



Survey of Potato Viral Diseases in Unnao, Kanpur and Sambhal Districts of Uttar Pradesh

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Abstract

Potato (*Solanum tuberosum* L.), which belongs to family Solanaceae, is the third major crop secondary to rice and wheat in more than 100 countries around the world. Potato viral disease is one of the major limiting factors in potato production, which decreases yield significantly. The experiment was carried out in forty five villages randomly selected in Uttar Pradesh viz, Unnao, Kanpur and Sambhal districts during 2022-23 and 2023-24 from December to February each year. The highest leaf curl incidence was noticed in Badarka harbansh (62.34% and 63.85%) followed by Sonik (61.07% and 62.44%) and Rithani (60.74% and 61.74%) in 2022-23 and 2023-24, respectively. In case of block wise, the maximum incidence was found Purwa (56.84% and 58.25%) and Kalayanpur (56.61 and 57.86%) in 2022-23 and 2023-24, respectively. While the lowest incidence was observed at Sambhal 50.10%, 2022-23 and 50.75% in 2023-24. whereas, the maximum viral disease observed at Kanpur districts (81.33% and 80.74%) followed by Unnao (54.89% and 56.20%) and Sambhal (52.87% and 53.50%) in both the years of study.

Keywords: *Potato, Survey, Uttar Pradesh, Viral diseases*

Introduction

Potato (*Solanum tuberosum* L.) is the world's leading vegetable crop along with staple food and is placed at fourth position after rice, wheat and maize, respectively (Rauscher *et al.*, 2006). Potato is native of Peru, South America and is believed to be introduced in India by Portuguese travelers during 17th century. Potato has two compensations over the other crops *i.e.* its production and calories per unit area are higher than wheat and rice while in term of total production potato provides 12-15 times more yield per hectare as compared with cereals. Potato tubers are excellent source of carbohydrates, protein, and vitamins. Potato contains 77.8% water, 2.0 g protein, 13g calcium, 0.06 riboflavin, 25mg/100g vitamin C, 12mg ascorbic acid, 0.11 mg mythiamin, 1.18 mg niacin and per 100g energy of edible protein is 85 calories (MacGillivray, 1953). Potato is one of the main cash crops for the farmer and also contributes a considerable amount in Gross Domestic Product (GDP) of India because potatoes are cultivated both as garden vegetable and also on commercial scale.

In the field, potato (*Solanum tuberosum* L.) is infected frequently with several viruses during a growing season (McDonald, 1984), which leads to reduced yield and quality of tubers. These viruses can occur in single or as mixed infections within the potato crop. It has high production potential and superior nutritional quality; therefore it may be a useful tool for fighting hunger and malnutrition in developing country like India. Considering the raising



demands, it is needed to study the strategic model to understanding the virus epidemiology for the management of virus. As a result enhances higher production, quality, processing and consumption markets.

Although several factors like biotic and abiotic stresses are considered for be a constraint to productivity (Burman *et al.*, 2007), out of which late blight followed by viruses is most important. Moreover, pest is indirectly responsible for infestation of various diseases on potato. India's tropical and humid climate also favors the development and infestation of different insect and pest (Landge *et al.*, 2021). Viral diseases greatly hampered the potato cultivation globally. The potato leaf roll virus spread through tubers and aphid species. Moreover, whitefly transmitted geminiviruses e.g., leaf curl viruses also causing severe curling and stunted growth. The spread of these diseases either by insect vector or tuber make it more devastating in nature. They occur abundantly in the warm and humid climatic condition during the cultivation, thus increase the chances of the spread of infection and reducing quality production (Schoen *et al.*, 2004). Scientific research on the biology of virus and the interactions with insect vector provided the current countermeasures against diseases. Potato leaf-roll virus (PLRV) is a type of species of the genus Polerovirus in the family Luteoviridae. It is responsible for the loss of more than 20 million tons of potato (J. F. Kreuze and J. P. T. Valkonen, 2020). Both primary and secondary infections of PLRV are encountered in field. Viruses are one of the most significant biotic constraints in global potato production, affecting both tuber yield and quality (Kruze *et al.*, 2020, and Rashid Kruze *et al.*, 2020). More than 50 viruses and one viroid have been identified as infecting potatoes around the world, causing varying degrees of loss depending on virus type, strain, seed system, and crop production practices (Kruze *et al.*, 2020).

