



Plant-Fungal Disease Management

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Abstract

Plant fungal pathogens can cause an enormous loss in quality and yield of crops, fruits including other plant materials. It is becoming increasingly more and more important matter for health's of human beings and the economy at a global scale. With increasing populations of human and changes in climate conditions threats for lands are emerging. Decoding fungal pathogenesis will help in better understanding that how the fungal pathogens able to infect the plant host and delivers valued information for controlling plants diseases which includes novel strategies for prevention, delay or inhibiting fungal development.

Keywords: Attacking Strategies, Fungal Pathogens, Food Spoilage, Plant Fungal Disease, Plant-Pathogen Control.

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1. Introduction:

Pathogenic fungi greatly vary when it comes to their lifestyles. Few fungi are necrotrophic, while the other fungi are hemibiotrophic, biotrophic, or the obligately biotrophic. Fungal pathogens generally use highly conserved proteins important in infection processes [1-3]. This conserved proteins that's why known as the potential targets for controlling those diseases caused by fungi. For the infection to host plant, the pathogenic fungus also able to develop special structure responsible for the infection, like appressoria for the penetration to host plant cells. At the time of this process, peroxisomes play key roles for the facilitation of full functions of the virulence proteins [2-5].

Fungal pathogens of plants play a vital role in the quantity, quality and profitability of the production. These types of phytopathogens are determined for avoiding the defence mechanism of plant disease with loss quality across the globe which includes billion dollars annually [6, 7]. For the controlling and prevention of plant fungal diseases, fungicides have been used by farmers for management of damaging pathogenic fungi of the plant [8, 9]. Drawbacks which include resistance development and toxicity of environment which associated with the chemicals motivated plant researchers and cultivators for investigating possibilities [10-12].

Many more databases can be accessed for the determination of the work for protecting plants and crops against plant fungal pathogens including plant extracts using the search term "plant fungal pathogen" or "plant extracts" and "phytopathogens".

When it comes to chemical fungicides, biological agents also used for dealing with the fungal disease of plants. In many examples in which plant extracts or the plant-derived compounds also used as commercial restrictions of plant fungi on large scale in horticulture and agriculture setups [13-15]. Advantage of this approach is plant extracts which usually contain antifungal compound more than one. Therefore, resistance

development against the plant fungal pathogen will decrease if different kinds of a compound which affect different kinds of metabolic processes [16, 17]. These kinds of plants which are cultivated using the plant extracts can also be marketed as organic plants produced with organic processes [18]. Many more research papers published till now on the effects of antimicrobial compounds which are present in plant extracts and focus on human health application [19]. More and more research is needed for the development of sustainable, suitable, appropriate, effective and cheaper plant products which can be used for help to overcome the threat of fungal diseases of plants [20-22].

Scientists who worked only on plants for controlling animal and human fungal pathogens consider advantages for focusing on fungal pathogens of the plant [23]. These kinds of approach not only increase the security of food potentially for farmers in rural areas, which can lead to rewards at commercial scale, but it's much easier for testing the efficacy in the greenhouse and field experiments. Even if the plant extracts are toxic, still it may be useful in the floriculture industry [24, 25, 26].

2. Fungal Pathogens:

Fungal pathogens of plants are responsible for causing various diseases of plants in horticulture and agriculture industry setups [27]. Cooperatively, phytopathogens have the developed mechanisms and various ways for attacking any type of plants, looking for the entry and nutrients sourcing forcefully for development and growth [28]. These kinds of pathogens also able to reproduce asexually and sexually, also able to overcome plant immune defence mechanism [29]. This affects negatively to the plant health, homeostasis of plant, physiology of plant and in some other cases which can cause systematic damage [30]. For occurring of plant fungal diseases, fungal pathogens of the plant must need to germinate first on the appropriate surface of the proper host [31, 32]. The fungal pathogens spores of plants can only and only germinate when conditions are most favourable, which includes appropriate humidity by rain or dew drops, with the availability of nutrients with lower molecular mass with appropriate host [33-36]. Spores of fungal which can remain viable for many more years by using self-inhibitors for stopping the germination until and unless conditions are favourable. When conditions will be favourable, the fungal pathogens of plants form structure able to cause infection such as appressorium including infection peg, for hyphae for penetrating host defence mechanism [37-40].

