We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300

Open access books available

172,000

International authors and editors

190M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Fungal Biotic Stresses in Plants and Its Control Strategy

Faisal Hussain and Farzana Usman

Abstract

Vegetable and fruit are economically very important and valuable crops throughout the world. According to Pakistan Agriculture Research Council (PARC) the same report, Pakistan was the fifth largest exporter in the world, but according to there is continuous decline in the production of fruit and vegetable in Pakistan. The reasons for this reduction are various and many but the major threat in yield production is various pests and pathogens which cause considerable losses every year. Major insects which attack on crop fields are aphids, mites, thrips, etc.; besides pests, different pathogens also cause various diseases in field crop and reduce yield of the plant, for example, fungi, viruses, bacteria, and nematodes. Among other pathogens, the fungal diseases are more destructive than diseases cause by other pathogens.

Keywords: fungi, phytopathogens, vegetables, losses, yield

1. Introduction

Commonly fungal diseases cause more damage than diseases cause by other pathogens. Several fungi cause various diseases in different crop fields and plants (Table 1). Sometime these fungi can cause similar symptoms and confused to

Crop stage	Common fungal diseases	Causal agent
<i>Vegetative stage</i>		
Seedling	Damping off, <i>Phytophthora</i> blight, <i>Fusarium</i> wilt	<i>Pythium</i> spp., <i>Phytophthora</i> sp., <i>Fusarium oxysporum</i>
After transplantation	Frog eye leaf spot, damping off, <i>Fusarium</i> wilt	<i>Cercospora capsici</i> , <i>Pythium</i> spp., <i>Fusarium oxysporum</i>
Root diseases	<i>Phytophthora</i> root rot, <i>Verticillium</i> wilt, <i>Rhizoctonia</i> root rot	<i>Phytophthora capsici</i> , <i>Verticillium</i> sp., <i>Rhizoctonia solani</i>
<i>Reproductive stage</i>		
Flowering	Powdery mildew	<i>Leveillula taurica</i>
Fruiting	<i>Aspergillus</i> , anthracnose, powdery mildew, <i>Phytophthora</i> pod rot, black mold	<i>Aspergillus</i> spp., <i>Colletotrichum</i> sp., <i>Leveillula taurica</i> , <i>Phytophthora capsici</i> , <i>Alternaria</i> spp.

Table 1.
Fungal diseases and their causal agents attacking on chili plant at different crop stages.

Regions	Subregions	Major areas in Pakistan
Saharo-Sindian		Lower Sindh, some areas of upper Sindh, Central and Southern Punjab, Southern Balochistan and KPK plains, Rawalpindi, Islamabad
Irano-Turanian	a. Western subregions	Waziristan and North Baluchistan Upper portion of northern areas, Baltistan, Chitral
	b. Eastern subregions or Central Asia	
Sino-Japanese		Kashmir, KPK, Der, Swat, Muzaffarabad, Hazaras
Indian		East and west of river Jhelum, Lahore

Table 2.
Major chili-producing phytogeographical regions of Pakistan.

one another. There are some preharvesting fungal diseases such as *Aspergillus*, *Alternaria*, anthracnose, *Cercospora* (frog-eye) leaf spot, charcoal rot, *Choanephora* blight (wet rot), damping-off, root-rot, downy mildew, *Fusarium* stem rot, *Fusarium* wilt, gray leaf spot, gray mold, *Phytophthora* blight, powdery mildew, Southern blight, *Verticillium* wilt, and white mold that are grown in different crops.

The vegetable and cereal crop are recorded about the entire region and areas of Pakistan. So there are no clear-cut boundaries between each region and intermingling of crop field occurs. Pakistan has four major phytogeographical regions [1, 2]. Major floristic zones are summarized in **Table 2**.

2. Major fungal diseases causing loss of crops

Commonly fungal diseases cause more damage than diseases caused by other pathogens. Several fungi caused various diseases in field crops. Some major fungal diseases which are responsible for heavy loss to the field crops are as follows:

2.1 *Alternaria* spp.