Major viruses infecting potato are *Potato virus X* (PVX), *Potato virus Y* (PVY), *Potato acuba mosaic virus* (PAMV), *Potato leaf roll virus* (PLRV), *Tomato leaf curl New Delhi virus* (ToLCNDV), *Potato virus A* (PVA), *Potato virus S* (PVS) and *Potato virus M* (PVM). Among these viruses, PVY causes yield loss up to 90 per cent. Virus infection in potatoes is critical because it causes seed degeneration and a gradual but long-term decrease in yield, especially in agricultural systems where the use of certified seed is limited (Bekele *et al.*, 2011 and ondit *et al.*, 2021). Foliar virus symptoms in potato can sometimes be mild or latent and hard to observe, unlike bacterial and fungal disease symptoms and thus receive little attention from farmers and researchers alike (Deloko *et al.*, 2021). Nevertheless, the presences of major six potato viruses which have a worldwide distribution (PLRV, PVY, PVX, PVS, PVM and PVA) were first reported in some parts of the country. This study was therefore conducted to



identify gaps in farmers' perceptions and practices in relation to potato virus control and to suggest aspects of virus control in order of priority for implementation.

Materials and Methods

The design adopted for the survey was stratified multistage sampling in three districts of Uttar Pradesh, namely Unnao, Kanpur and Sambhal. The districts were classified into three blocks based on number of village surveyed. The survey was confined to five village of each block and villages were selected at random. These survey villages were visited for two consecutive years 2022-23 and 2023-24 from planting stage to harvesting stage i.e. 3rd week of December, January and February. Data was recorded on the total number of plants, number of virus infected plants in per square meter. The days after disease appearance and visual disease incidence scoring method was adopted 0-4 point scale, percentage of disease incidence was obtained by standard methods (Mughal and Khan, 2001) viral disease symptoms on potato plant in the surveyed area were seen and collected separately for further confirmation through visual observation with consultation of standard literature (Quanjer *et al.*, 1916; Black and Price, 1940 and Murphy and McKay, 1932).

Plant Disease Intensity (PDI) was calculated by formula as given below:

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

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:

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

Where,

Y = per cent disease intensity

a = intercept

b₁ to b_n = partial regression coefficient (slop)

X₁ to X_n = Weather factors

Rating scale of viral diseases of potato (Mughal and Khan, 2001)

Grade Type of symptoms



- 0 No symptoms
- 1 (a) Blackening and banding of veins on a few leaves
(b) Mosaic starting on all the leaves
- 2 (a) Blackening and banding of veins on all the leaves
(b) Narrowing of leaves
(c) Venial necrosis with severe mosaic
(d) Leaf crinkling
- 3 Rigidity and leaf streak, dwarfing
- 4 Lower leaves dead, drooping, collapse of plants with very small size and lesser of tubers

Level of resistance/susceptibility

- 0 = Immune
- 1 = Resistant
- 2 = moderately resistant
- 3 = moderately susceptible
- 4 = Susceptible

Results and Discussion

Field survey were conducted during 2022-23 and 2023-24 in 45 villages and total 250 fields in major potato growing area of Unnao, Kanpur and Sambhal districts of Uttar Pradesh. The results of survey revealed that most of the fields were found more than one viral infected symptoms. The virus infected leaf sample were collected and visual identified as leaf curl, mosaic mottle, yellowing, leaf rolling and crinckling with the standard literature cited by (Quanjer *et al.*, 1916; Black and Price, 1940; Murphy and McKay, 1932 and Jones and Harrison, 1969).

