Screening of potato germplasm and evaluation of fungicides against late blight of potato

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Abstract

Late blight of potato, caused by *Phytophthora infestans* (Mont.) de Bary, is one of the most important diseases of potato (*Solanum tuberosum* L.) in all potato growing areas of Pakistan. Field experiments were conducted to screen out thirty potato varieties and to evaluate the efficacy of three fungicides namely Tazoline (mancozeb + metalaxy), Kocide (copper oxychloride) and Ridomil Gold (mefenoxam) on three most susceptible potato varieties against late blight. Most of the potato varieties showed susceptibility to *P. infestans*. None of the variety was found immune or resistant. Fourteen varieties were moderately resistant, eight were moderately susceptible, five were susceptible and three were highly susceptible. In case of fungicide effect Ridomil Gold (DI 44%) showed the best results followed by Tazoline (60%) and Kocide (73%) as compared to control (82%). Variety SH-479 gave the highest potato yield (217.7 g) per plant followed by SH-332 (194.3 g) as compared to control treatment (124.7 g).

Keywords: Fungicide, late blight of potato, *Phytophthora infestans*, potato, yield.

Introduction

Potato is an important vegetable cash crop grown all over the world and ranks fourth after wheat (*Triticum aestivum* L.), maize (*Zea mays* L.) and rice (*Oryza sativa* L.) (Ewing, 1997). It was introduced into England and Europe in 1590 from the Andean section of South America (Swiecz, 1995). It provides a balanced source of dietary nutrients such as dietary fiber (up to 3.3%), ascorbic acid (up to 42 mg 100 g^{-1}), potassium (up to 693.8 mg 100 g^{-1}), antioxidant phenols such as a solanine (0.001-47.2 mg 100 g^{-1}) and lesser amounts of protein (0.85-4.2%), amino acids, minerals, vitamins, and some beneficial and harmful bioactive components (Swiecz, 1995). In Pakistan, total area under potato production is 101,500 ha with an average yield of 16.4 t ha^{-1} (Agric Static of Pakistan, 2010). It is a cool season crop and a temperature up to 24 ° C is considered best for the growth of young plants. However, the production of tubers is ideal at 20 °C. In Pakistan, the average production of potato is quite low as compared to the rest of potato growing countries (Kelman, 1984). This low yield is due to the diseases that causes huge losses in terms of yield as well as market value of tubers. Potato late blight caused by fungus *P. infestans* is a devastating disease that causes yield losses up to 50-70% under favorable environmental conditions Abdul El-Khair and Haggag, 2007; Rahman *et al.*, 2008). Late blight of potato is identified by black/brown lesions on leaves and stems. These lesions soon expand rapidly and become necrotic. *P. infestans* produces sporangia on sporangiophores and are mainly disseminated by air. Lack of proper resistant materials i.e. tubers, seeds, poor agricultural practices and improper use of the chemical control are the most devastating limitations for potato production leading to lower potato yield. Appropriate fungicide application and screening of resistance sources against potato late blight can be useful to reduce the disease attack (Perez and Forbes, 2010). Keeping in view the economic and social importance of late blight disease, the present study was designed to screen 30 varieties of potato against *P. infestans* and to evaluate the efficiency of three fungicides to manage potato late blight disease.

Materials and Methods

The present study was conducted at the research area of Department of Plant Pathology University of Agriculture Faisalabad during 2010-2011. Potato tuber seeds of 30 potato cultivars were obtained from Potato Research Center (PRC), Sahiwal. Seeds of these potato varieties were sown on ridges having randomized complete block design (RCBD) with plant to plant distance 15 cm and row to row distance 60 cm with three replications. Each replication has 3 rows with ten plants in each row.

Isolation, purification and identification of the fungus

For the isolation of *P. infestans*, infected leaves were cut into small pieces and were surface disinfested with 0.1% mercuric chloride solution. The PARP media comprised of 25 g ampicillin, 5 mL PCNB solution, 1.01 mL rifampicin solution and 0.4 mL pimaricin was used for the isolation of *P. infestans* (Jeffers, 2006). For the purification of *P. infestans* single spore technique was used. Identification of *P. infestans* was done according to the morphological characters of the fungus.

Screening of potato varieties for resistance against *P. infestans*

For the pathogenicity test, potato seeds were sown in pots. After one month of sowing, these plants were sprayed with *P. infestans* inoculum having 3×10^6 spores mL^{-1} of water. The relative humidity was maintained over 75% by covering the inoculated plants with polythene bags. The symptoms so developed on the plants were compared with the diseased ones and identification of the pathogen was done according to the morphological characters of the fungus. The disease incidence was recorded soon after the appearance of disease symptoms and was assessed as:

$$\text{Disease incidence (\%)} = \frac{\text{No. of diseased plants}}{\text{No. of total plants}} \times 100$$

Disease severity data was recorded to assess the levels of susceptibility and resistance of each cultivar using 1-9 disease rating scale (Henfing, 1979) as shown in Table 1.

