



Research article

Disease progression in potato germplasm from different reaction groups against potato virus Y in relation to environmental factors

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Abstract: Germplasm of 10 potato varieties/lines were screened out against PVY. Out of 10, five (Tota-704, FD 71-1, FSD WHITE, FD 8-1, FD 76 24) were found susceptible, three (FD 74-41, FD 74-50 and N-96-25) moderately susceptible and two (Kuruda and SH 216 A) moderately resistant varieties. The mean incidence of PVY was 61%. ELISA confirmed virus in the samples from all varieties showing moderately yellow to yellow color in the ELISA plate. There was significant correlation between PVY and maximum, minimum temperature and relative humidity. Disease severity was maximum in the range of 20–29°C for maximum temperature, 5–6°C for minimum temperature in all three groups of Varieties. 82–83% relative humidity favors the disease severity.

Keywords: Correlation - Disease severity - Potyvirus - Relative humidity - Temperature.

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important vegetable crop all over the world. It is a staple food in different part of the world because of its high nutrition value. The production of potato is threatened by different biotic and abiotic factors not only in the world but also in Pakistan Qamar *et al.* (2015). Potato has very low production in Pakistan as compared to world production due to biotic and abiotic factors. Among those biotic factors viruses are the most devastating pathogens. Potato crop is affected by 40 viruses Valkonen (2007). In Pakistan, Eight potato viruses *viz.*, Potato virus Y (PVY), Potato virus X (PVX), Potato leaf roll virus (PLRV), Potato mop top virus (PMTV), Potato virus S (PVS), Potato virus A (PVA), Alfalfa mosaic virus (AMV) and Potato virus M (PVM) have been reported Mughal *et al.* (1988). Among these PVY, PVX and PLRV are widely distributed in Pakistan. PVY alone or along with PVX cause a huge loss to potato crop. Potato virus Y belongs to family *Potyviridae*, which contains economically most important and largest group of plant viruses Buchen & Osmend (1987). Ahmad *et al.* (2003) during a survey declared the PVY, PVX and PVS as major diseases in fields of potato. Losses due to PVY are up to 83% in Pakistan Mughal & Khalid (1985) and Khalid *et al.* (2000). Potato virus Y is ssRNA *Potyvirus* having different strains; PVY^N, PVY^O and PVY^C de Box & Huttinga (1981). It is transmitted mechanically and through insect vector in non-persistent manners. Green peach Aphid (*Myzus persicae* Sulzer) plays vital role in disease transmission. Environmental factors play an important role in disease development and their information will not only be helpful in understanding importance of epidemiological factors but also in formulating management strategies. Ahmad *et al.* (2011) studied the relation of environmental factors (rainfall, temperature and humidity) with incidence of PVY and PVX. They concluded that rainfall and

high humidity help to spreading of incidence. Environmental factors have positive relation with PVY and PVX incidence. PVY have significant and non-significant result at high and low temperature but it is negatively correlated Qamar *et al.* (2003). The current research work was carried out to monitor the disease incidence of PVY and influence of environmental factors on disease severity.

MATERIALS & METHODS

Screening of Potato germplasm

The research trial comprising of 10 potato varieties was planned to screen the potato germplasm against potato virus Y (PVY). Symptoms were observed carefully for screening using the disease rating scale Qamar *et al.* (2003) with slight modification (Table 1). Disease incidence was calculated as follows;

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

Table 1. Rating scale for the screening of potato germplasm.

Rating Scale	Response	Reaction
0	No visible symptom	Immune
1	Mosaic pattern starts on leaves(25% leaves showing symptoms)	Resistance
2	Mosaic and Mottling (50% leaves have symptoms)	Moderately resistance
3	Dwarfing, rugosity and mottling of leaves (75% leaves affected)	Moderately susceptible
4	Leaf drooping severe mosaic and mottling (100)	Susceptible

Enzyme Linked Immunosorbent Assay (ELISA)

Samples from 10 varieties on the basis of symptoms were collected and confirmed through DAS-ELISA by Iftikhar *et al.* (2009). Polyclonal antibodies diluted in coating buffer were coated in ELISA plate and incubation at 4°C for 24 hours was followed by washing for three times at five minutes interval. After washing wells of ELISA plate were charged with antigens. Incubation and washing were repeated prior to add conjugate antibody. After incubation and washing pNP (para nitro phenyl) was added as substrate. Reaction was observed visually after the incubation of 30–60 minutes at room temperature.