The highest viral disease incidence was noticed in Badarka harbansh (62.34% and 63.85%) followed by Sonik (61.07% and 62.44%) and Rithani(60.74% and 61.74%) in 2022-23 and 2023-24. The lowest leaf curl incidence was noticed in chandpura (42.25%-53.55%) bhojpur (43.38%- 50.01%) and Kalu Khera (42.25%-57.63%) in 2022-23 and 2023-24, respectively (Table-1). When the viral disease incidence data was analyzed at block wise. The maximum incidence was found 56.84%, 58.25% at Purwa and 56.61, 57.86% at Kalyanpur in 2022-23 and 2023-24, respectively. While the least incidence was observed at Sambhal50.10%-50.75% in 2022-23 and 2023-24 (Table-



2). The average viral disease to severe mosaic, necrotic streaks on the vein and petiole with stunted and bushy appearance were identified as necrotic leaves (Kolychikhina *et al.*, 2021). PLRV can result in serious economic losses and is now a major factor restricting sustainable potato production in China (Biao Wang, 2011). Characteristic symptoms of PLRV includes leaf-rolling and tuber stem necrosis in potato as well as some other manifestations such as thickening, curling, chlorotic spotting and yellowing of the leaves (Taliensky Mayo *et al.*, 2003) (Table-3). Among the most common viruses affecting potato crops are Potato leaf roll virus (PLRV, genus Polorovirus), Potato virus X (PVX, genus Potexvirus), Potato virus A and Potato virus Y (PVA, PVY, both genus Potyvirus), Potato virus S (PVS, genus Carlavirus) and leaf curl virus (Kumar *et al.*, 2023).

Infection of leaf curling, mosaic and leaf rolling was found severe in all blocks. Other disease symptoms were recorded moderate to mild infection.

Table.1- Survey of potato viral diseases incidence during the growing period of 2022 - 2023 and 2023-24 in different villages of Unnao, Kanpur and Sambhal districts.

S. No	Districts	Blocks	Villages	No. of field surveyed	Per cent disease incidence of potato viral diseases							
					2022-23				2023-24			
					3 rd week of December	3 rd week of January	3 rd week of February	Average	3 rd week of December	3 rd week of January	3 rd week of February	Average
1	Unnao	Sikandarpur karn	Badarka Harbansh	5	23.83	74.63	88.56	62.34	24.67	77.32	89.56	63.85
			Turkiya badarka	5	21.85	66.65	78.45	55.65	22.35	67.45	79.65	56.48
			Rithanai	5	22.98	71.378	87.85	60.74	24.21	72.56	88.45	61.74
			Bethar	5	11.50	47.37	71.26	43.38	13.75	52.34	73.56	46.55
			Bhaisai Naubausta	5	14.58	50.67	74.28	46.51	16.35	55.32	76.87	49.51
		Bichiya	Shivpur Grant	5	15.23	54.25	78.36	49.28	16.32	56.78	79.45	50.85
			Padri kalan	5	18.15	57.23	79.75	51.71	18.66	58.43	78.32	51.80
			Padri khurd	5	16.19	59.14	79.56	51.63	17.23	60.12	77.45	51.60
			Targaon	5	22.24	64.23	84.25	56.91	22.65	64.67	83.56	56.96
			Sonik	5	25.21	69.21	88.78	61.07	26.34	71.23	89.76	62.44
		Purwa	Behta	5	21.36	68.24	85.36	58.32	22.34	70.43	86.34	59.70
			Chaupai	5	21.52	69.25	84.25	58.34	22.45	71.45	86.34	60.08
			Kalu Khera	5	19.25	65.25	85..25	42.25	20.36	66.21	86.32	57.63



