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First Report of *Alternaria* Blight of Potatoes in Nomal Valley, Gilgit-Baltistan Pakistan

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Abstract

Gilgit-Baltistan (GB) having unique geographic and climatic conditions was free from plant diseases. Since the disease resistant traditional varieties of plants have been replaced by high yielding varieties. As a result major threats come in the form of diseases such as Late blight and Early blight of potato and tomato crops, Grey mold of Grapes, Powdery mildew of cucumbers, Botrytis leaf virus in onions, Crown gall disease of cherries and nematodes of potatoes. The introduction of handful of high yielding varieties have also reduced the genetic diversity. Potatoes are highly valuable, nutritious vegetable and major cash crop grown in Gilgit-Baltistan (GB) Pakistan. Recently early blight disease has severely infected the potato fields of Nomal valley of GB. Early blight is an important foliar disease under diverse climatic conditions of GB. Over the past few years, early blight became a major threat to potato crops in GB and highest incidences were recorded in Nomal Valley of GB. Nomal Valley has been divided into six major sectors or Mohallahs. The Mohallahs are as; Mohallah Jigot, Mohallah Batot, Mohallah Majini, Mohallah Das and Mohallah Sigal. During June-July, 2016 a survey were carried out in randomly selected five fields of each Mohallah of Valley Nomal. Within each field five potato plants were randomly selected and observed for typical early blight symptoms. Moreover at harvesting stage tubers were also observed for early blight symptoms. The disease incidence and disease severity were recorded. The highest percent disease severity (66.4) was recorded in potato fields of Mohallah Jigot followed by potato fields of Mohallah Sigel (63.2%), Mohallah Majini (42%) and Mohallah Batot (36%). Meanwhile the minimum percent disease severity was recorded on the potato fields of Mohallah Das (12%). It can be concluded from the present study that early blight is serious threat to potato production in Nomal Valley of GB.

Keywords: *Alternaria spp.*; Early blight; Potatoes; Gilgit-baltistan (GB); Nomal valley

Introduction

Gilgit Baltistan (GB) is dry and less humid region of Pakistan. In the recent years, a survey about the powdery mildew of cucumbers was conducted in the Nomal valley, District Gilgit. During this survey, whitish colonies of powdery mildew were observed in open fields of cucumber plants [1]. Among the fruits, grapes are severely infected by Grey mold disease caused by *Botrytis cinerea* [2]. The berries due to infection of Grey mold become unmarketable and inconsumable. Likewise Potatoes (*Solanum tuberosum L.*) are one of the most important, valuable, nutritious and major cash crop of Gilgit-Baltistan Pakistan. Recently early blight disease poses a serious threat to potato production in GB. As above mentioned the region is dry and less humid therefore the early blight should not be a problem. However in the recent decade enormous rainfall and frequent wetting of the leaves of potatoes favor the development of this disease. Similarly non availability of disease free high quality potato seed tubers and years of single cropping have also increased the incidence of early blight. Early blight not only causes disease in potatoes but other hosts of the family Solanum have also become infected. These hosts are tomato (*Solanum lycopersicum L.*), eggplant (*S. melongena L.*), bell pepper and hot pepper (*Capsicum spp.*) The production of potato crop in 2017 was approximately 20 bags (Each bag was of 70-80 Kg) per Kanal area. However to estimate total annual potato production of GB is difficult to do accurately due to the fact that the region is highly mountainous. Moreover there are diverse range of vegetation, ecological zones and diverse climatic conditions of GB.

The symptoms of early blight on potatoes appear as small 2-3 mm brownish or blackish spots especially on older leaves of Potatoes. The spots then became enlarge in size and somehow surrounded by yellowish color termed as yellow halo. The diameter of these spots was approximately 9-10 mm often have brown or dark concentric rings seem like bulls eye. As the disease progress these spots increased in size and the whole leaves became chlorotic and finally defoliated. Similarly the spots also appeared on stem, however the spots had oval shape with a greyish or light centre and often seem depressed. Potato tubers were also found to be infected with the disease. The symptoms were sunken and asymmetric shapes which are often surrounded by a pink or purple line. The subsurface of lesions were found leathery and shrivelled with a darkish appearance. The spots soon became dry therefore in contrast to other diseases no bad smell was observed. This indicates that there would have been no further invasion by secondary organisms. The strong winds of GB also cause the potato plants to sway excessively and create injuries. These injuries are entry points for early blight to infect the potato crop severely.

