# Susceptibility Behavior of Different Potato Accessions Against *Phytophthora Infestans*

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**ABSTRACT—** ***Late Blight of potato (Phytophthora infestans) remains the major disease throughout the world. To check the resistance/ susceptibility, thirty potato genotypes were planted for screening against late blight disease at Potato Research Institute, Sahiwal during the year 2010-11. Outbreak of late blight of potato caused by Phytophthora infestans have induced significant yield losses in the past and still a major threat to potato production in Pakistan. Potato genotypes were evaluated for their tolerance to late blight disease. Results revealed that eighteen genotypes expressed resistant response towards disease whereas two genotypes i.e. FD 8-1, and FD 52-2 showed moderately resistant. Similarly the genotype SH-70 exhibited moderately susceptible and four genotypes i.e. FD 49-62, FD 19-2, SH-473 and Hermes showed susceptible response towards disease. Hence it is concluded that the resistant genotypes could be used as a source in future potato breeding projects against phytophthora infestans..***

**Keywords—** Potato, Screening, PHYTOPHTHORA INFESTANS, Tuber yield

## 1. INTRODUCTION

The genus Solanum contains over 2000 species, of which only 150 is tuber bearing. An infestation of potatoes with Phytophthora infestans, also known as "potato late blight" is the most devastating potato disease worldwide. Potato (*Solanum tuberosum* L.) ranked 4th position in the world food production (Lung'aho et al., 2006) and over the years, it has become an important vegetable crop for farmers as well as consumers in Pakistan. In Pakistan, most of the people consume at least one tuber a day while in other countries of the world such as Europe and South America, potatoes are more important than cereals as a staple food (Haq, et al., 2008). In Pakistan, Potato occupies an area of 138.5 hectare with a production of 3141.4 million tons and its production has increased by 18.6 percent from the previous year (Anon, 2011). Among the diseases, late blight of potato caused by Phytophthora *infestans* (Mont.) De Barry is the most devastating and causing 50 – 70 % potato yield loss under favorable environmental conditions (Haq et al., 2008). Current control measures – involving extensive use of fungicides – come with environmental costs. Efforts have been made to develop commercial potato varieties with increased resistance to P. infestans (the causal agent of late blight) using a variety of approaches.The disease caused by the oomycete *Phytophthora infestans* (Mont. de Bary) is the greatest threat to the potato crop, accounting for significant annual losses in North America (Guenthner et al. 2001) and worldwide (Hijmans 2001). Tuber late blight results in tuber rotting in the field either in tubers intended for seed or consumption (Johnson and Cummings 2009; Kirk et al. 1999; Olanya *et al*. 2009). Screening potato genotypes for resistance to Phytophthora infestans is the most effective and environmental friendly way to prevent widespread devastation by late blight. Seed tubers infected with *P. infestans* will either rot in storage, after planting in the field or survive and initiate new epidemics of potato late blight (Kirk *et al*. 2009; Stevenson *et al*. 2007). Tubers can become blighted shortly after the disease is established on the foliage. *P. infestans* survives in tubers where it rots tubers intended for commercial use (Niemira *et al*. 1999). Three major components contribute to late blight resistance in tubers; 1) a physical barrier consisting of several layers of phellem cells, known as the periderm; 2) the outer cortical cell layers that retard the growth of lesions and can completely block hyphal growth; and 3) medulla storage tissues characterized by reduced hyphal growth and sporulation of *P. infestans* (Flier *et al*. 2001; Pathak and Clarke 1987). Chemical control is expensive, short durational and have health hazard while biological control is in its infancy for this disease. So the most effective and environmental friendly way to prevent wide spread devastation by late blight is to incorporate natural resistance in potato cultivars. The availability of resistant cultivars is scanty and calls for extensive screening of potato germplasm for the source of resistance. To identify the sources of resistance in the available germplasm, following studies were conducted.