2	Kanpur	Sarsaul	Kantha	5	18.24	60.24	82.45	53.64	18.78	61.43	84.34	54.85
			Mangat Khera	5	22.52	66.32	84.24	57.69	23.51	67.75	85.67	58.98
		Sarsaul	Katridhondhi	5	21.24	61.24	68.54	50.34	21.78	61.89	66.45	50.04
			Amauli	5	20.15	58.57	75.78	51.50	21.23	59.12	73.45	51.27
			Karbigawan Salempur	5	24.21	68.24	88.56	60.34	25.32	68.65	87.67	60.55
			Hathigaon	5	24.21	69.20	87.56	60.32	26.45	70.21	88.56	61.74
			Narwal	5	20.21	67.21	85.45	57.62	21.87	66.34	86.89	58.37
			Kalyanpur	Bhautikhera	5	20.36	64.25	87.25	57.29	21.34	65.34	88.46
		Bhautipratappur		5	21.25	64.29	82.45	56.00	22.12	67.32	83.47	57.64
		Singhpur Kachhar		5	22.23	69.26	86.36	59.28	22.65	72.32	87.39	60.79
		Rampur Bhimsen		5	19.24	67.21	87.45	57.97	20.12	69.45	89.56	59.71
		Ramelbanga		5	18.52	59.78	79.25	52.52	19.45	61.34	77.64	52.81
		Bhitargaoan	Lauli	5	21.36	68.56	84.25	58.06	22.12	69.76	79.49	57.12
			Kuwa Khera	5	18.52	61.25	74.25	51.34	19.45	63.23	71.38	51.35
			Milkinpur	5	17.54	67.57	78.46	54.52	18.34	70.32	76.87	55.18
			Etarora	5	16.42	59.54	74.56	50.17	17.32	58.34	72.36	49.34
			Devpura	5	19.56	61.14	79.78	53.49	20.25	62.45	77.37	53.36
3	Sambhal	Behjoi	Akbarpur	5	17.56	64.53	77.34	53.14	17.89	65.66	79.45	54.33
			Anandpur	5	18.36	66.65	78.34	62.34	19.57	68.21	76.45	54.74
			Baheria	5	18.78	67.56	80.32	55.65	19.67	68.65	78.44	55.59
			Bamneta	5	19.56	68.54	81.87	60.74	21.31	69.32	80.38	57.00
			Bhojpur	5	16.46	59.47	71.67	43.38	17.61	60.32	72.09	50.01
		Baniyakhera	Adampur	5	18.78	64.54	74.35	46.51	18.56	65.35	75.67	53.19
			Aitauli	5	19.67	66.53	76.19	49.28	19.34	67.32	78.45	55.04
			Akrauli	5	18.48	66.87	75.89	51.71	19.21	68.34	79.34	55.63
			Baniyakhera	5	18.93	68.37	80.63	51.63	19.45	70.32	77.56	55.78
			Alampur	5	19.56	69.23	82.54	56.91	20.21	71.56	80.34	57.37



	Sambhal	Alam sarai	5	18.34	63.28	73.35	61.07	19.34	64.34	74.59	52.76
		Barahi	5	17.34	59.39	72.56	58.32	18.32	61.45	74.22	51.33
		Bela	5	16.45	58.45	71.34	58.34	17.65	59.45	69.56	48.89
		Chandpura	5	18.45	64.56	77.23	42.25	18.98	65.32	76.34	53.55
		Manikhera	5	15.67	55.46	69.56	53.64	16.43	56.89	68.43	47.25

Table:2- Incidence of potato viral diseases in various block of Unnao, Kanpur and Sambhal districts during 2022 -2023 and 2023-24 Uttar Pradesh.

S. No.	Blocks	Per cent disease Incidence							
		2022-23				2023-24			
		3 rd week of December	3 rd week of January	3 rd week of February	Average	3 rd week of December	3 rd week of January	3 rd week of February	Average
1.	Sikandarpur karn	18.95	62.14	80.08	53.72	20.27	65.00	81.62	55.63
2.	Bichiya	19.40	60.81	82.14	54.12	20.24	62.25	81.71	54.73
3.	Purwa	20.58	65.86	84.08	56.84	21.49	67.45	85.80	58.25
4.	Sarsaul	22.00	64.89	81.18	56.02	23.33	65.24	80.60	56.39
5.	Kalyanpur	20.32	64.96	84.55	56.61	21.14	67.15	85.30	57.86
6.	Bhitargaon	18.68	63.61	78.26	53.52	19.50	64.82	75.49	53.27
7.	Behjoi	18.14	65.35	77.91	55.05	19.21	66.43	77.36	54.33
8.	Baniyakheda	18.97	66.58	76.77	54.10	19.35	68.58	78.27	55.40
9.	Sambhal	17.25	60.23	72.81	50.10	18.14	61.49	72.63	50.75