Correlation of Environmental factors

Environmental factors (Maximum and minimum temperature, rainfall and relative humidity) were recorded for crop duration (October–January).

Statistical Analysis

Correlation between environmental factors and disease severity in different varieties was analyzed by using “R for Windows”.

RESULTS

Screening and Incidence

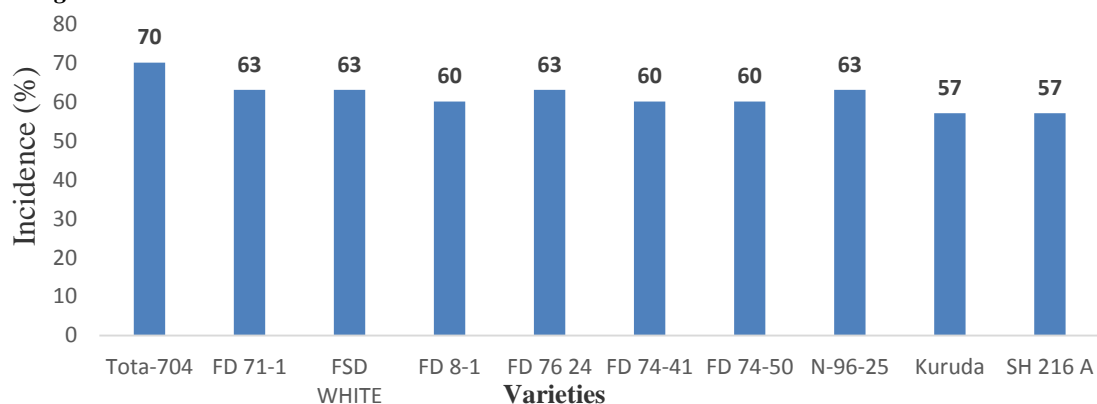


Figure 1. Incidence of PVY in different potato varieties.

Ten Varieties/lines were screened out against PVY. The disease incidence was in range from 70% (Tota-704) to 57% in two varieties Kuruda and SH 216A (Fig. 1). Varieties were grouped into three categories;

Susceptible (Tota-704, FD 71-1, FSD White, FD 8-1 and FD 76-24) Moderate susceptible (FD 74-41, FD 74-50 and N-96-25) and Moderate resistant (Kuruda and SH 216 A) on the basis of disease rating scale (Fig. 2).