Early blight disease is caused by a large-spored fungus called *Alternaria solani*. *Alternaria solani* is asexual stage however there is no known sexual stage. Therefore this fungus has been placed in class Deuteromycete. However the other species of genus *Alternaria* which is called small-spored *Alternaria alternate* is also considered a serious threat to potato cultivation [3]. *Alternaria solani* usually contaminate the cultures of other fungi in the molecular plant pathology

laboratories. Therefore nowadays it is considered as contaminant. It can easily be grown in Potato Dextrose Agar (PDA) and Potato Dextrose Broth (PDB) where it forms a grayish or blackish type of colony. The asexual conidia are normally formed 9-11 transverse septae. There are also variations in morphology and pathogenic abilities of the isolates of the fungus [4]. Recently it has been revealed that not only *Alternaria solani* cause early blight disease of potatoes but more than one *Alternaria spp*. can cause early blight. Those species identified based on morphological and molecular characteristics are *A. tomatophila* , *A. grandis*, *A. tenuissima*, *Alternaria interrupta*, *Alternaria infectoria*, *Alternaria dumosa*, *Alternaria arbusti* and *A. alternate* [5-9].

This *Alternaria spp*. overwinters primarily on infected debris of potato crops. The myceliums of these fungi are actually dark due to presence of pigments and resistant to lysis therefore persist in the soil for several years. Sometime these fungi produce hard resistant structures called chlamydospores. Potato traders of GB usually prefer big size potato tubers and the small size potatoes tubers were left in the fields. These small size tubers act as volunteer potatoes on which the pathogen survive till the next growing season. Climate conditions vary widely across GB, ranging from the monsoon-influenced regions, moist temperate zones, arid and semi-arid cold deserts. Moreover the region is regarded as altitude based region based on amount of rainfall. The region can be divided into low and high areas based on the amount of rainfall. In the low areas the amount of rainfall is 200 mm annually. However, in the high areas the amount of rainfall is 2,000 mm per year. However in May and June the weather become warm and temperature range (25-30°C). The dew or free moisture on the foliage of potato plants can cause conidia of *Alternaria spp*. to germinate within 30-40 min. The germ tube arises from the conidia penetrate the leaf epidermis directly or enter through the micro-pores such as stomata. The wounds or injuries are entry point for the pathogen. The pest also cause injuries particularly for feeding on tubers and as a result pathogen enter and cause disease. Post harvests losses also occurred due to wounds on tuber skin during harvest. The alternating wet and dry periods of GB also favour the sporulation of the fungi. If the nights are wet, conidiophores are produced and the following day light spores emerge on the conidiophores. These conidia are then dispersed to the adjacent potato fields primarily by high winds and rarely by sprinkle irrigation or splashing rains. These conidia are infecting and re-infecting during the same growing season. Therefore the early blight is considered as polycyclic diseases. Early blight can be managed by proper tillage, crop rotation, certified potato seeds, well-drained irrigation, plow under plant debris and volunteer potatoes, eradication of weeds and application of ash may also reduce the intensity of the disease. The wild species of potatoes exhibited a high degree of resistance however replaced by newly developed varieties. Newly introduced varieties such as Desiree and Diamont do not have complete resistance against early blight disease. Fungicides such as Mancozeb and Chlorothalonil can be used as protectant [10,11]. The curative fungicides such as Quinone Outside Inhibitors (QoI) (azoxystrobin, pyraclostrobin, trifloxystrobin, fenamidone and famoxidone) can also be used which can stop infection by inhibiting spore germinations of early blight disease [12]. The disease can also be managed by application of biological agents however the commercial application and grower acceptance of biological control is negligible due to the fact that biological agents vary in efficacy under the range of environmental conditions occur in the fields. The aim of this research is to report about the presence of early blight diseases on potato crops of Nomal Valley, GB, Pakistan.

Materials and Methods

The present survey on early blight disease was conducted in Nomal Valley, Gilgit Baltistan, Pakistan. The survey was conducted from the beginning of June until Mid-July at regular intervals (2016). Nomal valley is divided into five major sectors or Mohallahs. The Mohallahs are as; Mohallah Jigot, Mohallah Batot, Mohallah Majini, Mohallah Das and Mohallah Sigal. Five potato fields were randomly selected from each Mohallahs. Within each field five potato plants were randomly selected and observed for the presence of symptoms of early blight disease. The disease incidence was recorded using the following formula; the disease severity was recorded based on the following Disease severity scale of 0 to 5:

0=no visible lesions on leaf;

1=up to 10% leaf area affected;

2=11%–25%;

3=26%–50%;

4=51%–75%;

5=more than 75% leaf area affected or leaf abscised [13]

Statistical analysis

The data was analysed by Analysis of Variance (ANOVA) and least significant difference (LSD) tests ($P \leq 0.05$) were performed to compare means. The analyses were done using the Statistix 8.1 software (Table 1).

