Characterization and Screening of Synthetic Fungicides against *Alternaria solani* affecting Potato crop in Poonch Azad Kashmir

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Abstract

Temperate areas favor growth of potato crop globally but also favor attack of opportunistic fungi. Diseases caused by Alternaria fungi are considered one of the most common and dangerous diseases of many plants around the world. Early detection of early blight caused by *Alternaria solani* could promote a drastic reduction in the consumption of plant protection agents and the related production losses. Present study was aimed following screening application of various synthetic fungicides for timely management of *Alternaria solani*. A screening methodology was used to assess the resistance of different potato cultivars against early blight caused by *A. solani*. The experiment followed a randomized complete block design with three replications, with a selection of three potato cultivars selected for screening. Healthy potato plants were transplanted into individual plots and maintained using standard agronomic practices. Disease severity index was calculated at regular intervals. The results indicated that all fungicides viz; captafol, copper oxychloride + dichlofluanid, metiram+ carbendazim and Tebuconazole+ Flutriafol showed significant results against selected parameters. The application of applied fungicides apparently reduced the effect of *A. solani* on potato crop. The most effective fungicide was metiram+ carbendazim that exhibited most prominent effective results. To minimize losses caused by *A. solani*, early detection and application of suitable fungicide is suitable for reducing economic losses.

Keywords; Early blight, Potato, *A. Solani*, Fungicides.

1. INTRODUCTION

Potato is globally cultivated and recognized as the third significant staple food crop worldwide, (FAOSTAT, 2022). Potato crop also known as mother of hungry nations because of its rich source of carbohydrates, proteins, & vitamins. Potato plant was initially originated in Peru and is native to South America. The worldwide production of potatoes was approximately 362 million metric tonnes (FAO, 2023). Fresh potatoes are a staple diet for over 1.6 billion people in China and India (65 kilograms per person annually). The reality that developing countries frequently grow more potatoes than developed countries is the proof of the value of this crop as a source of jobs, revenue, & food, particularly in America, Africa, and Asia (Devaux et al., 2020). Pakistan is cultivating potato crop commercially and during year 2022, Pakistan successfully exported approximately 0.5 million tons of potatoes to various international markets, including Afghanistan, Sri Lanka, UAE, Russia, Qatar, etc. (Ahmad, 2022).

Biotic and abiotic factors are major threats against potato cultivation. Microbes including fungi, viruses, nematodes, bacteria, insects etc (Kumari et al. 2017). The major abiotic stresses affecting crop production are micro and macro-nutrient deficiency, viz; lack of zinc, salinity, elevated temperatures & acidulous pH levels. Furthermore, the high levels application of nitrogen not only leads to a delay in the development of tubers and increases their susceptibility to peeling and bruising during the harvest process, but also results in a reduction in starch levels. (Hooker, 1983).

In Pakistan, many potato diseases are reported in all growing areas (Ahmad et al., 1991). Fungal diseases of potato in Pakistan include late blight, early blight, black mold, green mold, Cladosporium rot & brown rot. Early blight disease is a major threat to potato production worldwide. Four types of Alternaria fungi, which produce large spores, have been identified as the sources of early blight in potato plants. These include *A. solani*, *A. grandis*, *A. protenta, and A. linariae* (Landschoot et al., 2017). The primary pathogen of this disease is a *(Alternaria solani)*. This pathogen damages the leaf, stem and potatoes. The cost in billions worldwide per year for only management of this disease (Kumar et al., 2008). The necrotrophic fungal phytopathogen belonging to the ascomycetes group is responsible for causing significant yield losses, reaching up to 80 per cent, in potato crops annually in certain regions worldwide (Rodrigues et al., 2010). Early blight spreads faster on mature potato crops and growing potato cultivars. Due to the capability of *Alternaria. spp*. to bear excessive temperatures, this disease will cause further damage in Europe

and all potato- producing regions over the next decade (Camire, 2016). Quinone outside inhibitors (Qols) are additional fungicides used for the control of early blight. The significance of these fungicides is based on their ability to show broad-spectrum activity and their efficacy at low application rates. Some of the beneficial benefits of these fungicides on plants include an increase in chlorophyll content. (Butkute et al., 2008). Fungicides produce their inhibitory effects on mitochondrial respiration by slowing electron transport. (Bartlett et al., 2002). The pathogen is highly susceptible to the evolution of resistance because of its single-site way of action (Leiminger et al., 2014).