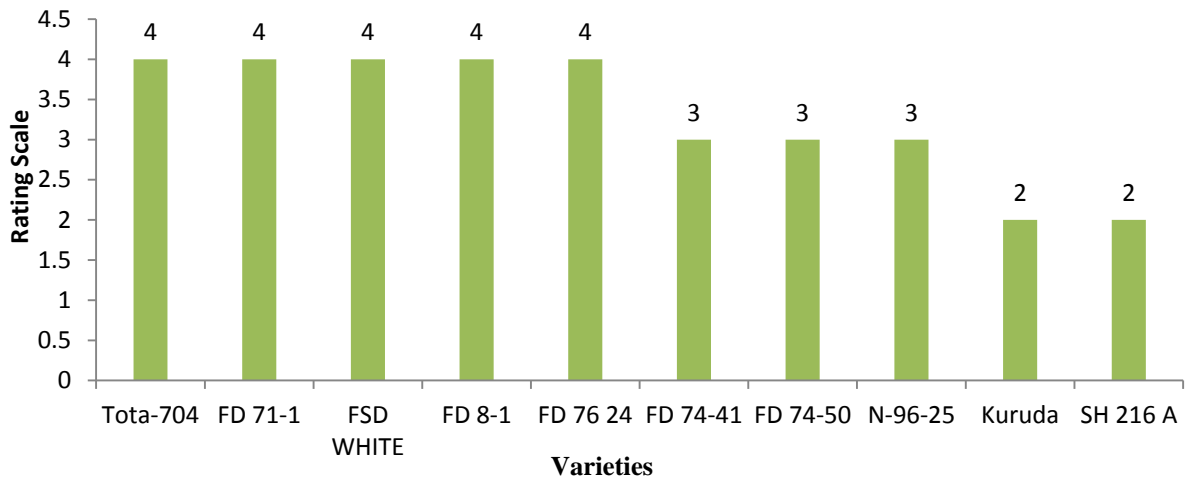


Figure 2. Disease severity in different potato varieties.

Enzyme Linked Immunosorbant Assay (ELISA)

ELISA confirmed the PVY in the samples collected from ten varieties on the basis of symptoms resembling to the virus. Light yellow to moderate yellow colour was observed in virus infected samples. The samples were tested against PVY and PVX antibodies separately on a same microplate and found the positive results (Fig. 3).

