-23.3 °C along with minimum humidity 53.8-51.2% and maximum humidity 93.6-92.7% during 2008-09 and minimum temperature 4.8-7.6 °C, maximum temperature 23.42-17.0 °C, minimum humidity 45.85-71.57% and maximum humidity from 87.71-90.71% during 2009-10. Maximum infection rate (0.342) was recorded in K. Ashoka than K. Chipsona-1 (0.296) during

last week of December to first week of January when minimum/ maximum temperature and minimum/ maximum relative humidity was 9.10/23.76 °C and 59.48/91.76%, respectively.

Konar and Singh (4) have also reported the incidence of viral diseases (mild mosaic, severe mosaic and potato leaf roll) in K. Jawahar, K. Chipsona-1 and K. Chipsona-2 and Atlantic during the period of the minimum and maximum temperature varied from 15.8 °C to 33.1 °C and minimum and maximum relative humidity from 37.2 to 99.1% with average rainfall of 27.3 mm. More or less same findings were also reported in previous studies (5), (6) and (7).

An interesting trend of potato virus x disease development at 15-31 °C maximum and 05-13 °C minimum temperature was explained by higher regression (r) values (0.82 and 0.99) by Qamar (9).

Qamar (9) have also recorded the maximum disease severity at 24-28 °C maximum and 9-12 °C minimum temperature with maximum regression value (r = 0.90) of increasing trend of potato virus Y disease at 15-31 °C maximum and 5-13 °C minimum temperature.

Table-1: Effect of meteorological factors on viral disease(s) of potato during 2008-09

S. No.	Observations	Standard weeks	Rainfall (mm)	Temperature (°C)		Relative humidity (%)		Varieties/PDI	
				Min.	Max.	Min.	Max.	K. Ashoka	K. Chipsona-1
1.	07-12-08	49	0.0	10.6	26.3	53.1	91.7	2.5	0.00
2.	14-12-08	50	0.0	10.2	26.3	52.1	91.7	5.7	0.00
3.	21-12-08	51	0.0	11.6	18.9	76.0	95.4	11.9	0.00
4.	28-12-08	52	0.0	7.5	27.1	53.8	93.6	20.5	1.75
5.	04-01-09	01	0.0	5.6	20.2	62.4	86.4	42.2	4.20
6.	11-01-09	02	2.0	10.3	23.3	51.2	92.7	65.7	5.15
7.	18-01-09	03	0.0	8.1	24.2	33.7	64.5	79.3	7.39
8.	25-01-09	04	0.0	10.2	23.3	56.8	92.7	80.5	10.20

Table-2: Effect of meteorological factors on viral disease(s) of potato during 2009-10

S. No.	Observations	Standard weeks	Rainfall (mm)	Temperature (°C)		Relative humidity (%)		Varieties/PDI	
				Min.	Max.	Min.	Max.	K. Ashoka	K. Chipsona-1
1.	06-12-09	49	0.0	8.0	26.14	39.71	87.71	3.10	0.00
2.	13-12-09	50	0.0	7.05	25.92	38.0	86.85	5.90	0.00
3.	20-12-09	51	0.0	11.0	25.92	44.42	84.42	10.25	0.00
4.	27-12-09	52	0.0	4.8	23.42	45.85	87.71	24.70	2.05
5.	03-01-10	01	0.0	4.9	19.9	67.42	88.57	47.95	3.95
6.	10-01-10	02	0.0	7.6	17.0	71.57	90.71	66.35	6.37
7.	17-01-10	03	5.2	9.2	13.7	77.57	92.51	80.55	8.18
8.	24-01-10	04	0.0	12.0	14.62	74.71	90.57	82.70	12.45

Table-4: Varieties and seasonal effect on infection rates ('Y') of viral disease(s) of potato during 2008-09

S. No.	Observations	Standard weeks	Rainfall (mm)	Temperature (°C)		Relative humidity (%)		Varieties/Infection rate	
				Min.	Max.	Min.	Max.	K. Ashoka	K. Chipsona-1
1.	07-12-08-14-12-08	49-50	0.0	10.4	26.30	52.60	91.70	0.282	0.0
2.	14-12-08-21-12-08	50-51	0.0	10.8	23.83	60.40	93.00	0.264	0.0
3.	21-12-08-28-12-08	51-52	0.0	9.97	24.65	58.75	93.10	0.212	0.0
4.	28-12-08-04-01-09	52-01	0.0	9.10	23.76	59.48	91.76	0.342	0.296
5.	04-01-09-11-01-09	01-02	0.33	9.30	23.68	58.10	91.92	0.317	0.070
6.	11-01-09-18-01-09	02-03	0.28	9.13	23.75	54.61	88.00	0.228	0.126
7.	18-01-09-	03-04	0.25	9.26	23.70	54.88	88.59	0.024	0.116

25-01-09

Table-5: Varieties and seasonal effect on infection rates ("Y") of viral disease(s) of potato during 2009-10

