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Relationship of Environmental Conditions Conducive for Potato Virus X (PVX) Disease Development on Six Varieties/advanced Lines of Potato

Naveed Qamar and M.A. Khan
Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan

Abstract: Six varieties/advance lines viz FSD-Red, Sante, Desiree, Kiran, Diamont and SH-5 were sown for the disease development of PVX and to study relationship with environmental conditions (Maximum and minimum temperature, relative humidity, wind velocity, clouds, pan evaporation and wind direction). Maximum PVX disease severity was recorded at 25-27°C maximum and 10-12°C minimum temperature. There was an increasing trend of disease development at 15-31°C maximum and at 5-13°C minimum temperature as explained by log regression models indicated by higher r values (0.82 and 0.99), 80-86 relative humidity with increasing trend with higher r values (0.99) and the highest PVX disease severity was recorded at 1.7-2.3 mm pan evaporation as explained by log regression models indicated by higher r values (0.98). None of the variety had significant correlation with clouds, wind velocity and wind direction.

Key words: Relationship, Environmental conditions, Potato virus X (PVX), Potato

Introduction

Potato (***Solanum tuberosum*** L.) occupies a prominent position among vegetable crops consumed by human beings due to high production, good nutritional value and better quality of the starch. Depsite of growing three crops as spring, summer and autumn crops, in Pakistan, the average yield of potato is 10417 kg ha^{-1} (Anonymous, 2001) which is very low as compared to other countries of world (U.S.A, Ireland and India etc.). among several factors responsible for the low potato production , potato diseases like early and late blights, potato scab, blackscurf and viral diseases i.e potato virus X (PVX), potato virus Y (PVY) and potato leaf roll virus (PLRV) are most important. Potato virus X (PVX) is distributed throughout potato growing areas of Pakistan ranging infection between 1.5-6.2 % being more in Punjab, even imported seeds have shown 0.7-30 % infections indicating the continuous introduction of PVX in the country (Hussain, 1980). Currently none of the available high yielding commercial varieties/advance lines has shown durable resistance against these diseases (Qamar ***et al.***, 2003). This is mainly due to the presence of disease virulence of these viruses (Ahmad and Ahmad, 1995), continuous introductions of the viruses through imported seeds, recurrent occurrence of the carrier/vector of these diseases i.e aphid (***Myzus persicae*** Schulz), non availability of chemical substances for directly controlling viral diseases of plants in the field. In order to manage the 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 the development of these viral diseases in epidemic form. Determination of conducive environmental conditions may help in forecasting of these diseases. The objective of this study was to investigate the relationship of weekly environmental conditions with (PVX) and (PVY) disease severitiy recorded on 21 advance lines/varieties.

Materials and Methods

Establishment of Potato germplasm nursery under field conditions

Six advanced lines/varieties were sown established in the research area of Department of Plant Pathology, University of Agriculture Faisalabad, during winter season 2001-02. The tubers of these advanced lines/ varieties were obtained from the vegetable section of Ayub Agricultural Research Institute (AARI) Faisalabad. Six varieties/ lines were sown at 30 cm plant to plant and 60 cm row-to-row distance. The diseased nursery was watered by surface irrigation at regular intervals throughout the season. First irrigation was applied immediately after sowing and then after one-week intervals. Irrigation stopped 15 days before harvesting. Well-rotted FYM at 30 t ha^{-1} was incorporated into the soil three to four weeks before planting. Fertilizers were applied according to the following ratio. (Malik, 1995)

N= 250kg ha^{-1}, P= 125kg ha^{-1}, K= 125 kg ha^{-1}

Establishment of Potato germplasm nursery in green house

Six varieties, which were planted in the field, were also planted in green house for the confirmation of PVY by mechanical inoculation of indicator plants. There were two plants in one pot and each variety was planted in three pots. Plants of two pots were used for inoculation while in the other pot, these were kept as positive control. These varieties/ lines were kept in good condition following recommended agronomic practices. Disease severity data was collected on weekly basis following the disease rating scale designed by Mughal and Khan (2001).

Procedure for sap inoculation

The young infected tissue showing primary symptoms of PVX were used for inoculation. The procedure was as follows:

- The leaves with severe disease symptom of PVX collected from the field were crushed in sterilized pestle and morter, preferably in chilled 0.05 M phosphate buffer (normally used at 1g/ml, till a fine homogenate was obtained. This sap was filtered through cheese cloth.
- Leaves of the test plants were dusted with Carborundum powder (600 mesh) using aspirator.
- Leaves of tested plants were held in the left palm and plant sap inoculum applied gently with forefinger of right hand covered with gloves.
- Each plant was labeled with date, time and name of the virus inoculated.
- The inoculated plants were rinsed off with water immediately after inoculation.

- These plants were kept under observation for a month to see the disease symptoms.

Confirmation of PVX on indicator plants

These varieties/ lines showing symptoms of PVX were tagged and from these varieties/ lines mechanical inoculation was done on indicator plants such as ***Nicotiana tabacum*** and ***Datura stramonium***.