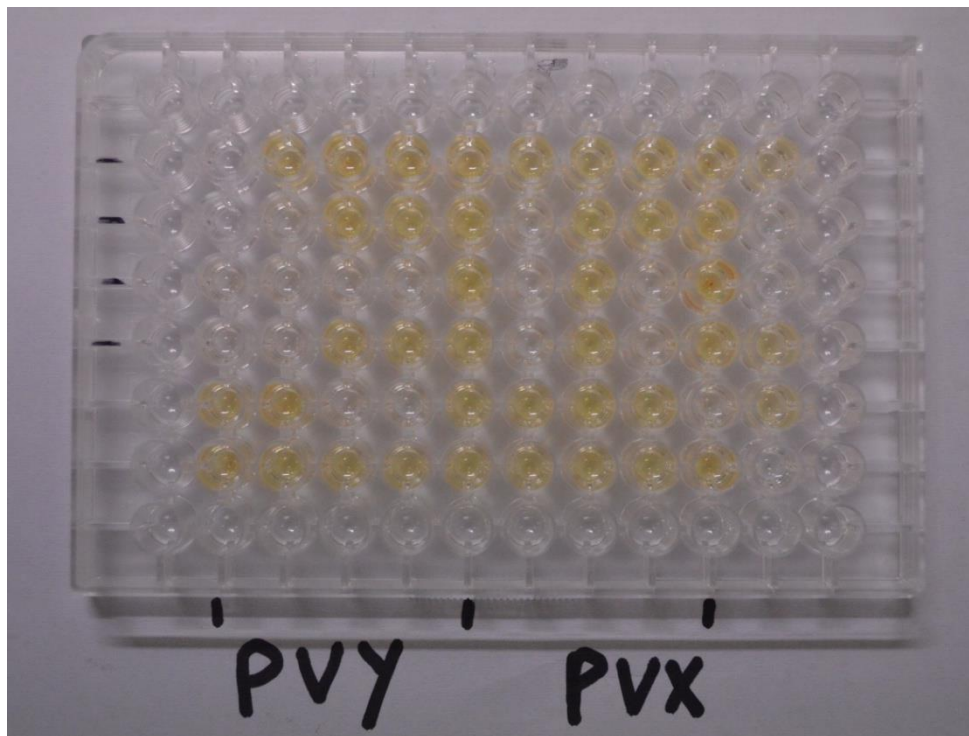


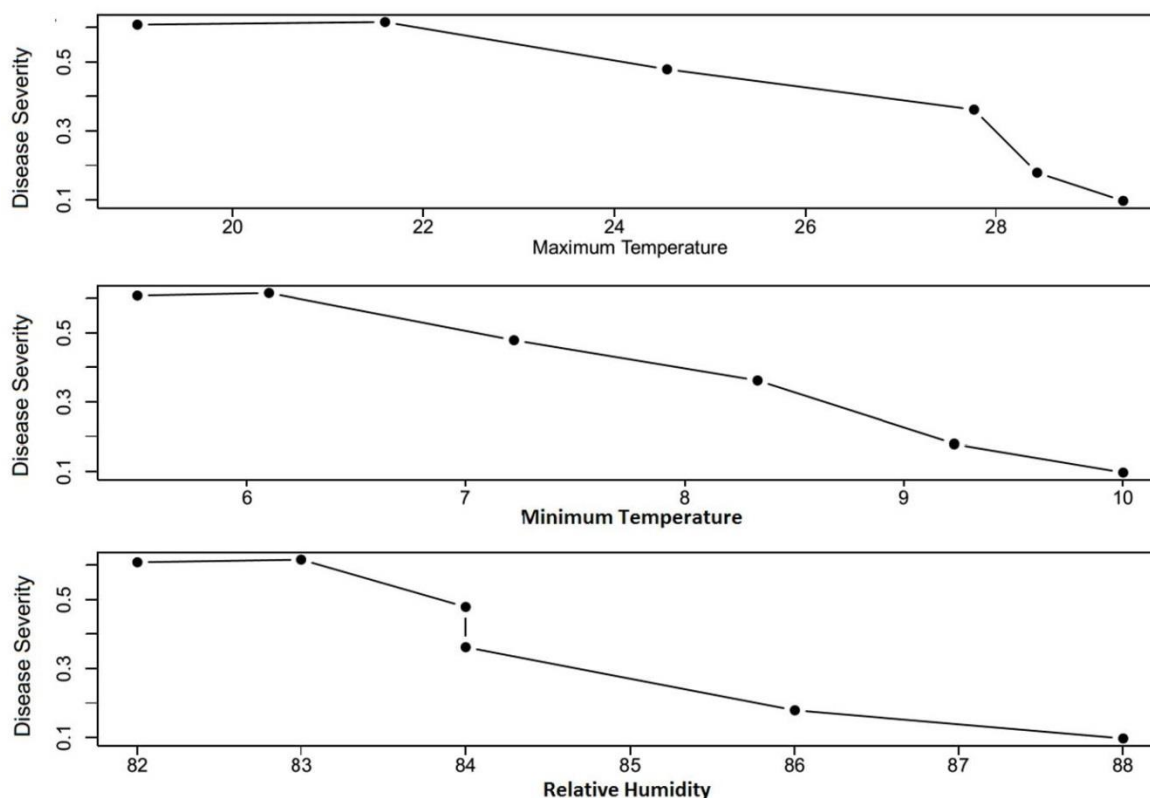
Figure 3. ELISA plate (wells) showing the reaction against positive samples of PVY.

Correlation of environmental factors with disease severity

All the environmental factors such as maximum, minimum temperature and relative humidity had highly significantly correlation with disease progression in susceptible varieties while maximum and minimum in moderately susceptible and only minimum temperature in moderately resistant (Table 2). Disease was progressed in susceptible varieties maximum severity was observed at temperature of 19–22°C and started decrease gradually as the temperature increases. Similarly high disease severity was observed minimum temperature of 5–6°C and started decrease with the increase in temperature. 82–83% relative humidity was found favorable for disease severity (Fig. 4).

Table 2. Correlation between varieties and environmental factors.

