J. Mycopathol. Res. ***51(2)*** *: 315-318, 2013;* (ISSN 0971-3719)
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Evaluation of potato germplasms against Late Blight disease in the red lateritic zone of West Bengal

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Received : 16.08.2011 RMS : 30.10.2012 Accepted : 03.04.2013 Published : 28.10.2013

Eighty cultivars of potato were screened for Late Blight under natural epiphytotic conditions for four successive years (2004 to 2008). Seven, fifteen and twelve cultivars were categorized as highly resistant, resistant and moderately resistant respectively, while the rest were susceptible. The resistance exhibited over the four seasons were stable and durable in nature.

Key words: Potato, Late blight, *Phytophthora infestans,* resistance

INTRODUCTION

Late blight caused by the Oomycetes *Phytophthora infestans* (Mont.) De Bary is the most economically important and destructive disease in potato cultivation, causing billion dollar losses every year and presenting a constant threat to the potato industry world wide (Cook and Less 2004). Reduced yield caused by late blight can be attributed to premature killing of the foliage and haulm and the infection of potato tubers (Flier *et al, 2001*). Mackey (1996) has reported that crop losses and pesticides application cost incurs a global cost of almost 3 billion USD, annually. Evidence is accumulating that *P. infestans* is reproducing sexually around the world, resulting in a high level of variation of the pathogen races that might lead to an increased and rapid adaptation to certain fungicides and host resistance (Turkensteen *et al,* 2000; Smart and Fry, 2001).

Late blight is controlled worldwide with fungicide sprays and in recent years their usage is in the increase (Fry and Goodwin 1997; Johnson *et al,* 2000). The disease might appear in such a severe form that 15-20 sprays in the growing seasons of potato is quite common (Cadena Hinjosa *et al,* 2007). With the overuse of chemicals and growing public consciousness regarding safe crop protection with low adverse effect on human health and environment, the demand of breeding for durable resistance to late bglight has become a focus for most of the potato breeding programmes (Inglis *et al,* 1996). Integration of host resistance, chemical control and forecasting models could considerably reduce late blight damage, control cost and increase yield and quality of the tubers (Fry and Shtienberg, 1990; Grunwald *et al,* 2002). Therefore, potato cultivars with diverse genetic background are screened in a naturally infested field to identify the resistance reaction of cultivars under normal growing practice.

MATERIALS AND METHODS

The experiment was carried out during four years (2004 to 2008) at Anandapur, Midnapur (West), West Bengal with a geographic location of 22.57^{0}N and 87.42^{0}E, and an altitude of 23.2 metres above sea level (MSL)

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Eighty potato cultivars were planted in naturally infested field at the farm during the second fortnight of November, every year. The cultivars were interspersed with a known susceptible check,cv. Voran. The field selected for the experiment had been under potato cultivation for last ten years and the late blight disease incidence has been reported (Anon.2002) every year. The experiment was laid in a randomized complete block design with plots of 2.5 m x 1 m in three replicates. Each plot had two rows, with 90 cm. spacing between them while the tubers were planted every 25 cm along the rows.

Fertilizer (N-P-K: 120-140-60) was applied during the season with 60 kg of N each as basal and top dressing. As severe late blight develops every year in this region, no artificial inoculation was necessary and infection was allowed to start from natural inoculum. Pencycuron 25 EC and Imidachloprid 17.8 SL were sparyed twice at 15 days interval to control *Rhizoctonia solani* and insect vectors respectively. Foliar insects were controlled by endosulfan and was applied as required.