Genus *Alternaria* is considered as seed-borne fungi, widespread, and highly cause of decline that usually infects chili plants. The loss of fruit yield has been recorded to be up to 100% under certain environment conditions [3]. The disease is characterized by fairly firm, superficial lesions which often occur on berries near the pedicel. Lesions are tan at first, become dark brown to black with age, and remain localized. Under humid conditions provided by cold transit, fluffy gray tufts of fungus often occur on rachis and pedicels, occasionally without causing visible lesions [4]. Symptoms of *Alternaria* begin as water-soaked, gray lesion on either the side or blossom-end of the fruit [5]. As the lesion progresses, they darken and become covered with spores. Internal necrosis and mycelial growth occur on the seeds, placenta, and pericarp but are not noticed until the harvesting [6]. Infection can occur through the flowers or insect injury, mechanical damage, chilling injury, sunburn, or blossom-end rot [6–9].

2.2 Anthracnose/dieback/fruit rot (*Colletotrichum* spp.)

Anthracnose or dieback and fruit rot are caused by *Colletotrichum* sp. [10–12]. The fruit-rot diseases the diseases of crops which belong to the tropical regions has been reported heavy damage. It is remarked as major harmful disease of vegetable

crop [13]. Anthracnose also caused by *Colletotrichum* spp. is a major problem of ripened fruit (Hence, it is also called as ripe fruit rot.), occurs worldwide wherever cereal and other crops are grown [14], is severely infected by anthracnose which may cause yield losses up to 50% [15]. It is a seed-borne fungus. It produces dark spot, water-soaked lesions that rapidly expand. In some cases, the lesions are brown and then turn black from the formation of setae and sclerotia [16]. Infections spread rapidly during periods of excess irrigation or rain on immature pods.

2.3 *Aspergillus* spp.

Several fungi may be present on fruit after the postharvest and storage due to the relative humidity is not controlled during the storage process [17]. There are a number of *Aspergillus* sp. recorded in different crop-growing areas of Pakistan including *Aspergillus flavus*, *A. niger*, *A. fumigates*, etc. Several fruit and vegetables are reported to be contaminated with molds and their toxic metabolites, and *Aspergillus flavus* is the predominant mold on collected samples in several cases [18–22]. Aflatoxins are chemically classified in secondary metabolite which is mostly produced by *Aspergillus flavus*, *A. bombycis*, *A. nomius*, *A. parasiticus*, and *A. tamarii* in chili [23–25].

2.4 Damping off (*Pythium* spp.)

Damping off is a very common disease in nursery seedling beds showing irregular patches. *Pythium* spp. cause this disease which is basically a soil-borne fungus. This disease is more severe in soils with poor drainage.

2.5 Powdery mildew (*Leveillula taurica*)

Powdery mildew is caused by *Leveillula taurica* (asexual stage of fungus). It usually occurs in warm climates (65–95°F), both dry and humid weather. It affects the lower leaf surface, where the lesions are covered with a white to gray powdery growth. Disease progresses from the older leaves to younger leaves, and defoliation is a prominent symptom which reduces the size and number of fruits.

2.6 *Fusarium* wilt (*Fusarium oxysporum*)

Fusarium sp. is a soil-borne fungus and can survive for several years. It is usually grown in wet soil and high temperature. It causes wilting of the plant and upward and inward rolling of the leaves, and as a result leaves turn yellow and die. It causes discoloration of the vascular system of plant, particularly in the lower stem and roots.

2.7 *Cercospora* leaf spot (frog eye) (*Cercospora* spp.)

The leaf lesions due to this disease are circular about 1 cm in diameter with brown border and light gray centers. Lesions are also appearing on stem, petioles, and peduncles. It is a seed-borne fungus. It is also spread by water, wind, and leaf to leaf contact. Severely infected leaves turn yellow and drop from the plant. The fungus usually survives from one season to another on crop debris.

2.8 *Phytophthora* blight (*Phytophthora* spp.)

This disease is also known as *Phytophthora* root rot. Fungus affected all parts of plant. It commonly creates problem when soils are excessively wet either from over

irrigation, heavy rain, or both. The most common symptom is a stem or collar rot by sudden wilting without foliar yellowing.

3. Common recommended cultural control

Integration of chemicals and biotic agents along with resistance for managing plant disease has been considered as a novel approach [26]. The studies of chemical and biological management are valuable to comprehend and understand biodiversity. In general, isolating, identifying, and determining structures of new metabolites are fundamental to reveal their chemical potential, a first step to use, conserve, and protect them [27]. Several attempts to control root-rot fungi could be amended including disinfestations of the soil and planting material with fungicidal chemicals, crop rotation with nonhosts of the fungus, and use of resistant cultivars [28–30].