Varieties	Group	Max. temperature	Min. temperature	Humidity
Tota-704				
FD 71-1				
FSD WHITE	Susceptible	0.00063 ***	2.31e-09 ***	0.01192 *
FD 8-1				
FD 76-24				
FD 74-41				
FD 74-50	Moderate Susceptible	0.00361 **	3.41e-06 ***	0.28519
N-96-25				
Kuruda				
SH 216 A	Moderate Resistance	0.10435	0.00182 **	0.13293

**Figure 4.** Disease progression in susceptible varieties against PVY in Sargodha.

Moderately susceptible varieties showed that highest disease severity at 22°C in case of maximum temperature and increase in temperature reduced the disease severity. In minimum temperature disease severity was maximum at 6°C and minimum disease severity was recorded at 10°C. Intensity of disease decreased with the increase in relative humidity (Fig. 5). Moderately resistant varieties showed minimum temperature was highly significant correlation with disease intensity. Disease severity was at peak at 19°C in case of maximum temperature while at 5°C in minimum temperature. Maximum disease intensity was recorded at the 83% relative humidity (Fig. 6).

DISCUSSION

Potato virus *potyvirus* (PVY) is one of the most economically declared threatening viruses in potato not only in Pakistan also all over the world. Variety of symptoms exhibited by PVY depends upon the viral strains. PVY⁰ is the most prevailing strain. Potato varieties/lines were screened out to record the disease incidence and disease severity according to disease rating scale Qamar *et al.* (2003) with slight modification. Ten varieties were divided to three groups i.e. moderately resistant, moderately susceptible and Susceptible. Out of ten varieties no variety showed immune or resistance response with the mean disease incidence of 62% was recorded. Out of ten varieties five were susceptible, three moderately susceptible and two moderately resistant. Our results were in accordance with the results of Abbas *et al.* (2012). They reported disease incidence of 55%

during a survey in the different localities of Punjab. Similarly Ahmed *et al.* (2013) recorded the incidence of PVY up to 67% in Egypt. They reported that PVY^O and PVY^N were most prevalent strains.

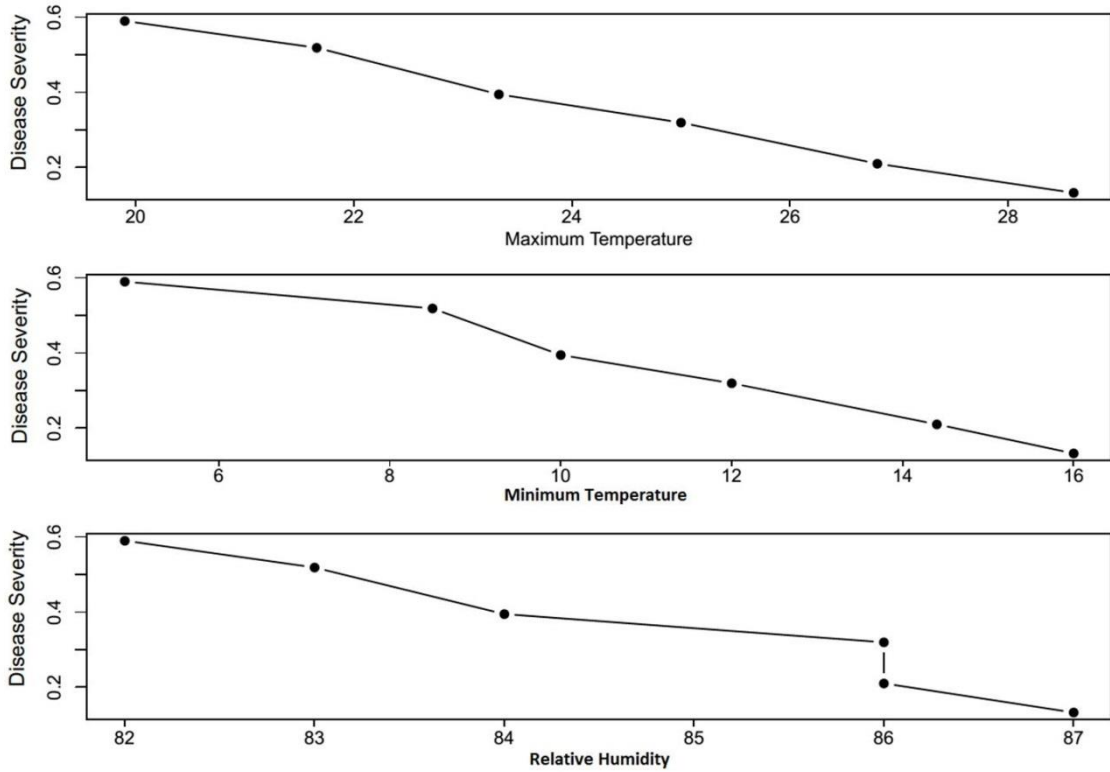


Figure 5. Disease progression in moderately susceptible varieties against PVY in Sargodha.