Table:3- Incidence of potato viral diseases at district level during the different growing periods of 2022-2023 and 2023-24.

S.N o.	Yea rs	Per cent disease Incidence											
		Unnao				Kanpur				Sambhal			
		3 rd week	3 rd	3 rd	Avera	3 rd week	3 rd	3 rd	Avera	3 rd week	3 rd	3 rd	Avera



		of Decemb er	week of Januar y	week of Februa ry	ge	of Decemb er	week of Januar y	week of Februa ry	ge	of Decemb er	week of Januar y	week of Februa ry	ge
1	2022 -23	19.64	62.9 4	82.10	54.89	20.33	64.4 9	81.33	55.38	18.16	64.2 3	76.21	52.87
2	2023 -24	20.66	64.9 0	83.04	56.20	21.32	65.7 4	80.47	55.84	18.90	65.5 0	76.09	53.50

Table:4- Types of viral symptoms in potato at different blocks of Uttar Pradesh.

S.No.	Blocks	Symptoms
1.	Sikandarpur karn	Leaf curling**, Leaf rolling***, Mosaic*, Necrosis of leaves*, Distortion mosaic and mosaic mottling***
2.	Bichiya	Leaf curling**, Leaf rolling***, Mosaic*, Necrosis of leaves**, Distortion mosaic* and mosaic mottling*
3.	Purwa	Leaf curling**, Leaf rolling***, Mosaic*, Necrosis of leaves**, Distortion mosaic* and mosaic mottling*
4.	Sarsaul	Leaf curling**, Necrosis of leaves** and Mosaic*
5.	Kalyanpur	Leaf curling***, Mosaic**, Leaf rolling***, Necrosis of leaves **and Mosaic mottling**
6.	Bhitargaon	Leaf curling***, Mosaic mottling* and Necrosis of leaves**
7.	Behjoi	Leaf curling***, Mosaic*, Leaf rolling**and Mosaic mottling**
8.	Baniyakheda	Leaf curling**, Necrosis of leaves**, mosaic mottling* and Mosaic*
9.	Sambhal	Leaf curling**, Necrosis of leaves**, Leaf rolling** and Mosaic*

***Severe incidence, **Moderate Incidence and *Mild Incidence.

Conflict of Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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References