- Crop rotation.
- Discard the weeds from the crop.
- Disease-resistant variety should be used.
- Same family crops should not be planted in the same field more than once every 3 years.
- Excessive irrigation prior to seedling emergence should be avoided and, after establishment, water should not stand in the field for more than 12 hours.
- Before sowing, the seed should be dried by artificial (machine) method or sunlight method.

4. Chemical control

- Disinfect containers, seed trays, and propagators thoroughly. Dettol is good but tea-tree oil and camomile tea make good alternatives and are safe to use on plants.
- The strobilurin fungicides azoxystrobin (Quadris), trifloxystrobin (Flint), and pyraclostrobin (Cabrio) have been labeled for the control of anthracnose fungus in chili crop.
- Spray twice at 10–15 days interval with 2.5 g mancozeb or 1 g carbendazim/lit of water for the control of *Cercospora* leaf spot.
- Soil sterilization by drenching the soil 4" deep with formaldehyde diluted 50 times with water or with some other effective chemical soil sterilant.
- Soil drenching with 1% Bordeaux mixture or 3 g copper oxychloride like Blue Copper per liter of water at 12 and 20 days after sowing is also useful.
- Seed treatment with 3 g captan or thiram per kg seed.

- Seed treatment with 4 g *Trichoderma viride* formulation combined with 6 g metalaxyl is highly effective.
- Foliar spraying with captafol at 0.2% followed by copper oxychloride at 0.25% and carbendazim at 0.1% during the start of anthracnose disease.

5. Conclusion

The yield of fruit and vegetable is reducing gradually every year due to the presence of different pests and pathogens which cause heavy losses. There is a need to find out different effective methods for the control of these diseases and reduce field crop losses. Due to the use of improper methods of disease management, different fungi particularly *Aspergillus* sp. grow on fruits and produce toxic compound (mycotoxins), which are harmful for human health. Due to the presence of high percentage (%) of these mycotoxins in different vegetables and fruit products, European Union countries and Japan governments have banned import of consignment products in their countries. It is need to improve disease management methods to prevent the growth of fungi during processing, marketing, and transportation and reduce the percentage (%) of mycotoxins in our products which increase our products' export, and thus country will get more foreign exchange.

Author details

Faisal Hussain* and Farzana Usman
Laboratory of Plant Pathology and Aerobiology, Department of Botany, Federal Urdu University of Art, Science and Technology, Karachi, Pakistan