## 2. MATERIALS AND METHODS

Thirty potato genotypes were planted at Potato Research Institute, Sahiwal, Pakistan for their screening during the year 2010-11, against late blight disease. The plot size was kept 7 X 0.75m2. One row of a most susceptible check SH-788 was planted all around the experimental field and each entry was sown in single replicate only. Progression of the disease based on visual symptoms was recorded at weekly basis by following Henfling modified disease estimation scale (Henfling, 1987). Infection percentage was calculated as suggested by the following researchers (Agrios, 2005; Haq et al., 2008). Standard agronomic practices were followed to raise the crop. No pesticide was sprayed so as to develop maximum disease pressure. The disease incidence was calculated on each genotype of potato by using following formula:

$$\text{Disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of observed plant}} \times 100$$

Disease rating was scored on weekly basis. The level of resistance or susceptibility was determined by following 1-9 grades developed by Henfling (2006) modified disease estimation scale for late blight disease of potato (Table.2). The results were statistically analyzed according to the formula given by Steel and Torrie (1980).

## 3. RESULTS AND DISCUSSION

The selection of superior genotypes with stable resistance and good adaptation to a wide range of environments is the main goal of potato late blight breeding projects (Wulff et al., 2006). A standard set of genotypes with a range of known and stable responses to late blight can be a very useful tool in this selection process. It can help to monitor the level of resistance of the tested plant materials as well as to monitor the disease pressure in the different environments (Wulff et al., 2006).Late blight is caused by the fungus P. infestans is the most devastating disease in the field grown potato. Like most pathogenic fungi, the late blight fungus cannot survive in soil or dead plant debris. Disease development is favored by cool, moist weather (Mukalazi et al., 2001). Disease development is favored by cool and moist weather. Under these conditions, lesions may appear on leaves within 3-5 days of infection, followed by the white mould growth (Younis et al., 2009). Spores formed on the mould are spread readily by irrigation, rain and equipment. They are easily dislodged by wind and rain and can be blown into neighbouring fields within 5-10 miles or more, thus beginning another cycle of disease (Mukalazi et al., 2001).To determine the present condition of resistance against late blight of potato, thirty genotypes were evaluated for their prospective against *Phytophthora infestans*. Symptoms appeared at first as water soaked spots, usually at the edges of lower leaves. In moist weather, the spots enlarged rapidly and form brown, blighted area with indefinite borders. Thirty genotypes were tested in disease favorable environment but out of thirty tested genotypes eighteen genotypes i.e. FD3-9, FD49-28, FD8-3, Asterix, FD35-25, FD35-36, FD69-1, SH-297, SH-5, SH-204, SH-692, SH-216, FD51-5, N-22, N-18, N-30, N2002-1 and FD1-10 depicted highly resistant response (0.0-2.99 grade) while 5 genotypes i.e., FD1-3, FD37-13, FD1-9, FSD White and FSD Red expressed resistant response ( 3-3.99 grade) towards disease whereas two genotypes i.e. FD 8-1, and FD52-2 showed moderately resistant (4 - 4.99 grade) Similarly the genotype SH-70 exhibited moderately susceptible (5-5.99 grade) and four genotypes i.e. FD49-62, FD19-2, SH473 and Hermes showed Susceptible response towards disease (6 - 9 grade). In this study, minimum disease rating 0.00 was recorded on FD 69-1 while maximum (7.22) in SH-473. Our data showed that a source of resistance against *phytophthora infestans* is available in some of potato genotypes tested under field conditions.

## 4. CONCLUSION

The results concluded that potato cultivars were markedly different in their resistance against late blight caused by P. infestans. Late blight disease fungus P. infestans development, sporulation, resistance and susceptibility tests were performed in the field tests with over than thirty potato genotypes of very different genetic resources.