Mohallahs	Potato Fields					Average disease severity level	% Disease severity
	I	II	III	IV	V		
Majini	1	1.2	1.8	3	3.5	2.1[c]	42
Das	1	0	0.4	1	0.6	0.6[e]	12
Batot	1	1	2	2	3	1.8[d]	36
Jigot	3	4	3.6	3	3	3.32[a]	66.4
Sigal	3	3	3	2.8	4	3.16[b]	63.2
Total	1.8	1.84	2.16	2.56	2.82	5	**47.92**
*Disease severity levels							

Table 1: The average disease severity of early blight disease in potato fields.

Results and Discussion

Potato leaflets and tubers showing symptoms of early blight were randomly sampled from naturally infected potato fields of Nomal-Nalter valley (Figure 1). Among five Mohallahs of the Valley Nomal, the highest disease severity of early blight disease was recorded at the potato fields of Mohallah Jigot with the value of 3.32 followed by potato fields of Sigal and Majini Mohallah with the value of 3.16 and 2.1 respectively. However minimum disease severity was recorded on the potato fields of Das (0.6) and Batot (1.8). In terms of disease severity of early blight, the potato fields of Mohallahs were significantly

different from each other at P ≤ 0.05 probability. The percent disease severity of early blight disease was also calculated. The highest percent disease severity was recorded in the potato fields of Mohallah Jigot whereas the minimum percent disease severity was recorded in the potato fields were recorded in Das Mohallah. Overall percent disease severity of early blight disease in Nomal valley was 47.92%. Early blight disease is distributed throughout the world [14]. The potato fields of the remote areas like GB are now no more free from the early blight disease. The disease is found throughout the world infected solanaceous crops in particular tomato and potato. The disease severity and disease incidence however vary from area to area. It is usually not a menace in the less humid regions. Anyway if it is controlled the disease become more severe and resulted severe defoliations of potato crop, resulted in the fruit size and number. However to estimate the losses caused by this disease vary enormously from 5 to 90 percent. The annual expenditure on chemicals to manage this is around $45 million in potatoes. Early blight disease is also destructive disease of tomato crop. Each 1% increase in disease severity of early blight can reduce yield by 1.36%, and complete crop failure can occur when the disease is most severe [15]. Early blight disease also reduces the quantity and quality of marketable tubers [16].

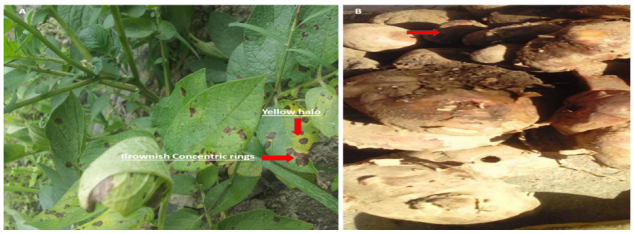

Figure 1: Potato leaflets and tubers infected by early blight disease A. Typical symptoms (Yellow halo and concentric rings) on leaflets B. Shrivelled and darkish potatoes.

Conclusion and Future Perspectives

From the present research it is concluded that though the highest disease severity of early blight was recorded in Sector or Mohallah Jigot whereas minimum was recorded in Sector or Mohallah Das. However the disease can be managed by breeding of resistant cultivars and other IDM (Integrated Disease Management) strategies such as foliar fungicides, eco-friendly foliar bio-pesticides and proper cultural practices. However the application of foliar fungicides causes undesirable environmental changes and resistance in the communities of *Alternaria spp*. The use of elicitors or plant strengtheners can also increase the immunity of potato crops against *Alternaria solani*. Moreover the Greenhouse and field experiments involving combinations between cultural practices, partially resistant cultivars and combinations/alterations of fungicides with different modes of action should be conducted. Moreover to determine the levels of genetic variation of *Alternaria spp*. is important to know the population structure and migration structures of the pathogen.

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