Late blight scores were recorded periodically following the prescribed standard scale (James, 1971). Twenty leaves each from ten plants (expected the ones at the edges) were scored and Percentage Disease Index (PDI) was determined by using the formula :

$$PDI = \frac{\text{Summation of total scores}}{\text{No. of observation x maximum score}} \times 100$$

Disease assessment was carried out every ten days, from the time of plant emergence, and stopped when Kufri Jyoti was more than 90% infected. The PDI values of each year was pooled and potato cultivars were grouped as Highly resistant (HR), Resistant (R), Moderately resistant (MR), Moderately susceptible (MS) and Highly susceptible (HS) (Black, 1970). The average temperature and relative humidity (RH) of four years during the growing seasons (Oct-Feb.) have been represented in Fig.1. The data obtained were subjected to standard statistical procedures (Chandel, 1997)

RESULTS AND DISCUSSION

In the present study, the cultivars were exposed to highly complex (9-10 genes) races of *Phytophthora infections* prevalent under natural field conditions and the possibility of disease avoidance was negligible as the disease was severe in all the years. Results clearly showed (Table 1) that except Voran, the resistant check, only the tissue cultured (TC) entries of Kufri Chipsona, Kufri Pokhraj, TPS-D-150, TPS-13, MFI and JT8/6-107 exhibited HR reaction. Non-tissue cultured entries of Kufri Pokhraj, TPS-13 and TPS-D-150 exhibited a response variation, being in the HS category. Tissue culture technique has been adopted widely to eliminate viruses (Hollings, 1965; Griffith *et al,* 1990) and bacteria (Knauss, 1976) and in the recent times fungi, too can be eliminated by the technique (Singh,2006). However, non tissue cultured Kufri Chipsona 1 was categorized in MR group and may be used as a parent material for breeding purposes in this regiuon. All the red cultivars used in the study i.e., PRT 1/6, PRT3 A/6, PRT8A/6, PRT7/6, PRT0/19, PRT12/19 and Kufri Kanchan registered R reaction. The correlation between disease susceptibility and skin colour may be of importance as reported in case of red skinned cultivars Kufri Sindhuri which was less susceptible to scab pathogen, *Streptomyces scabies* (Singh and Singh, 1992; Masoodi, 1986). Similar variation in disease susceptibility was observed in onion smudge caused by *Colletotrichum circinans* where red skinned onions were more resistant to the disease than the white skinned ones (Agrios, 2010). Non red cultivars like FTL 1-1533, CPS-182, 374 (a), HYV-3, C-990, Bronder's Slab, JX -123 and CP3262X13 also registered R reactions in the present study just as Kufri Kundan and Kraigs Defiance, two not red skinned varieties were least susceptible to the scab pathogen (Mishra and Srivastav 2001). There has been reports, *P.infestans* is capable to adapt to cultivars bearing rate - reducing resistance (Caten, 1974; Latin *et al,* 1981) but all the HR and R cultivars showed high level of resistance and this resistance was effective and stable during the period of study. Moreover, the results are in agreement with similar studies conducted in other locations (Grunwald *et al*, 2002; Cadena Hinjosa *et al.,* 2007) where the resistance was stable without any decay of the same during four years of investigation. The presence of aggressive, variable population of the pathogen may also have an influence on the stability of field resistance due to their high level of parasitic fitness (Nelson, 1979; Latin *et al*, 1981).

Table 1 : Classification of cultivars on the basis of their disease reaction

Class	Per cent blight foliage	Cultivars/Germplasm lines
Highly resistant (HR)	< 3	Voran, Kufri Chipsona 1 (TC), TPS-D-150(TC), Kufri Pokohraj (TC), TPS-13 (TC), MF 1 (TC), JT 8/6-107(TC)
Resistant (R)	4-10	FTL 1-1533, CPS-182, 374 (a), Kufri Kanchan, HYV-3,C-990, Bronder's slab, JX-123, CP 3262 x 13, PRT 1/6 (RED), PRT 8A/6 (RED), PRT7/6 (RED), PRT 20/19 (RED), PRT 12/19 (RED), PRT 3a/6 (RED),
Moderatly resistance (MR)	11-30	HYV-5, Kufri Ahoka, Diamond, KufriChipsona 1 (normal), 85-P-718, 1591/11, CP-3192XTPS-D-150, CP 3358x13, CP 1263x13, CP3360x13, 92-Pt 27 (TPS), Chipsona-2
Susceptible (S)	31-60	92-PT 27, 107/MST-1, Cardinal, JX-214, Azax, HPS-1/13, ON-102, B-2-29/2,I API-16-17-16, Australian white, K-22, Red Pontiac, Freshco, PRT8a/6, prt2/6, PRT 20/19, PRT 10/6, JI-5857
Highly Susceptible (HS)	> 60	Kufri Chandramukhi, Kufri Jyoti, S-380, MP-90-G, Duster standard, Sante Arran Peak, SE-D/51, SH-68, 85-P-678, Kufri Anand, B-24, Anosta, JX-161, MP-90-94, 7/1-MST-1, Arren Pilot, PRT–10-13A/19, 31-92 x PRT 19, PRT 12/19, PRT-313/6, PRT-13.3/19, TPS-D-150, CP 3156 x 13, TPS-13, JEX/A–680-16, Kufri Pokhraj, JEX/680-16