After testing results it was determined that the most of tested genotypes had highly resistant response, only cultivars FD49-62, FD19-2, SH473 and Hermes showed susceptible response to the late blight while genotype SH-70 exhibited moderately susceptible. So it is concluded that out of thirty genotypes > 50% genotypes are highly resistant to late blight and these are recommended for growing on ecological farm.The resistant cultivars should be exploited directly or indirectly in conventional breeding to improve potato germplasm at desirable level.

## 5. REFERENCES


- Agrios, G. N. Plant Pathology 4th edition. PP. 442-445. Academic Press, London, 2005.
- Anonymous,. Area, production and year of important crops. Part 1. In: Government of Pakistan, Statistic division, Pakistan Bureau of Statistic. Agricultural Statistic of Pakistan (2010-2011).
- Campbell, C. L. and Madden, L. V. Introduction to Plant Disease Epidemiology. New York: John Wiley and Sons.1990.
- Flier, W.G., L.J. Turkensteen, G.B.M. van den Bosch, P.F.G. Vereijken, and A. Mulder.. Differential interaction of *Phytophthora infestans* of potato cultivars with different levels of blight resistance. *Plant Pathology.* Vol.50, pp. 292-301, 2001.
- Guenthner, J.F., K.C. Michael, and P. Nolte.. The economic impact of potato late blight on US growers. *Potato Research* Vol.44, pp. 121-125, 2001.
- Haq, I., A. Rashid and S.A. Khan. Relative efficacy of various fungicides, chemicals and biochemicals against late blight of potato. *Pak. J. Phytopathol*., Vol.21, No. 1, pp. 129-133, 2008.
- Henfling, J.W.. Late blight of potato. *Technical Information Bulletin* 4. CIP,Lima, Peru. 25 pp, 1987.
- Hijmans, R. Global distribution of the potato crop. *American Journal of Potato Research* Vol.78, pp. 408-412, 2001.
- Johnson, D.A., and T.F. Cummings. Latent infection of potato seed tubers by *Phytophthora infestans* during long-term cold storage. *Plant Disease*. Vol. 93, pp. 940-946, 2009.
- Kirk, W.W., B.A. Niemira BA, and J.M. Stein.. Late blight (*Phytophthora infestans* (Mont.) de Bary) development from infected potato seed pieces treated with fungicides. *Pesticide Science* Vol. 55, pp. 1151-1158, 1999.
- Kirk, W.W., F. Abu el, Samen, P. Wharton, D. Douches, P. Tumbalam, C. Thill, and A. Thompson.. Impact of different US genotypes of *Phytophthora infestans* on potato seed tuber rot and plant emergence in a range of cultivars and advanced breeding lines. *Potato Research* Vol. 51, pp. 121-40, 2009.
- Lung'aho, C., Nderitu, S.K.N., Kabira, J.N., El-Bedewey, R., Olanya, O.M. & Walingo, A.. Yield performance and release of four late blight tolerant potato varieties in Kenya. Journal of Agronomy Vol. 5, pp. 57-61, 2006.
- Mukalazi, J., E. Adipala, T. Sengooba, J.J. Hakiza, M. Olanya and H.M. Kidanemariam. Variability in potato late blight severity and its effect on tuber yield in Uganda. Afr. Crop Sci. J. Vol. 9, pp. 195-201, 2001.
- Niemira, B.A., W.W. Kirk, and J.M. Stein.. Screening for late blight susceptibility in potato tubers by digital analysis of cut tuber surfaces. *Plant Disease.* Vol . 83, pp. 469-73, 1999.
- Olanya, M.O., P.S. Ojiambo, R.O. Nyankanga, C.W. Honeycutt, and W.W. Kirk. Recent developments in managing tuber blight of potato (*Solanum tuberosum*) caused by *Phytophthora infestans*. *Canadian Journal of Plant Pathology* Vol. 31, pp. 280- 289, 2009.
- Steel, R.G.D. and J. H. Torrie.. Principles and Procedures of Statistics. A biometrical approach. 2nd edit. McGraw Hill Pub. Co., New York. P. 633. 1997.
- Stevenson, W.R., W.W. Kirk, and Z.K. Atallah.. Management of foliar disease, early blight, late blight and white mold. In *Potato Health Management*, ed. D.A. Johnson, pp. 209-22. St. Paul, MN, USA: APS Press, 2007.
- Wullf, G. E., Pervez.W., Nelson. J. R., Bonierable. M., Landeo. A. J and Forbes. A. G.. Identification of stable resistance to *Phytophthora infestans* in potato genotypes evaluated in field experiments in Peru. Experimental Agriculture. Vol.43, no. 3, pp. 353-363. 2006.
- Younis, M., M. A. Khan, S. T. Sahi and R. Ahmad,. Genotypic variations among different potato lines/varieties for tolerance against late blight disease.*Pak. J. Phytopathol*., Vol. 21, no. 1, pp. 13-17, 2009.

