Study of fungal diseases on aerial parts of tomato plant

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Abstract

Fungal plant pathogens play a significant role in limiting the development of tomatoes. Recognizing the differentiation between pathogenic and non-pathogenic diseases is crucial for effective disease control, as well as for identifying the specific microorganisms responsible for infectious diseases. Among the various diseases affecting tomato plants, foliar diseases are particularly significant production constraints. Fungal foliar diseases such as early blight, septoria leaf spot, and late blight are especially economically impactful. Our study investigated the incidence of fungal diseases on the aerial parts of tomato plants at the research farm of the Faculty of Agriculture, Kabul University, during the growing season. We reported five fungal diseases affecting the aerial parts of tomato plants throughout this period. The identified pathogens included *Alternaria*, *Oidium*, *Phytophthora*, *Septoria*, and *Stemphylium*, which were confirmed through visual assessments and laboratory analyses of diseased tomato samples.

Key words: Fungal pathogens, Identification, Isolation, Symptoms, Tomato

مطالعه امراض قارچی بخش‌های هوایی نبات بادنجان رومی

غلام رسول فیضی
دیپارتمنت حفاظه نباتات، پوهنځی زراعت، پوهنتون کابل

خلاصه

پتوجن‌های قارچی نباتی نقش قابل ملاحظه بازدارنده را در انکشاف نبات بادنجان رومی دارا می‌باشد. دریافت تفاوت میان امراض پتوجنی و غیرپتوجنی برای تنظیم موفقانه مرض، و شناسایی نوع میکروارگانیزم که باعث مرض ساری می‌شود، دارای اهمیت می‌باشد. در پهلوی تمام امراض نبات بادنجان رومی، امراض قسمت‌های برگی نگرانی قابل ملاحظه‌ای را در تولید بادنجان رومی به وجود آورده است. در میان آن‌ها، امراض قارچی قسمت‌های برگی در نباتات بادنجان رومی، مانند بلایت وقتینه، داغبرگ سپتوریایی، و بلایت پسینه، دارای اهمیت ویژه اقتصادی می‌باشند. مطالعه و تحقیق ما را امراض قسمت‌های هوایی نبات بادنجان رومی در فارم تحقیقاتی پوهنځی زراعت، پوهنتون کابل در جریان فصل نمویی این نبات تشکیل می‌داد. به تعداد پنج مرض قارچی بالای نباتات بادنجان رومی در نتیجه تحقیق گزارش گردید که بخش‌های هوایی نباتات بادنجان رومی را در جریان فصل نمویی مورد حمله قرار داده بودند. پتوجن‌های مانند *Alternatia* ، *Oidium*، *Phytophthora*، *Septoria* و *Stemphilum*بودند که در نمونه‌های تحت آزمایش بادنجان رومی، شناسایی گردیدند.

واژه‌های کلیدی: بادنجان رومی، پتوجن‌های قارچی، تجرید، شناسایی، علایم

Introduction

The cultivated tomato has become a prominent food crop, gaining popularity largely over the past century. Its versatility in both fresh and processed forms, along with its adaptability, has significantly contributed to its rapid and widespread use. Global production and consumption of tomatoes have risen dramatically, with an estimated total world production of around 190 million metric tons per year (5). Recently, tomatoes have been added to the list of important global produce, serving as a vital source of beta-carotene, lycopene, vitamin C, and essential minerals such as phosphorus, potassium, and calcium. These nutrients are highly valued for their antioxidant properties and are appreciated in various dishes (2).

From the time of cultivation, starting from the seed stage to harvest, and finally to market supply and storage in warehouses, the tomato plant is susceptible to both biotic and abiotic factors. The biotic factors include diseases caused by fungi, bacteria, viruses, and nematodes, which limit tomato production (7). Currently, more than 200 pests and diseases have been identified in tomatoes, causing direct or indirect losses in production (10, 11).

Diseases caused by biotic agents are contagious and can be transferred from diseased plants to healthy ones. Since tomatoes are among the most important agricultural products globally and in our country, and they contain essential nutrients for our health, it is crucial to research the fungal factors that lead to the decline of this vital plant. Given this context, we aimed to gather information about the fungal diseases affecting the aerial parts of the tomato plant and to identify which fungal organisms infect these areas in our research farm during the growing season.