- Bekele B., Dickinson M., Asefa A., Abate E. Incidence of potato viruses and bacterial wilt disease in the west Amhara sub-region of Ethiopia. Incidence of Potato Viruses and Bacterial Wilt Disease in the West Amhara Sub-Region of Ethiopia. *J Plant Pathol*; 2011; 93(1):149–157
- Biao Wang, Yanli M., Zhibo Zhang, Zhanmin Wu, Yunfeng Wu, Qiaochun Wang, Mingfu Li. Potato viruses in China. *Crop Protection*; 2011; 30: 1117-1123.
- Black L.M. and Price W.C. The relationship between virus of potato calico and alfalfa mosaic. *Phytopath*; 1940; 30 : 444-447.
- Burman R. R., Kumar M. and Nagaraj K. M. Organic potato production- practices and extension strategy Umiam, India. *ICAR Research Complex for NEH Region*; 2007; 271- 279.
- Darby J.F., Larson R.H. and Walker J.C. Variation in virulence and properties of potato virus Y strains. *Wis. Agric. Exp. Stn. Res. Bull.*; 1951; pp. 177.
- Jones R.A.C. and Harrison B.D. The behaviour of potato mop top virus in soil and evidence for its transmission by spongospora subterranea (Walker) Lagerh. *Ann. Appl. Biol.*; 1969; 63 : 1-17.
- Kreuze J.F., Souza-Dias J.A.C., Jeevalatha A., Figueira A. R., Valkonen J.P.T., Jones R.A. C. Viral Diseases in Potato In: *The Potato Crop: Its Agricultural, Nutritional and Social Contribution to Humankind eds. Hugo Campos and Oscar Ortiz (Springer)*; 2020; pp. 389-430.
- Kumar P., Kumar R., Shah M. A. Tuber Yield and Incidence of Virus-Vectors in Late-Planted Seed Potato Crops in North-Western Plains of India. *Potato Research*; 2023; 1-20.
- Landge S. S., Bansode G. M., More S. A., Lohate S. R. Studies on Seasonal Incidence of Aphid on Potato (*Solanum tuberosum* L.). *Biological Forum – An International Journal*; 2021; 13(4): 111-115.
- Kolychikhina M. S., Beloshapkina O. O., Phiri C. Change in potato productivity under the impact of viral diseases. *Earth Environ. Sci.*; 2017; 663.
- McDonald G. J. Viruses associated with mosaic symptoms in Russet Burbank potato. *Canadian Journal of Plant Pathology*; 1984; 6(3): 224-226.
- McGillivray J.H. Vegetable production: with special reference to Western Crops. *Blakiston, New York*; 1953; pp.354-364.
- Morante M.C., Salazar E.C., Villegas J.B., Ponce N.T. Virus incidence associated with native potato yield in Microcenters on potato genetic diversity of Bolivia. *Am J Potato Res.*; 2021. <https://doi.org/10.1007/s12230-021-09850-3>
- Mughal S. M., Khan M. A. Disease rating scale for the assessment of disease severity of PVX and PVY to facilitate the researchers and students working on plant viruses. M.Sc. (Hon). Agriculture Thesis Department of Plant Pathology, *University of Agriculture, Faisalabad*; 2001.
- Murphy P.A., McKay R. A comparison of some European and American virus diseases in potato. *Scientific Proceeding Royal Dublin Society NS*; 1932; 20: 347-358.
- Onditi J., Nyongesa M. W., Van der Vlugt R. Prevalence, distribution, and control of six major potato viruses in Kenya. *Tropical Plant Pathology*; 2020; <https://doi.org/10.1007/s40858-020-00409-x>
- Quanjier H.M. New work on leaf-curl on allied diseases in Holland. Royal Horticultural Society, London, Report International Potato Conference; 1921; pp. 127-145.
- Quanjier, H.M., Vander Lek, H.A.A. and Botjes, J.G.O. (1916). Award, verspreidingswijze en bestrijding van phloemnecrose en verwante ziekten, Mededelingen van de Landouwhogeschool. 10 : 1-38.
- Rashid M-O., Wang Y., Han C-G. Molecular detection of potato viruses in Bangladesh and their phylogenetic analysis. *Plants*; 2020; 9:1413. 10.3390/plants9111413
- Rauscher G.M., Smart C.D., Simko I., Bonierbale M., Mayton H., Greenland A., Fry W. E. Characterization and mapping of RPi-ber, a novel potato late blight resistance gene from *Solanum berthaultii*. *Theor. Appl. Genet.*; 2006; 112: 674-687.



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- Schoen C. D., Knorr D., Leone, G. Detection of Potato *Leaf roll Virus* in Dormant Potato Tubers by Immunocapture and a Fluorogenic 5' Nuclease RT-PCR Assay. *Phytopathology*; 2004; 86: 993-999.
- Taliansky M., Mayo M.A., Barker H. Potato leaf roll virus: a classic pathogen shows some new tricks. *Mol plant Pathol.*; 2003; 4(2):81-9.
- Turkensteen L.J., Hiskias Y. Report on survey of potato diseases in Ethiopia. (1989) 33 pp.