For the confirmation of PVX, indicator plants were divided into two sets; one set was sap inoculated, the other was kept as positive control.

Collection of environmental data

Environmental data, consisting of maximum and minimum temperature, rainfall, clouds, relative humidity and wind speed etc, was collected by a meteorological station (100 m) run from research Trial area of Plant Pathology.

Results and Discussion

Six varieties namely FSD-Red, Sante, Desiree, Kiran, Diamont and SH-5 were selected to study the relationship of different environmental conditions (Maximum and minimum temperature, relative humidity, clouds, wind velocity, pan evaporation and wind direction) with disease development. According to disease ratings all the varieties were moderately resistant to moderately susceptible to PVX.

Temperature played a vital role in the development of the disease on these varieties/ lines. Maximum disease severity was recorded at 25-27°C maximum temperature and 10-12°C minimum air temperature (Fig. 1 and 2). There was increasing trend in potato virus X disease development at maximum air temperature i.e. 15-31°C and 5-13°C minimum temperature and this trend was best explained by log regression models indicated by very high r values (r=0.82) on the six varieties.

The maximum disease development was recorded at 80-86 % relative humidity on the six varieties. All the varieties showed increasing disease development in log regression fashion as indicated by high r values (r = 0.99) (Fig. 3). Highest disease severity was recorded at 1.7-2.3 mm pan evaporation. All the varieties showed increasing potato virus X disease development (Fig. 4) on the significant parameters of the environment. Under the wide range of temperature, disease severity of PVX was also behaving differently. It is due to the availability of optimum conditions of environment, regular/recurrent occurance of aphid (***Myzus persicae***) which is the major vector of this disease (Hussain, 1994). Fluctuation in the temperature may be helpful for the population build up of Aphid (which is the sole carrier of this disease). Zaklukiewicz (1983) also reported the prominent role of temperature for the causation of this disease and treated plants infected by potato virus X at 37°C and observed that nearly meristems samples from heat treated plants were virus free. Relative humidity also played its crucial role at the range of 80-86 % on six varieties. All the varieties showed increasing trend of disease development in log regression fashion as indicated by higher values of r (r = 0.99). This range of relative humidity may be helpful for the

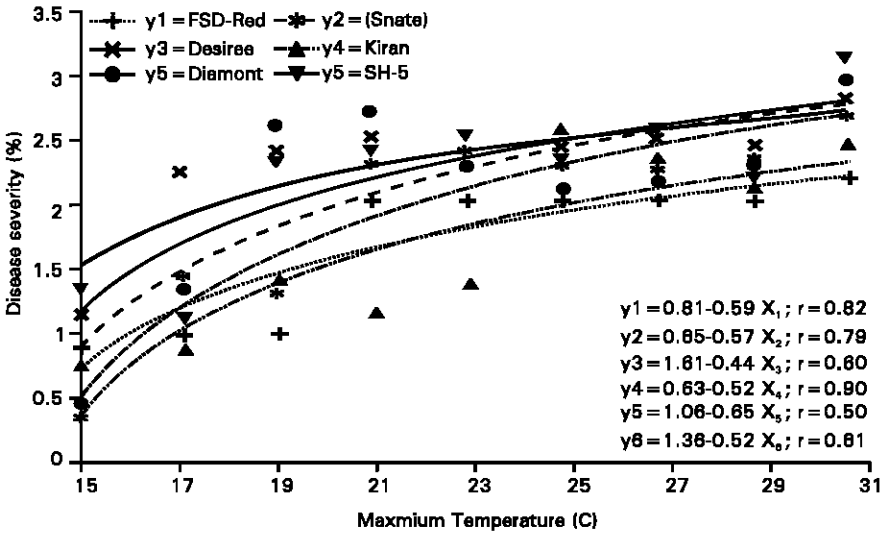

Fig. 1: Relationship of maxmium temperature with potato virus X disease severity on six potato varieties

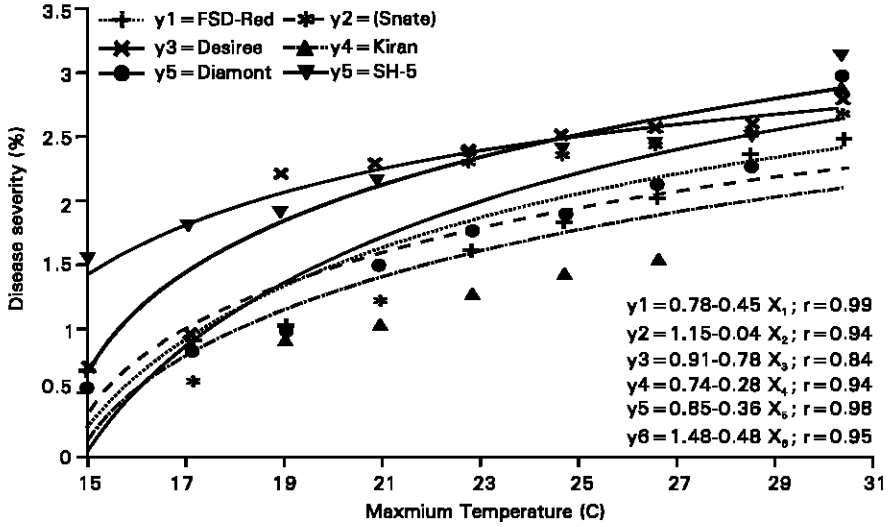

Fig. 2: Relationship of minimum temperature with potato virus X disease severity on six potato varieties