N.B: TC: Tissue cultured

The susceptible control Kufri Jyoti was not affected by the pathogen, being almost immune to late blight till the late 90s in this region. This is because, the variety has three major genes R3, R4 and R7 for resistance to late blight (Gopal and Singh, 2003) derived from *Solanum demissum.* The break down of resistance occur due to emergence to complex races which indicated the absence of minor genes for resistance to late blight in this cultivar. In the present study 28 and 18 cultivars were graded as HS and S respectively Polygenic resistance (Vander Plank, 1984) being the preferred type of resistance as monogenic resistance is not durable (Umaerus and Umaerus; 1994), molecular characterization of these cultivars need to be done for ascertaining the R-gene content, if any.

The cultivars found to be highly resistant or resistant to late blight in the present trial can be evaluated further for mining of other economic trait of

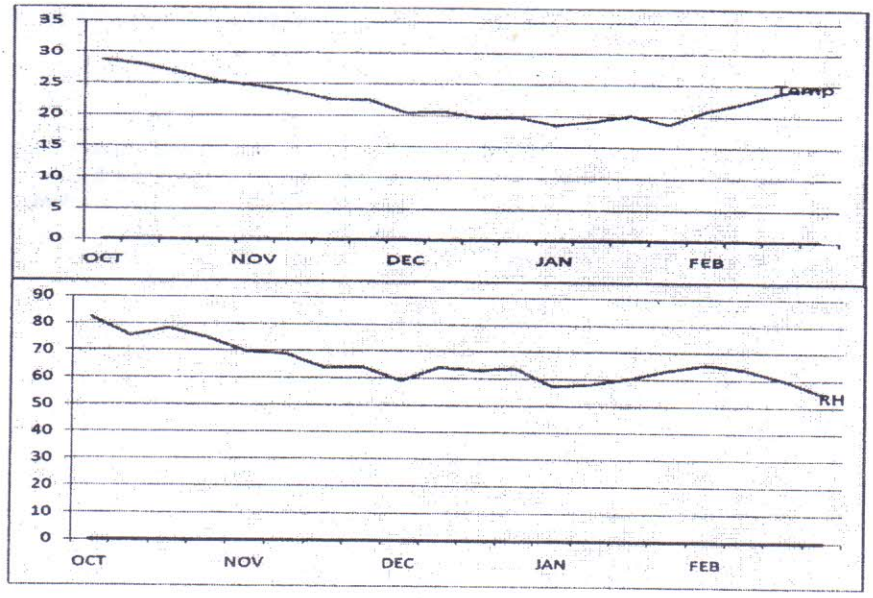

Fig. 1 : Average temperature and relative humidity of Anandpur during 2004-2008

importance so as to accentuate their commercial viability. They may also be useful as parental lines for late blight resistant breeding programme as they are expected to produce populations with higher proportion of resistant genotypes (Black, 1970). For an unequivocal conclusion regarding the resistant staus of the cultivars used in the study, a more precise and finer differentiation can be done using AUDPC (Area Under Disease Progress Curve) for at least two years.

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