Material and Methods

Site of Study

This study carried out in the research farm of Agriculture Faculty, Kabul University on the RIO GRANDE tomato variety, which was Turkish in origin. The research was conducted during the tomato growing season in 2023. The tomato seedlings were prepared in greenhouse and after sufficient growth transplanted in the main field in the form of rows. The distance between each plant was 35 cm. The process of transferring the seedlings in the evening made it possible for the seedlings to adapt the ground, soil and conditions outside the greenhouse before sunrise the next day.

Collection of Diseased Plant Parts

The infected tomato plant parts (leaves, stems and fruits) were picked up and collected in polythene bags. The samples were carried out to the laboratory. Our observations were done in six different time of plant growth and in each time more than 10 samples were collected. The symptoms of disease were observed carefully and the same was noted. It should be noted that the sampling was done fifteen days after transferring the seedlings to the field, in the flowering stage, fifteen days after flowering, in the stage when fruit was raw, in the ripening stage of the fruit, and at maturity.

Isolation and identification of fungal pathogens

The fungal pathogens were isolated from diseased part (leaves and fruits) of tomato plants. By the help of sterilized needles and forceps some pieces of diseased parts of tomato plants

were transferred on Petri plate containing PDA media then it was incubated in an incubator at 27°C for one week. After one week the growth of fungal colony were observed in Petri plate and colony of culture was observed under the compound microscope and studied the characteristics of the pathogen. The temporary prepared slide was observed under compound microscope. The identification of fungal pathogens was made on the basis of somatic structure fruiting bodies, asexual and sexual reproductive structures. The keys were used for identification of fungal pathogens (8, 9).
The test fungus was identified with the help of standard literature.

Results and Discussion

In the current inspection, the incidence of fungal diseases on the upper parts of tomato plant was studied at different times during the growing season. Visual observation of the tomato filed were regularly done during the growing season. Diseased tomato plants leaves and fruits (more than 50) were comprehensively studied to identify the occurred diseases based on their morphological characteristics. As a result, it was found that tomato plants were infected with early blight (3), powdery mildew, late blight, Septoria leaf spot and grey leaf spot, which are shown in Table 1. The symptoms of different diseases and their causal organism were recorded as follows.

Table 1. Diseases of tomato plant in growing stage

		Disease	Causal agent
1	Tomato plant	Early bight	*Alternaria solani*
		Powdery mildew	*Oidium lycopersicum*
		Late blight	*Phytophthora infestans*
		Septorial leaf spot	*Septoria lycopersici*
		Grey leaf spot	*Stemphylium solani*

Early Blight

Early blight occurs on the foliage, stem, and fruit of tomato plant and can cause severe damage during all stages of development of the plant. This disease is caused by *Alternaria solani*. No sexual stage has been reported for this fungus (1, 4). It is first observed in the field as small brownish black lesions on the older foliage's. The tissue surrounding a spot may become yellow and when the number of the spot is raised, the entire leaf may become yellow. Lesion enlarges rapidly to form concentric rings (4, 7).

Fig. 1. Symptom of early blight on leaf of tomato.

The same symptoms we also have been seen on leaves (fig. 1), which is the same as literatures. On PDA the causal agent of early blight produced conidia, which were borne on distinct conidiophores singly and in a chain as well. As we have seen conidia had septum which is the same as literatures. On PDA the isolated pathogen produces yellowish to reddish pigments which the same as literatures.

Powdery Mildew

The most common symptoms are light green to bright yellow lesions on the upper leaf surface. Powdery, whitish rings around the margins of blighted areas. We have seen the whitish material consists of mycelia and zoosporangia of the pathogen (fig. 2). These fruiting bodies looks like powdery masses. All the mentioned symptoms are the same as literatures (7).

Fig. 2. Symptoms of powdery mildew on upper surface of leaves.

This disease is caused by *Oidium lycopersicum.* We have seen a light powdery covering of these lesions, may occur on the lower surface (fig. 3). Under conditions favourable for disease development, a luxuriant growth of conidia and conidiophores may develop on the upper and lower surfaces. Heavily infected leaves die but seldom drop from the plant (7).

Fig. 3. Powdery mildew symptoms on lower surface of leaves.