**Table.1. Disease incidence, level of resistance/ susceptibility on 30 potato genotypes in 2010-11**

| No | Genotypes | Ratings | Response |
|---|---|---|---|
| 1 | FD3-9 | 1.59 | HR |
| 2 | FD8-1 | 4.98 | MR |
| 3 | FD49-28 | 0.27 | HR |
| 4 | FD1-3 | 3.19 | R |
| 5 | FD8-3 | 0.62 | HR |
| 6 | FD52-2 | 4.58 | MR |
| 7 | FD37-13 | 3.05 | R |
| 8 | Asterix | 2.98 | HR |
| 9 | FD35-25 | 2.75 | HR |
| 10 | FD1-9 | 3.66 | R |
| 11 | FD35-36 | 1.87 | HR |
| 12 | FD49-62 | 6.15 | S |
| 13 | FD69-1 | 0.00 | HR |
| 14 | Fsd White | 3.52 | R |
| 15 | FD19-2 | 6.75 | S |
| 16 | SH-297 | 0.66 | HR |
| 17 | SH-5 | 2.52 | HR |
| 18 | SH-704 | 2.43 | HR |
| 19 | SH-692 | 0.33 | HR |
| 20 | SH-473 | 7.22 | S |
| 21 | Fsd Red | 3.54 | R |
| 22 | SH-70 | 5.68 | MS |
| 23 | SH-216 | 0.55 | HR |
| 24 | FD51-5 | 0.78 | HR |
| 25 | N-22 | 1.15 | HR |
| 26 | Hermes | 6.44 | S |
| 27 | N-18 | 1.28 | HR |
| 28 | N2002-1 | 1.62 | HR |
| 29 | N-30 | 1.24 | HR |
| 30 | FD1-10 | 0.25 | HR |
| LSD 5% = 1.12 | | | |

**Table.2. Henfling modified disease estimation scale for *Phytophthora infestans***

| Grade | % Incidence | Nature of Infection (Level of Resistance / Susceptibility) |
|---|---|---|
| 1 | 0.000 | Not seen on field |
| 2 | 0.100 | Only few plants affected here and there; up to 1or2 spots in12 yards radius. |
| 3 | 1.000 | Up to 10 spots per plant, or general light spotting |
| 4 | 5.000 | About 50 spots per plant or up to 1 leaflet in 10 attacked. |
| 5 | 25.00 | Nearly every leaflet with lesions, plants still retaining normal form; field may smell of blight but looks green, although every plant is affected. |
| 6 | 50.00 | Every plant affected and about 50% of leaf area destroyed by blight; field looks green flecked with brown. |
| 7 | 75.00 | About 75% of leaf area destroyed by blight, field looks neither predominantly brown nor green. |
| 8 | 95.00 | Only a few leaves left green but stems green. |
| 9 | 100.0 | All leaves dead, stem dead or drying. |

HR = Highly resistant; R = Resistant; MR = Moderately resistant; MS = Moderately susceptible; S = Susceptible; HS = Highly susceptible;