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Relationship of Environmental Conditions with Potato Virus Y (PVY) Disease Development on Six Varieties / Advanced Lines of Potato

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ABSTRACT

Six varieties/advance lines *viz* TPS-9801, 394017-45, TPS-9620, 394029-129, TPS-9804 and 391202-103 were selected to study the relationship of environmental conditions (maximum and minimum temperature, relative humidity, wind velocity, clouds, pan evaporation and wind direction) with Potato Virus Y (PVY) disease. Maximum PVY severity was recorded at 24-28°C and 9-12°C as maximum and minimum temperatures, respectively. There was an increasing trend of PVY disease development at maximum temperature i.e. 15-31°C and at 5-13°C minimum temperature. Relative humidity of 78-84% showed increasing trend with higher r values (0.98). Disease severity was recorded at 1.7-2.5 mm pan evaporation as explained by higher r values (0.98). None of the variety had significant correlation with clouds, wind velocity and wind direction.

Key Words: Potato; Virus; Environment

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. Despite of growing three crops as spring, summer and autumn crops, in Pakistan, the average yield of potato is 16415 kg ha^{-1} (Govt. of Pakistan, 2001), which is very low as compared to other countries of world (USA, 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). Disease incidence of PVY in potato ranges between 5-25% in Pakistan (Mughal *et al*., 1988) and it can destroy the whole crop if it occurs along with PVX and PVS. 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 & 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 condition 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 diseases. The objective of these studies was to investigate the relationship of weekly environmental conditions with PVY disease severity recorded on six advance lines/varieties.

MATERIALS AND METHODS

Establishment of potato germplasm nursery under field conditions. Potato virus Y (PVY) disease screening nursery comprising of six advanced lines/varieties *viz.* TPS-9801, 394017-45, TPS-9620, 394029-129, TPS-9804, and 391202-103 was established in the research area of Plant Pathology Department, 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. The varieties 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= 250 kg ha^{-1}, P= 125 kg 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. Similarly there were three pots of each variety to be treated against PVY. In this case, one pot was inoculated with PVY, other was kept as positive control, while the third one was placed in a wooden cage covered with muslin cloth and it was used for the study of aphid transmission of PVY. 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):

For PVY

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

Level of resistance/susceptibility

0 = Immune
1 = Resistant
2 = Moderately Resistant
3 = Moderately Susceptible
4 = Susceptible

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

1- The leaves with severe disease symptom PVY 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.

2- Leaves of the test plants were dusted with Carborundum powder (600 mesh) using aspirator.

3- Leaves of tested plants were held in the left palm and plant sap inoculum applied gently with forefinger of right hand covered with gloves.

4- Each plant was labeled with date, time and name of the virus inoculated.

5- The inoculated plants were rinsed off with water immediately after inoculation.

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

Confirmation of PVY on indicator plants. These varieties/ lines showing symptoms PVY was tagged and from these varieties/ lines mechanical inoculation was done on indicator plants such as *Physalis floridana* and *Nicotiana glutinosa* for PVY.

For the confirmation of PVY indicator, plants were divided into three sets; one set was inoculated from the sap of leaves of varieties/lines having the symptoms of PVY; other set/ second was kept as positive control, while the third set was placed in an isolated wooden chamber and aphids collected from PVY disease affected plants were released on such indicator plants.

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 / advanced lines namely TPS-9801, 394017-45, TPS-9620, 394029-129, TPS-9804 and 391202-103 were selected to study the relationship of different environmental conditions (maximum and minimum temperature, relative humidity, clouds, wind velocity, pan evaporation and wind direction). According to disease ratings, the varieties are moderately resistant to moderately susceptible.

Maximum disease severity was recorded at 24-28°C maximum temperature (Fig. 1) and 9-12°C minimum air temperature (Fig. 2). There was increasing trend in potato virus Y 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 values (r=0.90). Under the wide range of temperature, disease severity was also behaving differently. It is due to the availability of optimum conditions of the environment, regular/recurrent occurance of aphid (*Myzus persicae*) which is the major vector of this disease was also reported that potato virus Y (PVY) was also virulent pathogen of potato crop (Kostiw, 1984; Hussain, 1994).