Late Blight

The fungus attacks all aboveground parts of the tomato plant. This disease is caused by *Phytophthora infestans.* Late blight caused by the *Phytophthora infestans* is one of the most destructive diseases of tomato resulting in significant economic loss (20–70%) (6, 10, 11). Symptoms on leaves, twigs and fruits are more common. Blight appears on foliage as light-pale green water-soaked dead area. The lesions are wet in morning and dried, shriveled in daylight. It enlarges rapidly until entire leaves are killed and exposing all the fruits for infection. In moist and cloudy weather, a downy white fungus develops near the outer margin of lesion on underside of the leaves. Green and ripe fruit affected by the blight appeared as greenish brown and internal tissues become spongy with bad odor (7). Infected fruits show shallow, brown, or purple lesion-like discoloration on their surface (13, 14). In leaves we have seen indefinite, water-soaked spots. After few days moldy growth were observed on around the underside of large brown lesions, which is the same as literatures. Leaf lesions first appear as indefinite, water-soaked spots, which may enlarge rapidly into pale green to brown lesions and cover large areas of the leaf (fig. 4).

In our observation this pathogen produced coenocytic, multinucleate mycelium although septation is seen in old cultures. The asexual spores known as sporangia were borne singly at the tip of alternately branched sporangiophores. The sporangia produced are hyaline, lemon shaped with a distinct papilla at the distal end.

Fig. 4. Symptoms of late blight on leaves of tomato.

Septoria Leaf Spot

Typical symptoms include small, round, or oval water-soaked spots on the undersurface of lower leaves that gradually turn dark in color and develop to become necrotic lesions with a tan or light grey center. Initially small, water-soaked circular spots on the underside of older leaves. Dark brown margin with gray or tan center. Spots may coalesce. Tiny black specks

present in mature spots. In addition to leaves symptoms may appear on petioles, stems, and the calyx (3). This disease is caused by *Septoria lycopersici*. The symptoms that we have seen were circular, with dark brown margins and tan to grey centers dotted with black pycnidia (fig. 5). A narrow yellow halo is often associated with leaf lesions. We have seen its fruiting bodies (pycnidia) in the lesions. Our findings were the same as literatures.

Fig. 5. Symptom of septoria leaf spot.

Grey Leaf Spot

On tomato, grey leaf spot infections occur primarily on the leaflets, with some symptoms developing on petioles and stems under favorable conditions and high disease pressure. This disease is caused by S*temphylium solani.* The pathogens can attack tomato leaves at all growth stages, and no symptoms occur on the fruit. Symptoms initially appear as minute brown to black specks on the lower leaf surfaces. The specks develop into lesions that are small, round to oblong, and randomly scattered on both the upper and lower leaf surfaces. The lesions become grey in the center and surrounded by brown to black margins and a yellow halo (12).

In the field we have seen small circular dark brown necrotic, numerous spots appeared all over the leaf lamina that is uniformly distributed on entire foliage. Sometime clear narrow yellow halo was visible around the spots. Usually, these spots are isolated but in later stage they coalesced to each other (fig. 6). Severely infected older leaves blighted and fall. In our work in lab colonies are with typical septate mycelium with the young hyphae at first it was greyish green and dark brown with age. All our findings are the same as literatures.

Fig. 6. Symptom of grey leaf spot on tomato leaf.

Conclusion

The rate of growth and yield of plants depends on environmental factors such as water, soil, light, heat, humidity, and finally their preservation against unfavorable factors. In other words, any factor that endangers the health, growth and development of plants has a negative impact on the growth and yield of the plant. Among them, we can mention the plant pathogenic factors that reduce the yield and sometimes cause the destruction of plants. Therefore, the importance of controlling plant diseases for humans is due to the damage caused by plant diseases to plants and plant products, which causes a huge economic loss to work of farmes.

According to the research conducted in the farm field of the Faculty of Agriculture, it seems that there are a number of fungal diseases that attack tomato plant at different times under different conditions and make them sick. The infection of this plant actually causes a decrease in the yield and quality of the fruit. Although we have found and diagnosed a number of diseases including early blight, powdery mildew, late blight, septoria leaf spot and grey leaf spot, but this work is not enough and requires more research in the field of identifying the causes of various diseases. In order to prevent the occurrence of these diseases in the farm, it is necessary to take preventive measures and finally treat them if necessary.

Our recommendations to farmers are to compliance with farm hygiene, collect plant residues, use certified seeds, choose healthy seedling, regulate fertilizer and irrigation, fallow the fields, rotate crop, avoid contact of the fruit with ground, destroy weeds, use resistant varieties, sterillize the seed bed by chemical and heat, use a protective fungicides, treat seeds with fungicides and timely use fungicides.

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