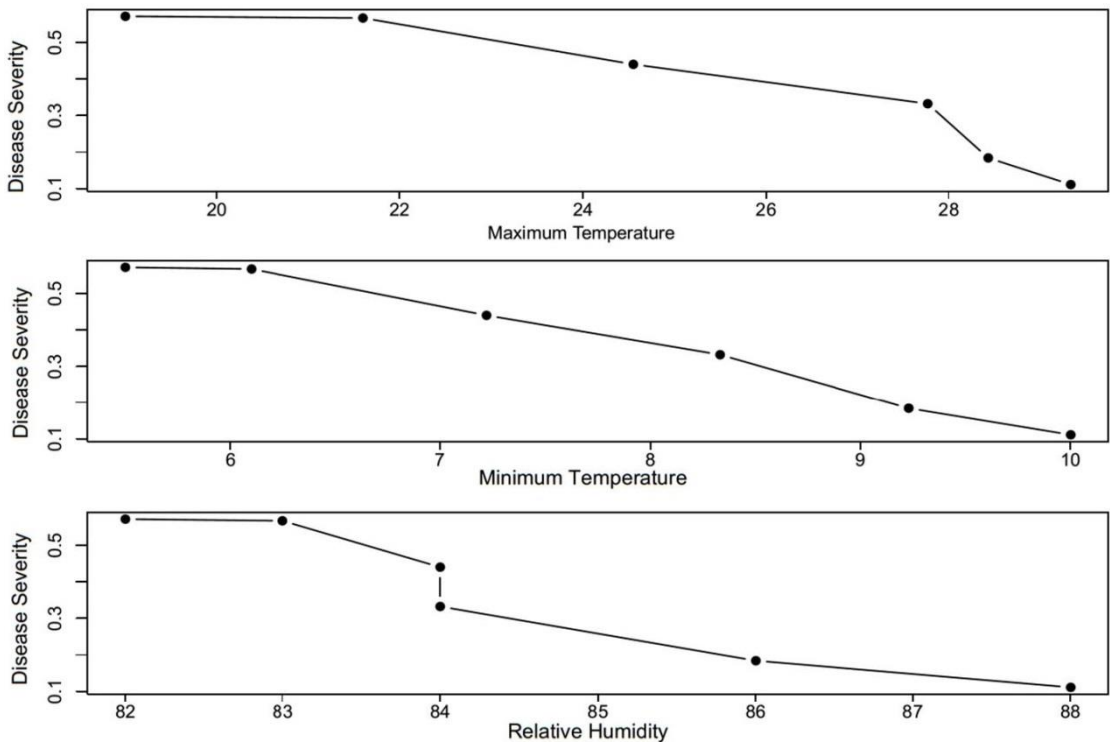


Figure 6. Disease progression in moderately resistant varieties against PVY in Sargodha.