S. No.	Observations	Standard weeks	Rainfall (mm)	Temperature (°C)		Relative humidity (%)		Varieties/Infection rate	
				Min.	Max.	Min.	Max.	K. Ashoka	K. Chipsona-1
1.	06-12-09-13-12-09	49-50	0.0	7.52	26.16	38.85	87.28	0.221	0.0
2.	13-12-09-20-12-09	50-51	0.0	8.68	25.99	40.71	86.32	0.197	0.0
3.	20-12-09-27-12-09	51-52	0.0	7.71	25.35	41.99	86.67	0.347	0.0
4.	27-12-09-03-01-10	52-01	0.0	7.15	24.26	47.08	87.05	0.339	0.222
5.	03-01-10-10-01-10	01-02	0.0	7.22	23.05	51.16	87.66	0.250	0.165
6.	10-01-10-17-01-10	02-03	0.74	7.51	21.71	54.93	88.35	0.244	0.088
7.	17-01-10-24-01-10	03-04	0.65	8.07	20.82	57.40	88.63	0.047	0.153

Table-6: Correlation coefficient between potato viral disease(s) intensity and meteorological factors

S. No.	Varieties	Meteorological factors	Correlation coefficient	
			2008-09	2009-10
1.	Kufri Ashoka	Temperature Min.	-0.223 ^{NS}	0.289 ^{NS}
		Temperature Max.	-0.195 ^{NS}	-0.996**
		Rainfall	0.333 ^{NS}	0.486 ^{NS}
		Relative Humidity Min.	-0.456 ^{NS}	0.980**
		Relative Humidity Max.	-0.514 ^{NS}	0.879**
2.	Kufri Chipsona-1	Temperature Min.	-0.226 ^{NS}	0.358 ^{NS}
		Temperature Max.	-0.141 ^{NS}	0.433 ^{NS}
		Rainfall	0.165 ^{NS}	-0.946**
		Relative Humidity Min.	-0.397 ^{NS}	0.899**
		Relative Humidity Max.	-0.426 ^{NS}	0.817*

Table-7: Regression of potato viral disease(s) intensity and meteorological factors

S.No.	Varieties	2008-09	R ²	2009-10	R ²
1.	Kufri Ashoka	$Y = 647.38 + (-1.52)X_1 + (-29.05)X_2 + (-31.76)X_3 + (-10.90)X_4 + 7.90 X_5$	0.919	$Y = 373.59 + (-0.25) X_1 + (-7.67) X_2 + (-1.21) X_3 + (-0.06)X_4 + (-1.89) X_5$	0.999
2.	Kufri Chipsona-1	$Y = 80.78 + (-0.21)X_1 + (-4.11)X_2 + (-6.23) X_3 + (-1.59) X_4 + 1.25 X_5$	0.912	$Y = 67.50 + 0.23X_1 + (-1.67) X_2 + (-0.69) X_3 + (-0.21)X_4 + (-0.21) X_5$	0.992

Table-8: Correlation coefficient between infection rate of viral diseases of potato and meteorological factors

S. No.	Varieties	Meteorological factors	Correlation coefficient	
			2008-09	2009-10
1.	Kufri Ashoka	Temperature Min.	0.135 ^{NS}	-0.527 ^{NS}
		Temperature Max.	0.156 ^{NS}	0.499 ^{NS}
		Rainfall	-0.313 ^{NS}	-0.563 ^{NS}
		Relative Humidity Min.	0.363 ^{NS}	-0.460 ^{NS}
		Relative Humidity Max.	0.564 ^{NS}	-0.575 ^{NS}
2.	Kufri Chipsona-1	Temperature Min.	-0.757*	-0.534 ^{NS}
		Temperature Max.	-0.488 ^{NS}	-0.621 ^{NS}
		Rainfall	0.127 ^{NS}	0.211 ^{NS}
		Relative Humidity Min.	0.148 ^{NS}	0.671 ^{NS}
		Relative Humidity Max.	-0.351 ^{NS}	0.473 ^{NS}

Table-9: Regression of infection rates of viral disease(s) of potato and meteorological factors

S.No.	Varieties	2008-09	R ²	2009-10	R ²
1.	Kufri Ashoka	$Y = -6.74 + (-0.052) X_1 + 0.311 X_2 + 0.626 X_3 + 0.111 X_4 + (-0.071) X_5$	0.682	$Y = 24.61 + (-0.202) X_1 + (-0.075) X_2 + 0.243 X_3 + (-0.016) X_4 + (-0.232) X_5$	0.989
2.	Kufri Chipsona-1	$Y = 6.78 + (-0.169) X_1 + (-0.311) X_2 + (-1.107) X_3 + (-0.106) X_4 + 0.098 X_5$	0.949	$Y = -6.65 + (-0.035) X_1 + 0.132 X_2 + (-0.145) X_3 + 0.049 X_4 + 0.017 X_5$	0.913

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