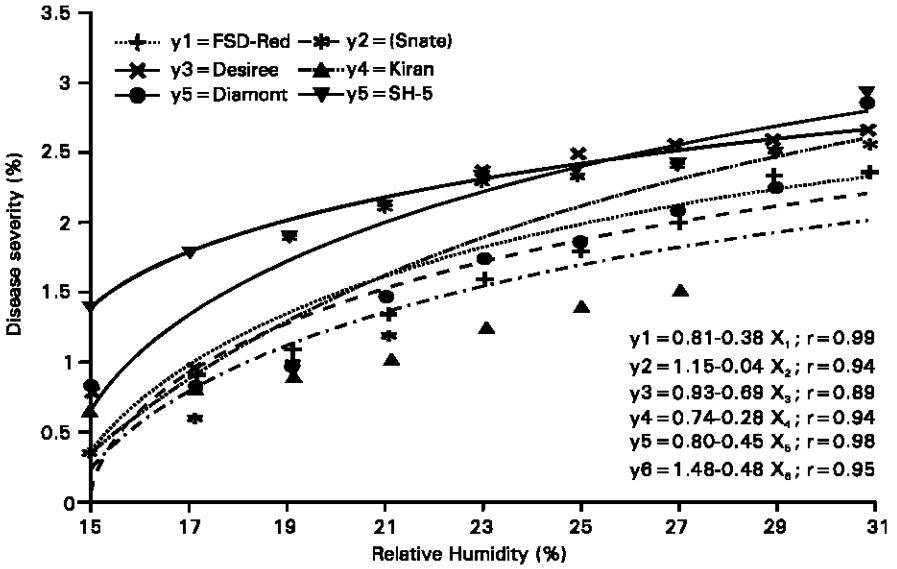

Fig. 3: Relationship of Relative humidity with potato virus X disease serverity on six potato varieties

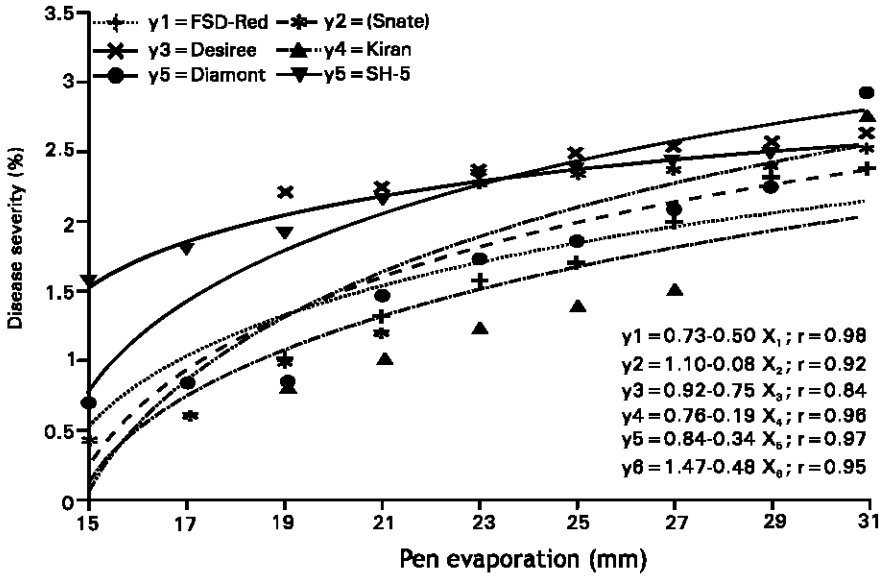

Fig. 4: Relationship of Pen evaporation with potato virus X disease severity on six potato varieties

insect vector to work efficiently as (Mirza ***et al.***, 1982) indicated that aphid population (***Myzus persicae***) starting appearing in traps in the last week of Octuber, second week of January and December. There was no aphid during July to September (During high temperature and low humidity). Pan evaporation also played its crucial role in disease severity on (1.7-2.3 mm) which is clearly explained by log regression model by higher values of r (r = 0.98). All the six varieties did not show any significant correlations with other parameters of the environment like clouds, wind velocity and wind direction. There will be indirect role of these parameters for the causation of potato virus X. The findings may be helpful for the breeders , growers and scientists to develop a disease predictive model on the basis of these environmental factors conducive for disease development or to develop disease forecasting system to plan for the escape of this disease under the favourable conditions.

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