Evaluation of fungicides

A field trail was conducted to evaluate the effect of three fungicides (Tazoline, Ridomil gold and Kocide) against the *P. infestans* on three susceptible potato varieties. These fungicides were applied as foliar spray after 7, 14, 21 and 28 days interval after the appearance of 1st disease symptom. For control treatment, the potato plants were sprayed with water. The data on disease incidence/severity was recorded at regular intervals, one day before spraying and ten days after spraying, using 1-9 grade scale of Henfing (1979). To evaluate the effect of used fungicides, at the end of the experiment yield data was recorded. Ten plants per treatment were selected randomly and were dug out manually and weighted.

Statistical analysis

The data was subjected to analysis of variance (ANOVA) at 5% level of significance for comparing the difference among treatment means (Steel *et al.*, 1997).

Results and Discussion

Screening of potato varieties for resistance against *P. infestans*

Comparative mean of late blight disease incidence on thirty potato varieties is shown in Fig. 1. Most of the potato varieties showed susceptibility to *P. infestans* because the weather conditions during the crop season were conducive for the disease development. Disease incidence was more in varieties namely SH-332 (80%), SH-479 (76%) and FD-76-35 (73%) followed by FD-52 (70%), FD-53-1(66%) and FD-52-2 (66%). Disease incidence was very low in variety Desire (23%) followed by SH-297 (30%). Resistance sources determination against late blight of potato is common practice among Spartan in potato germplasm. Cristinzio and Testa (1999) reported that resistance against ten potato cultivars (Agria, Ajax, Desiree Liseta, Kennebec, Majestic, Monalisa, Prima, Spunta ar Tonda di Berlino) against eight fungal strains of *P. infestans*.

Level of resistance/susceptibility of thirty potato varieties against *P. instance* were presented in Fig. 2. Out of thirty potato varieties, none was found to be immune or resistant, fourteen were moderately resistant (MR), eight were moderately susceptible (MS), five were susceptible (S) and three were highly susceptible (HS). Variety SH-332 was highly susceptible having disease severity value (8) followed by variety desire and SH-479 each having DS value (7). El-Shimy and Tomader (2006) screened twenty-five potato cultivars for resistance to late blight pathogen in Behira Governorate, Egypt during 2003-04. For yield losses evaluation (2003-04), 6 cultivars (Lady Roseta, Nicola, Spunta, Atlas, Diamont and Hermes) were used. Cultivars Altesse, Occania, Safrane and Soleia were highly resistant, while Daisy, Hermine and Isabel were highly susceptible to the cultivar. Yield (tuber) loss ranged from 11.75 kg $plot^{-1}$ (in Hermes) to 18 kg $plot^{-1}$ (in Lady Roseta) during 2003, while this ranged from

11.25 kg $plot^{-1}$ (in Hermes) to 23.75 kg $plot^{-1}$ (in Spunta) during 2004.

Evaluation of Fungicides

The effect of three fungicides i.e. Ridomil gold, Tazoline and Kocide applied on three potato varieties SH-479, SH-332 and FD-76-35 is presented in Fig. 3. Ridomil gold showed the best results with disease severity (DS) 4.4 followed by Tazoline (DS 6.0) and Kocide (DS 7.3) as compared to control (DS 8.2). Variety SH-479 was the best having mean disease severity 6.0 followed by FD-76-35 having mean disease severity 6.2. Variety SH-332 showed maximum disease severity 7.2. Dithane M-45 gave good control of late blight of potato in field tests in the Kaghan valley, Pakistan (Jan, 1999). In an experiment disease was effective by 8% metalaxyl + 64% mancozeb (as Ridomil MZ 72 WP) (Dhanbir *et al.*, 1994). Oliveria *et al.* (2003) investigated the activities of 2 adjuvant in azoxystrobin solution at different rates in controlling late blight and early blight (*Alternaria solani*) infecting potato and tomato. All the fungicides treatments minimized the severity of the disease and increased yield as compared to the control. Azoxystrobin 9 + Fixade (8 g + 50 mL) showed higher yield than azoxystrobin alone at 4 g on potato.

Effect of fungicides on potato yield

The effect of fungicide on potato yield reflects that SH-479 gave higher potato yield (217.7 g) per plant whereas SH-332 gave 194.3 g per plant as compared to control (124.7 g) (Fig. 4). The effect of copper fungicide was used against *P. infestans* for two years in England. The copper fungicide reduced the foliar blight severity in all cultivars for both years by 27% average as well as increase yield about 20% average but did not affect tuber blight disease (Speiser *et al.*, 2006). Integration of host plant resistance with fungicide application reduce late blight severity more than 50% as a result gains in yield by 30 % when compared with untreated control Kankwatsa *et al.* (2002)

Conclusions

Most of the potato varieties used showed susceptibility to *P. infestans*. None of the variety was found to be immune or resistant, fourteen were moderately resistant, eight were moderately susceptible, five were susceptible and three were highly susceptible. In case of fungicidal evaluation, Ridomil gold showed the best results followed by Tazoline and Kocide as compared to control. Minimum disease severity and higher potato yield per plant was shown by variety SH-479 followed by FD-76-35. Whereas variety SH-332 showed maximum disease severity as compared to control.