Fungicides are an essential defensive measure adopted within the broad spectrum of an integrated disease management (IDM) approach. Fungicides comprise around 27% of the global agricultural pest control sector, successfully reducing approximately 41% of food loss caused by plant pathogens. A total of 3600 fungicides were granted licenses on a worldwide basis. (Reilly, et al., 2012). The control strategy that has been widely regarded as the most successful involves regular application of protectant fungicides, commencing early in the growth season and continuing until the vine's end of growth. The proposed research aims following major objective of screening potato germplasm and in vivo evaluation of selected fungicides against early blight disease.

2. MATERIAL & METHODOLOGY

A field survey was conducted for potato sample collection from district Poonch Rawalakot AJK. Samples were placed in polythene bags and were brought to Fungal Plant Pathology Laboratory, University of Poonch Rawalakot for isolation, characterization, purification and preservation. Pathogenicity was conducted to fulfil Koch’s postulates and further screening of potato cultivars was conducted. Disease severity index was measured using DSI scale.

DSI = (Σ (disease rating × number of plants with that rating) ÷ (total number of plants assessed × highest rating)) × 100.

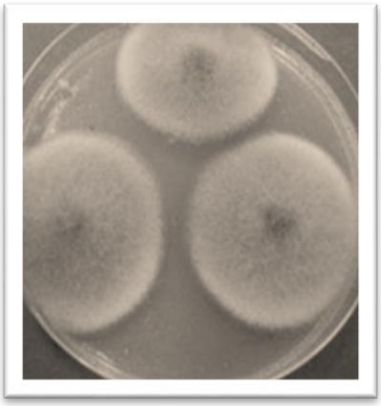
Invitro and in vivo screening of selected fungicides was carried out for possible evaluation of best effective fungicide against early blight of potato.

2.1. Statistical analysis

The analysis will be conducted using Statistic 8.1 software following Tuckey's test.

3. RESULTS & DISCUSSION

The fungal pathogen was identified followed by morphological and microscopic features. Circular and irregular colonies were observed showing whitish to dark brown colour and colony texture (Fig 1). Colonies were velvety and fluffy in appearance showing dark color spores. The conidiophores exhibited a brown color and were occasionally observed to have a zigzag shape. They were also characterized by having septa. The fungi produced either simple or branched large spores (6-11 x 23-35 µm) with horizontal and vertical divisions (Figure 2 and 3).



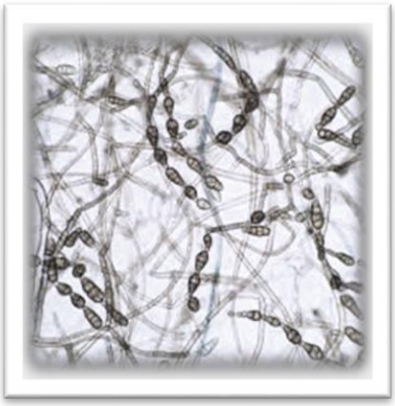


Fig 1: Colony color and texture. **Figure 2 and 3: Spores, Conidiophores of *Alternaria solani***

3.1. Evaluation (invitro) of different fungicides against isolated fungi

The efficacy of selected fungicides viz; captafol, copper oxychloride + dichlofluanid, metiram+ carbendazim and Tebuconazole+ Flutriafol against potato early blight was done using Poisoned Food Technique (Schmitz, 1930). The Potato Dextrose Agar (PDA) medium was supplemented with fungicides at concentrations of 40, 80, 160, and 240 parts per million (ppm), where control treatment was lacking fungicide application.

The media were meticulously transferred into sterilized Petri plates and allowed to remain undisturbed until they underwent solidification. A pristine culture of the *Alternaria solani* isolate, aged for seven days, was introduced into the experiment by meticulously placing 5mm discs at the

central area of each plate, including the control sample. The experimental treatments underwent a process of replication three times and were effectively sealed using paraffin wax strips. Following this, the specimens were subjected to incubation under precise temperature conditions of 25°C ± 2°C. The temporal evolution of colony expansion in each experimental group was monitored at consistent $\text{Inhibition zone (\%)} = \frac{X-Y}{X} x\,100$ were completely colonized by the fungal organism. :entage in the fungicide treatments was accomplished by computing the relative disparity in comparison to the control. The growth of the fungal colony will be calculated according to colony diameter on the control plate by using the formula.