*Address all correspondence to: faisalhussain@fuuast.edu.pk

IntechOpen

© 2019 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

References

- [1] Ali SI, Qaiser M. A phyto-geographical analysis of the phanerogames of Pakistan and Kashmir. Proceedings of the Royal Society of Edinburgh. 1986;**98**(B):89-101
- [2] Nasir JY, Rafique RA. Wild Flowers of Pakistan. Karachi: Oxford University Press; 1995. pp. 24-33
- [3] Mahal MF. Study of fruit rot disease of chili caused by *Alternaria tenuis* and its control in Bangladesh dissertation. Rajshahi: University of Rajshahi; 2004. 360 p
- [4] Swart AE, Holz G. *Alternaria alternata* rot of cold-stored table grapes in the Cape Province of South Africa. Phytophylactica. 1991;**23**:217-222
- [5] Snowden AI. Post-Harvest Diseases and Disorders of Fruits and Vegetables. Vol. 2. Boca Raton, Florida, USA: CRC Press; 1992. p. 237
- [6] Halfon-Meiri A, Ryalski I. Internal mold caused in sweet pepper by *Alternaria alternata*: fungal ingress. Phytopathology. 1983;**73**:67-70
- [7] McColloch LP, Worthington JT. Low temperature as a factor in the susceptibility of mature-green tomatoes to *Alternaria* rot. Phytopathology. 1952;**42**:425-427
- [8] Barakai-Golan R, Kopeliovitch E. Effect of peel injury and enzymatic activity of the fruit on the tolerance of tomato genotypes of *Alternaria* infection. Acta Horticulturae. 1989;**258**:631-637
- [9] Bruton BD, Chandler LD, Miller ME. Relationships between pepper weevil and internal mold of sweet pepper. Plant Disease. 1989;**73**:170-173
- [10] Khaleeqe MI, Khan SM. Fungi associated with fruit rot and die back diseases of chillies in Faisalabad. Pakistan Journal of Phytopathology. 1991;**3**:50-52
- [11] Sultana N, Khanzada AK, Aslam M. A new cause of fruit rot of chillies in Pakistan. Pakistan Journal of Scientific and Industrial Research. 1992;**35**:491-462
- [12] Amusa NA, Kehinde IA, Adegbite AA. Pepper (*Capsicum frutescens*) fruit anthracnose in humid forest region of South-western Nigeria. Nutrition and Food Science. 2004;**34**:130-134
- [13] Tindall B. Vegetable in the Tropics. London: Macmillan Press; 1983. pp. 347-354
- [14] Poulos JM. Problems and progress of chilli pepper production in the tropics. In: Hock CB, Hong LW, Rejab M, Syed AR, editors. Proceedings of the Conference on Chilli Pepper Production in the Tropics. Kuala Lumpur, Malaysia: MARDI; 1992. pp. 98-129
- [15] Pakdeeveraporn P, Wasee S, Taylor PWJ, Mongkolporn O. Inheritance of resistance to anthracnose caused by *Colletotrichum capsici* in *Capsicum*. Plant Breeding. 2005;**124**:206-208
- [16] Robert PD, Pernezny KL, Kucharek TA. Anthracnose caused by *Colletotrichum* spp., on pepper. University of Florida Extension Note; 2001. p. 104. www.edis.ifas.ufl.eduS, December 2007
- [17] Aziz NH, Youssef YA, El-Fouly MZ, Moussa LA. Contamination of some common medicinal plant samples and spices by fungi and their mycotoxins. Botanical Bulletin of Academia Sinica. 1998;**39**:279-285
- [18] Christensen CM, Fause HA, Nelson GH, Bates F, Mirocha CJ. Microflora of black and red pepper. Cooperative

Extension Circular. Applied Microbiology. 1967;15:622-628

[19] Scott PM, Kennedy BPC. Survey of ground black, white and *capsicum* peppers for aflatoxins. Journal of the Association of Official Agricultural Chemists. 1973;56:1452-1457

[20] Flannigan B, Hui SC. The occurrence of aflatoxin producing strains of *Aspergillus flavus* in the mold flora of spices. The Journal of Applied Bacteriology. 1976;41:411-418

[21] Seenappa M, Stobbs LW, Kempton AG. *Aspergillus* colonization of Indian red pepper during storage. Phytopathology. 1980;70:218-222

[22] Patel S, Hazel CM, Winterson AGM, Morthy E. Survey of ethnic foods for mycotoxins. Food Additives and Contaminants. 1996;7:833-841

[23] Kurtzman CP, Horn BW, Hesseltine CW. *Aspergillus nomius*, a new aflatoxin producing species related to *Aspergillus flavus* and *Aspergillus tamari*. Antonie Van Leeuwenhoek. 1987;53:147-158

[24] Goto T, Ito Y, Peterson SW, Wicklow DT. Mycotoxin production ability of *Aspergillus tamari*. Mycotoxins. 1997;44:17-20

[25] Peterson SW, Ito Y, Horn BW, Goto T. *Aspergillus bombycis*, a new aflatoxigenic species and genetic variation in its sibling species *A. nomius*. Mycologia. 2001;93:689-703

[26] Papavizas GS. Status of biological control of soil borne plant pathogens. Soil Biology and Biochemistry. 1973;5:709

[27] Castillo M. Now what?? In: Muñoz O, editor. Química flora of Chile. University of Chile, Department T? Technician of researching. Santiago, Chile; 1992. 341 p

[28] Jones JP, Jones JB, Miller W. Fusarium wilt on tomato. Fla. Dept. Agric. and Consumer Serv., Div. of Plant Industry. Plant Pathology Circular No; 1982. 237 p

[29] Agrios GN. Plant Pathology. 5th ed. Elsevier Academic Press; 2005. pp. 510-514

[30] Smith IM, Dunez J, Phillips DH, Lelliott RA, Archer SA. European Handbook of Plant Diseases. Oxford: Blackwell Scientific Publications; 1988. 583 p