Table 1: Disease severity rating scale of Henfing (1979).

Grade	Level of resistance and susceptibility
1	No symptoms seen in field
2	Only few plants affected, up to 1 or 2 spots
3	Up to 10 spots per plant, or general light spotting
4	About 50 spots per plant or up to 1 fully attacked leaflet out of 10.
5	Nearly every leaflet with lesions, plants still retaining normal form, field may smell of blight but looks green, although every plant is affected.
6	Early plant affected and about 50% of leaf area destroyed by blight, field looks green flecked with brown.
7	About 75% of leaf area destroyed by blight, field looks neither predominantly brown nor green.
8	Only a few leaves left green but stems green.
9	All leaves dead, stem dead or dying.

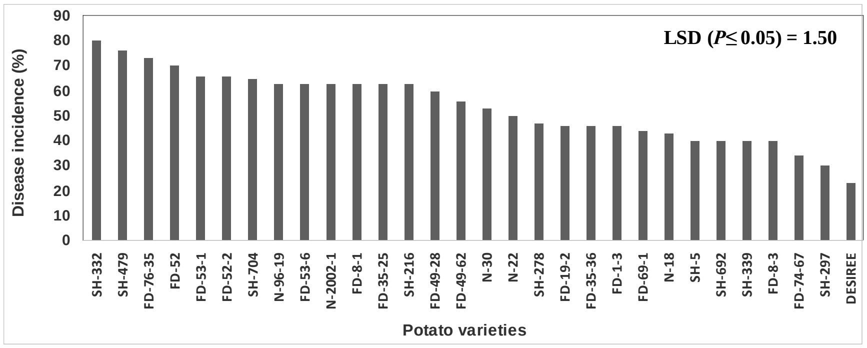

Fig 1: Incidence of late bight disease on different potato varieties.

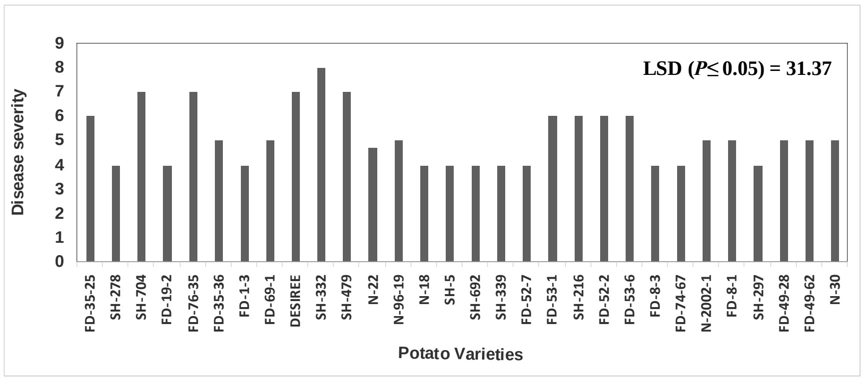

Fig. 2: Level of Resistance in potato varieties against *P. infestance.*

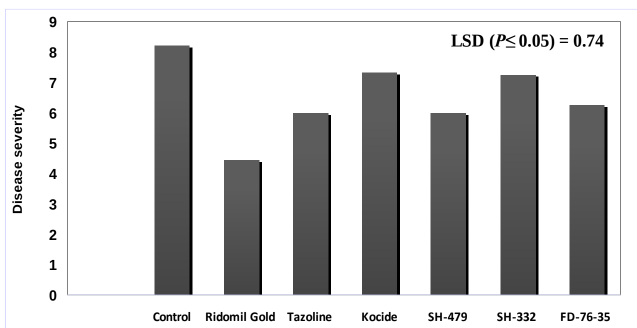

Fig. 3: Effect of fungicides on disease severity in different potato varieties.

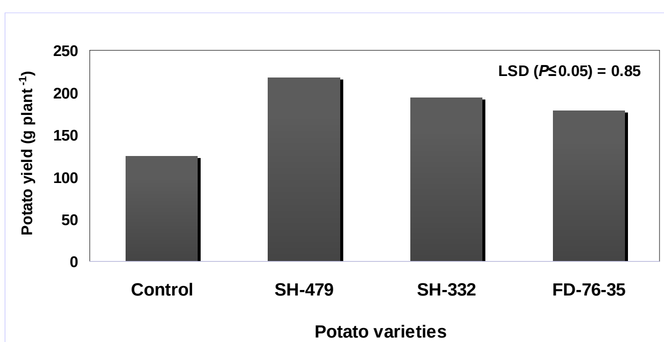

Fig. 4: Effect of fungicides on potato yield.

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