3.2. Evaluation (in vivo) of various fungicides against Early Blight of Potato

The present study aimed to assess the effectiveness of different fungicides, specifically captafol, copper oxychloride + dichlofluanid, metiram + carbendazim and Tebuconazole+ Flutriafol in controlling early blight in potato cultivars through in vivo evaluation. The experiment was conducted using a randomized complete block design with four replications.

Potato plants, belonging to a susceptible cultivar, that exhibited good health were meticulously chosen and subsequently transplanted into separate plots within the designated experimental field. The fungicides were administered at various concentrations, specifically 40, 80, 160, and 240 ppm (parts per million), in accordance with prescribed dosages as per label instructions and local agricultural norms. The fungicide treatment was carefully administered using a handheld sprayer, ensuring thorough and uniform application across the plant's foliage, including both the upper and lower leaf surfaces. The experimental plots underwent systematic monitoring to assess the progression and severity of diseases over the entire duration of the study. Disease assessments were systematically performed at predetermined time intervals, commencing from the onset of initial manifestations of early blight symptoms.

3.3. Impact of different fungicides on plant height

The ANOVA results indicate that all the fungicides had significant effects on plant height ($p \leq 0.05$). The application of different types of fungicides such as captafol, copper oxychloride + dichlofluanid, metiram+ carbendazim and Tebuconazole+ Flutriafol reduced the effect of

Alternaria solani on potato plant. Maximum plant height (81 cm) was observed in metiram + carbendazim. Minimum plant height (70 cm) was observed in captafol. The increasing trend of plant height in metiram + carbendazim followed by copper oxychloride + dichlofluanid and Tebuconazole+ Flutriafol respectively. The results revealed that metiram + carbendazim approved the most effective fungicide. Graph showed that fungicide metiram + carbendazim was highly effective as compared to other. Overall, as compared to the control, all the fungicides improved plant height.

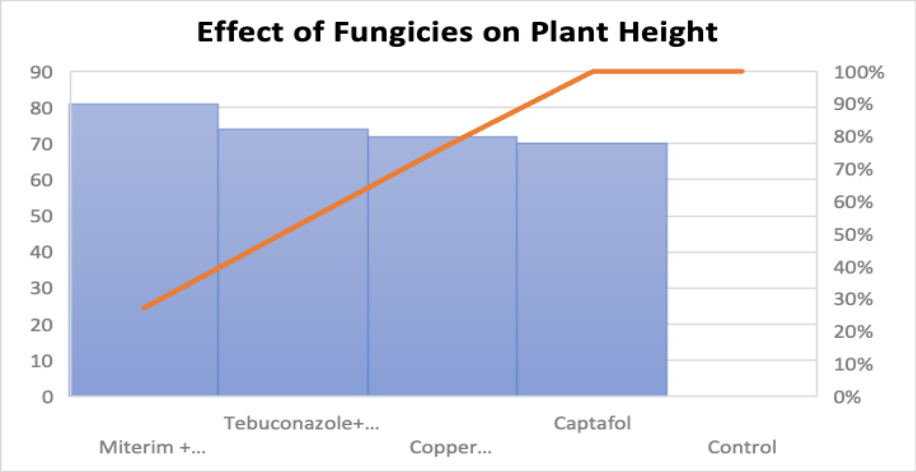


Figure 1: Evaluating efficacy of various fungicides against plant height after final dose application

Early blight, attributed to *Alternaria solani*, represents a prominent fungal ailment impacting potato plants. The disease is characterized by the emergence of concentric lesions on foliage, commencing as minute brown discolorations that progressively enlarge. These lesions manifest a distinctive concentric pattern, often encircled by dark-hued bands. As the ailment advances, premature leaf abscission may occur, culminating in diminished photosynthetic efficacy and potential yield diminishment. The efficacious management of early blight necessitates strategic interventions, encompassing crop rotation, utilization of resistant cultivars, and timely application of fungicidal measures, all pivotal in abating the repercussions of this affliction on potato cultivation (Van der Waals *et al.*, 2001).

4. CONCLUSION

The study demonstrates the effectiveness of selected synthetic fungicides viz; captafol, copper oxychloride + dichlofluanid, metiram + carbendazim and Tebuconazole+ Flutrifol against potato

early blight disease in Pakistan. Evaluation of these synthetic fungicides effectively inhibited growth of early blight invitro and increased plant height in vivo. Whereas metiram + carbendazim were the most effective combination for potato early blight management. It is concluded that impact of these applied fungicides during adverse conditions of disease severity in field conditions is positive.

5. CONFLICT OF INTEREST

No potential conflict of interest is declared by any author.

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