2.1: Attacking Strategies of Fungal Pathogens:

Different strategies for attacking and entering into the host will be used by plant fungal pathogens. Some of the pathogens use mechanical pressure including chemical action for entering into host while other pathogens enter into their host through wounds and stomata present in plant leaf [40-45]. During evolution, plants established a defence mechanism against the fungal pathogens. That's why this approach has become more and more motivational for investigation of the antifungal compounds present in plants. Fungal pathogens also need different strategies to overcome the plant defence mechanism i.e. pathogen-associated molecular patterns (PAMP) and PAMP triggered immunity (PTI) inducible defence including effector-triggered immunity (ETI) defence [46-50]. The pathogen which becomes successful in disease-causing can able to overcome ETI and PTI plant defence system, especially those pathogens which evolved avirulent

genes for overcoming the R-resistance genes of the host plant. These kinds of pathogens were able to cause disaster disease in host plant which can lead to epidemics. Not every kind of pathogens can spread diseases in the host plant. Some pathogens possess a narrow range of host while the other pathogens possess a broad range of plant host for causing a fungal infection. Few plants also are a host for many more fungal pathogens [51-55].

Fungal pathogens can infect the plant parts where they never present before because of birds, insects, humans, winds, infected parts of the particular plant and water. Not every species of fungi attack on plants but only plant pathogenic fungi attack every plant group. These are the fungi which are collectively attacking 80% of the plant. Nearly 1,00,000 plant diseases caused by only 8000 different fungi. Generally, fungal pathogens of plants can be grouped as necrotrophs, biotrophs and hemibiotrophic on the bases of infection mechanism [56-58]. Organisms are known as biotrophs which survive on the tissues of living organisms which cause infection without killing its host. Few pathogens use appressorium for penetrating their host and nourishing structure like the haustoria for sourcing nutrients present in the surrounding cells. Biotrophs generally have a narrow host range e.g. rust fungi and powdery mildew fungi. Necrotrophs are the organism which infects the living host and eventually kill infected area. Because necrotrophs are only able to complete their life cycle on dead tissues. They constantly produce hydrolytic enzymes including toxins for destroying plant cells [59, 60]. They generally produce two types of toxins such as host-specific toxins which are specific to host plant which allows fungal pathogens to infect the plant for causing hosts specific diseases. Other type includes a wide range of toxins that can enable few pathogens for the infection and destruction of unrelated plant species. Hemibiotrophs also uses a similar mechanism like biotrophs which can cause infections and then killing of their host as necrotrophs [61].

3. Problems Elicited by Fungal Pathogens in Agricultural Production and Food Spoilage:

Sustainable plant products are important for poverty and starvation alleviation which can be delivered by agricultural production. Epidemics such as potato late blight disease, rye ergot, rust of coffee, rusts and smuts of cereals and rice brown spots including chestnut blight etc. which can cause severe destruction to agricultural products. Pathogenic fungi can also cause problems to human health by decreasing product quality and its quantity. It may lead to food displacement, political uncertainty, a shift in economic prospects between countries and humans migration [62-65]. These kinds of phytopathogens also cause an enormous problem to the farmers, researchers, consumers including policymakers. Fungal pathogens of plants also provide problems complexity for the farmers in the production of the plant. Few types of pathogens can cause infections in new plants and cause problems to its related new species and also able to infect multiple plants. Many more pathogens are weak pathogens and their host also able to destruct its related species across the whole continent. Fungal pathogens destruct the plant product and cause an economic crisis which exceeds up to 200 billion US dollars. It's very clear that plant fungal pathogens able to cause many more problems with enormous potential impacts on plant product [66-68].

4. Food Spoilage Including Post-Harvest Problems Cause by Fungal Pathogens:

Post-harvesting diseases including food spoilage cause many more problems by the fungal pathogens of plants. It happens throughout the different stages of the product processing like harvesting and handling, storage and packaging including transportation until it comes in the customer's hand. These kinds of fungal pathogens are the main causative agents of fresh vegetables and fruits rotting during the post-harvest processing. It includes more than 100 fungal species which are responsible for common in diseases during post-harvest processes. It also can able to decrease the rate and destroy 10-30% crop yields. Especially in developing countries including tropical regions faces the loss of consumable merchandises and it can be high till 50%. Because of fungal spoilage due to many more fungal pathogens product loses will be occurring [69, 70].

5. Problems Occur by Mycotoxins:

Mycotoxins are the compounds having low molecular weight. These are the secondary fungal metabolites which are toxic for the vertebrates at the very low concentrations. It is not playing any role in fungal development and growth. Mycotoxins are common in food and it is important as it can cause diseases in humans and animals like dermatitis, cancer etc. Moreover, contaminated plant food consumption or animal feed having mycotoxins able to lead many more metabolic problems including malfunction of liver and its deterioration, interference in protein synthesis, skin disorders, immunodeficiency at an extreme level. There are approximate 25% of crops contaminated with mycotoxins every year, and that's why it is a severe problem for food security [71]. It also affects the economy approximate 1 billion tons of food and another food product which will lose every year. Toxins which include aflatoxins, fumonisins toxins and alkaloids like ergot harm the animal as well on human health. It also negatively effects on agro-economy. That is why fungal pathogens of plants have an enormous negative role in food production for the overgrowing population of the world. Fungal diseases of plants and toxins produced by them harm the agricultural production, it affects the quality of product and its quantity which leads to pre and post-harvesting economic loss. For minimizing the damage caused by the fungi in horticultural and agricultural setups needs various control and management innovations [72].