On the four varieties/ lines disease development was recorded on 78-84% relative humidity (Fig. 3). All the varieties showed increasing disease development in log regression fashion as indicated by high r values (r=0.90). Some varieties showed different reaction at the same range of temperature, it might be due to the effect of age of plants inoculated with PVY than those at early stage of growth (Sanger, 1988). This wide range of temperature may also be helpful for the population build up of aphid that is the sole carrier of this disease. Similarly, relative humidity plays a vital role for the causation of viral diseases especially PVY, which influences by dry conditions before and at various times after inoculation of potato cultivars with PVY. It was also reported the incidence of disease was maximum under dry conditions after inoculation with PVY than that growing under optimum conditions. Pan evaporation also played a profound role in the disease severity recorded on (1.7-2.3 mm) which is clearly explained by log regression model by higher values of r= 0.98. All the six varieties did not show any significant correlation with clouds, wind velocity and wind direction. These findings may be helpful for the breeders and growers to plan to escape from the disease

Fig. 1. Relationship of maximum temperature with potato virus Y disease severity on four potato varieties

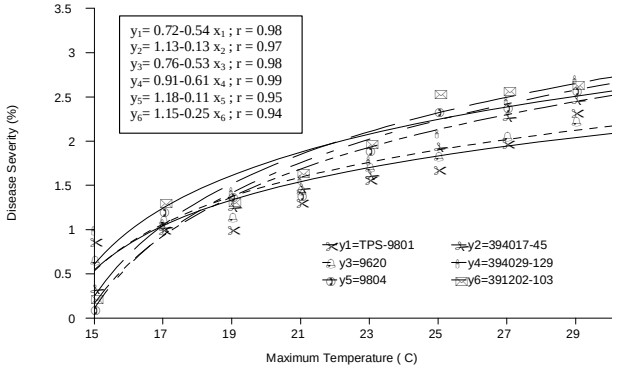


Fig. 2. Relationship of minimum temperature with potato disease severity on four potato varieties

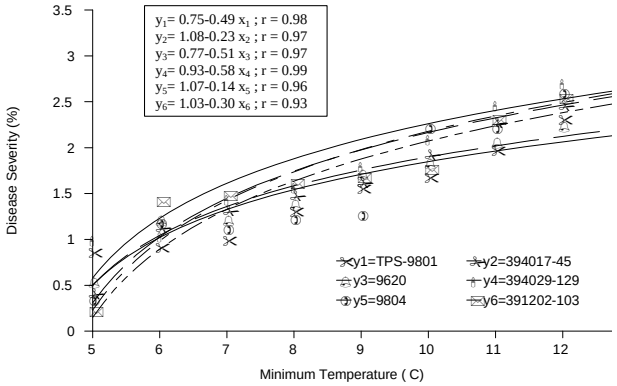


Fig. 3. Relationship of relative humidity with potato virus Y disease severity on four potato varieties

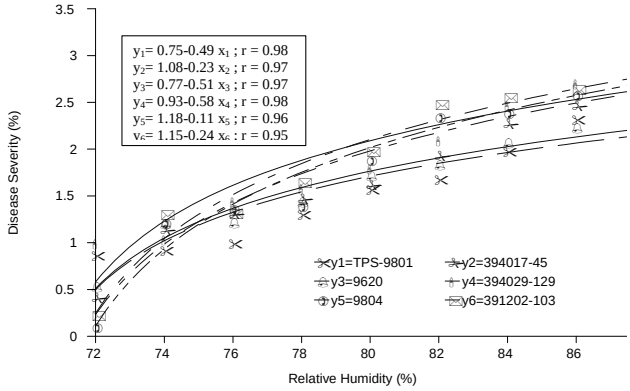
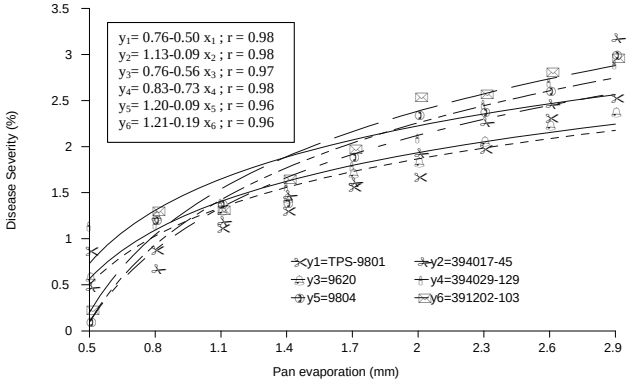


Fig. 4. Relationship of pan evaporation with potato virus Y disease severity on four potato varieties



under the favorable conditions concentrating on the temperatures (maximum and minimum), relative humidity and pan evaporation.

Disease severity was recorded at 1.7-2.3 mm pan evaporation (Fig. 4). All the varieties showed increasing disease development with increase in temperature from15-31°C.

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