Mughal *et al.* (1988) detected the presence of PVY through ELISA. Similarly Ahmed *et al.* (1995) confirmed the PVY, PLRV and PVX in potato samples through ELISA. Susceptible Varieties significantly correlated with maximum, minimum temperature and relative humidity. While maximum and minimum temperature showed significant correlation with moderately susceptible varieties. Whereas moderately resistant

varieties had significantly correlated only with minimum temperature. Our results confirmed the work of Qamar *et al.* (2003) who studied the correlation of environmental variables (maximum and minimum air temperature, pan evaporation, wind velocity, wind speed, clouds and relative humidity) with PVY disease on six Potato varieties viz; 394017-45, TPS-8901, 394029-129, TPS- 9620, 3912202-103 and TPS 9804. Maximum disease severity was recorded at 24–28°C as maximum temperature and 9–12°C as minimum temperature. He also indicated the increasing trend of PVY disease development at minimum temperature of 5–13°C and 15–31°C maximum temperature. He also indicated the increasing trend of PVY at minimum temperature of 5–13°C. Therefore it is concluded that environmental factors have significant impact on disease severity and will be helpful not only in formulating management strategies but also finding a resistant source against PVY.

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REFERENCES

- Abbas MF, Hamed S, Rauf A, Nosheen Q, Ghani A, Qadir A & Zakia S (2012) Incidence of six viruses in potato growing areas of Pakistan. *Pakistan Journal of Phytopathology* 24: 44–47.
- Ahmad N, Khan MA, Ali S, Khan NA, Binyamin R & Sandhu AF (2011) Epidemiological studies and management of potato germplasm against PVX and PVY. *Pakistan Journal of Phytopathology* 23(2): 159–165.
- Ahmad W, Iman D & Jan HU (2003) Recent trend of potato virus prevailing in potato growing areas of Punjab. *Pakistan Journal of Phytopathology* 15: 21–24.
- Ahmed M, Ahmed W & Hussain A (1995) Detection of major potato viruses from different potato growing localities of Punjab. In: *Research and development of potato production in Pakistan*. Proceedings of the National Seminar held (23–25 Apr) at NARC Islamabad, Pakistan pp. 175–179.
- Ahmed RZ, Ibrahim IAM, Hassan HMS & El-Wakil DA (2013) Incidence of virus Y Strains and Effect of Infection on the Productivity of Potato Tubers. *Journal of Agriculture and Vegetable Science* 2: 58–64.
- Buchen & Osmend C (1987) *Plant viruses online descriptions and list from VIDE database*. Potato virus Y, Potyvirus.
- de Box JA & Huttinga H (1981) *CMI/AAB description of plant viruses*. Potato virus Y 242. Available from: www.dpvweb.ent/dprv/showdpv.php?dpvNo=242. (accessed: 10 Sep. 2016).
- Iftikhar Y, Khan MA, Rashid A, Mughal SM, Iqbal Z, Batool A, Abbas M, Khan MM, Muhammad S & Jaskani MJ (2009) Occurrence and distribution of citrus tristeza closterovirus in the Punjab and NWFP, Pakistan. *Pakistan Journal of Botany* 41: 373–380.
- Khalid S, Iftikhar S, Munir A & Ahmad I (2000) *Potato diseases in Pakistan*. PARC Islamabad, Pakistan pp. 165.
- Mughal SM & Khalid S (1985) *Virus diseases in relation to potato production in Pakistan*. In: National Seminar on Potato in Pakistan (2–4 Apr 1985). PARC Islamabad, Pakistan.
- Mughal SM, Khalid S, Gillani TS & Devaux A (1988) Detection of potato viruses in Pakistan. In: *Proceeding of 2nd Triennial Conference*. PARC Islamabad, Pakistan pp. 12–26.
- Qamar MI, Iftikhar Y, Iqbal Z, Mubeen M & Haq A (2015) Screening of Potato Germplasm through ELISA against Potato Virus X (PVX). *Universal Journal of Plant Science* 3(2): 21–24.
- Qamar N, Khan M & Rashid A (2003) Correlation of Environmental Conditions with Potato Virus X (PVX) and Y (PVY) Disease Severities Recorded on 21 Advance Lines/Varieties of Potato (*Solanum tuberosum* L.). *International Journal of Agriculture and Biology* 5: 181–184.
- Valkonen JPT (2007) Viruses, Economical losses and Biotechnological potential. In: Vreugdenhil J (ed) *Potato Biology and Biotechnology*. Elsevier, New York, pp. 619–641.