6. Plant Pathogens Control:

People will suffer from dreadful epidemic diseases and outbreaks which occur from time to time if controlling and induction of plant defence mechanism are not work. People will also face starvation. For overcoming the obstinate attack of fungal pathogens of the plant on horticultural and agricultural products, including different agrochemical products which have been developed from plants and used. Few agrochemicals are toxic compounds for the humans; it also required withdrawal time duration between the doses and harvesting. Many more fungicides have negative effects on the environment and the organism present in soil including insects and pollinators. That's why they use natural products getting more and more attention for the organic food production which is recommended strongly from the consumers and environmentalists to farmers [73].

7. Resistance Induction against Fungi:

Natural resistance which is based on plant defence mechanism in horticultural and agricultural production for resistance induction against the foreign fungal pathogens of the plant.

7.1: Fungicides:

First-time fungicides used in the 1800s, synthetic chemicals used for the relief in plant-fungal disease management for horticulture and agriculture production. The introduction of different types of synthetic chemicals in horticultural and agricultural production decreased over the year. Many more fungal diseases impact and the rate of product yield decreased lead to financial increment. Since 1970, farmers struggle is becoming more and more because of the resistance emergence against fungicides present in the market. This leads to loss of production and increased in the cost and losses. In the year 1996, fungicides sales across the globe increases and it covered approximate 5.9 billion US dollars. Every year, USA devotes more than 600 million dollars for synthetic chemicals. In 2002, Japan covered the large scale market including 818 million US dollars across the globe for the fungicides. Fungicides which can decrease the fungal infection in plants are generally toxic compounds for the non-targeted organisms such as earthworms. It causes inequalities in the ecosystems. Many chemicals present in fungicides degrade slowly which are difficult for removing. It also includes contamination of water resources including rivers and ponds [74].

7.2: Biological Control:

All the problems which are associated with synthetic chemicals, scientist across the globe are involved in research for biological pesticides development. A biological pesticide which includes chemicals extracts from the microbes, animals and plants sources. In the United States, many more active biological pesticides are registered at current time duration which can use in hundreds of different products. It includes more than 20% of active pesticides ingredients which are registered in the country. The probable use of the microorganisms for plant fungal disease treatment is completely based on the antagonistic nature of microorganism against the fungal pathogens of the plant. Experimental results and field trials of microorganism extracted antagonistic against fungal pathogens of plants are promising [75].

8. Discussion:

This is clear that enormous problems caused by the plant fungal pathogens in horticulture and agriculture production industry which is an inadequate control and it can lead to various problems in the food production industry. Phytopathogens generally not able to influence floriculture and food industries, but when it comes to planting medicinal industry, fungi affects more and more problems for safety and production issues after harvesting medicinal plants. Current control measures are not able to deal with the plant fungal pathogens when it comes to an emergency or outbreaks situation. That's why continued research is needed which includes products on the bases of the plant. It also needs to deliver active biological products which are cheap, more effective and less toxic. Plant-based products for controlling plant fungal diseases may be more effective for providing relief. Still, more research is needed for improving the products. Research is needed for screening the products against

plant fungal pathogens and phytopathogens. An only limited number of secondary metabolites isolated till now. Identification of new antifungal compounds from plants is important. But it includes other possibilities for using complex molecules from plant extracts. This approach has the advantage of decreasing resistance when it comes to various antifungal compounds present in the plant extract and for different targets. However, there is a major disadvantage as compared to single chemical compounds for ensuring good quality control with activity variation which is based on environmental as well as genetic factors. Hence, different methods which have been used for finding effective new antifungal compounds that may have potential effects in horticulture and agriculture production. It is important to examine how plants having no use in horticultural and agricultural production can protect themselves against the plant fungal pathogens. It may possible that they produce novel antifungal compounds for overcoming invasion of fungal pathogens.

9. Conclusion:

There are many publications related to plant products for the animal as well as human medicine. Research in the area of plant biotechnology is important for finding effective products which can be productive against the plant fungal pathogens. And it is the most important area of research. When it comes to using organic products based on the plant as compared to chemical products is important in research for antifungal replacement in near future. The cost which includes production, harvesting including extraction and quality control is also important to analyze. The plant-based product uses plays an important role in horticulture and agriculture production for plant treatment at the time of withdrawal period before harvesting which can allow chemical agents concentration for decreasing to the safety level. There are many more papers which are published till now including how plants can protect themselves against fungal pathogens and other productive areas of research for improving and increasing the life quality of the people living in a rural area.

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