



Chili pepper Anthrax: Current condition, Identification, and Treatment

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ABSTRACT

Chili (*Capsicum annum* L.) is one of the most economically important vegetable plants in the world. Among various biological limitations, anthracnose disease is the most important limiting factor for chili pepper yield and production. Various symptoms associated with this disease include fruit rot, leaf spot, stem dieback, seedling blight or leaf blight. Many species of the genus *Colletotrichum* are associated with this disease worldwide. Three major important species are found in India: *Colletotrichum truncatum*, C.; *acutatum* and *C. gleosporoides* are the causative agents of chili pepper anthrax. Selecting the correct management strategy to control this disease requires accurate identification of the pathogen. Both conventional and molecular methods have been adapted for this disease along with various management strategies that are recommended: cultural, chemical, and other environmental methods.

Keywords: *Colletotrichum*, biological control agents, diagnosis, molecular methods.

INTRODUCTION

The genus *Capsicum* includes many cultivated species, among which *Capsicum annum* L. is one of the most commonly cultivated species. Additionally, other dome-like species include *C. baccatum*, *C. chinensis*, *C. frutescens*, and *C. Adolescence*. *C. annum* consists of both sweet (bell pepper) and spicy (chili) fruits of various shapes and sizes. It is an excellent source of vitamins A and C, potassium, and folate. Fresh green chili peppers contain more vitamin C than citrus fruits, while red chili peppers contain more vitamin A than carrots. It is widely used as a vegetable, spice, and seasoning, as well as in medicines and beverages. *Capsaicinoids* and *caretenoids* are the active components of chili peppers. Capsaicinoids are non-volatile alkaloids that make chili peppers spicy, and caretinoids also have nutritional value that give color to chili pepper fruits. In tropical and subtropical countries, chili is considered the most important ingredient in various dishes. Chili peppers originate from tropical America, where they still grow in the wild. Its introduction to India is believed to be due to the voyage of Columbus who brought seeds from Spain and introduced them to Europe, which then spread to Africa and Asia in. India is the world's largest producer of dried chili peppers, and in 2018, India produced 1.8 million tons of the world's production of million tons. There are two important commercial qualities that make Indian chili peppers famous worldwide. Its color and color.



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2. Anthracnose disease losses:

In field, chili pepper crops are being attacked by various pests and pathogens, and post-harvest mycotoxin contamination is a major obstacle to chili production. Globally, chili peppers are susceptible to a variety of pests, weeds, fungi, bacteria, and viral pathogens. Among fungal diseases, anthracnose/damping-off/fruit rot of chili pepper is an important disease that causes significant losses in the field, transport, transportation, and storage. 2. Losses from Anthrax The word anthrax is of Greek origin and means "coal." This is the common name for a plant disease with very dark, sunken lesions containing fungal spores. Typical symptoms of anthracnose on chili pepper fruits of cultivar (Figure 1) are black spots, sunken necrotic tissue with concentric callous rings. In addition to fruit rot, it also causes leaf

spotting, stem blight, seedling rot, or leaf blight. The disease not only affects fruit quality through the appearance of anthracnose lesions, but also reduces fruit dry weight, capsaicin and oleoresin content. The disease has caused, deaths worldwide. It has been reported to cause 20-80% yield loss in Vietnam, 10% yield loss in South Korea, 50% yield loss in Malaysian, and up to 80% yield loss (during severe outbreaks) in Thailand. Calculated yield losses of 10–5 % have been reported in India due to this disease. Although the disease has been reported across India, it has been found to be a more common and aggressive form in Assam, Bihar, Andhra Pradesh, and Uttar Pradesh. The anthracnose pathogen has been found in seeds, and the presence of the pathogen in seed samples was reported in. Infection indices up to 5D indicate widespread occurrence in India.



Figure 1. (a) Healthy chilli plant, (b) chilli plant affected with anthracnose disease, and (c) chilli fruits showing anthracnose symptom

Table 1. Different Colletotrichum species associated with the disease anthracnose of chilli in different countries.

Country	Pathogen
Australia	<i>C. acutatum</i> , <i>C. atramentarium</i> , <i>C. dematium</i> , <i>C. gloeosporioides</i> var. <i>minor</i> , <i>C. gloeosporioides</i> var. <i>gloeosporioides</i> , <i>C. brisbanense</i>
Brazil	<i>C. boninense</i>
India	<i>C. capsici</i> , <i>C. dematium</i> , <i>C. truncatum</i> , <i>C. gloeosporioides</i> , <i>C. graminicola</i> , <i>C. acutatum</i> , <i>C. piperatum</i> , <i>C. atramentarium</i> , <i>C. fructicola</i> , <i>C. siamense</i> , <i>C. cliviae</i> , <i>C. coccodes</i> , <i>C. karstii</i>
Indonesia	<i>C. gloeosporioides</i> , <i>C. truncatum</i> , <i>C. acutatum</i>
South Korea	<i>C. acutatum</i> , <i>C. gloeosporioides</i> , <i>C. coccodes</i> , <i>C. dematium</i>
Mexico	<i>C. truncatum</i>
Malaysia	<i>C. truncatum</i>
New Zealand	<i>C. coccodes</i> , <i>C. karstii</i> , <i>C. novae-zelandiae</i> , <i>C. nigrum</i>
Papua New Guinea	<i>C. truncatum</i> , <i>C. gloeosporioides</i>
Philippines	<i>C. gloeosporioides</i> , <i>C. truncatum</i> , <i>C. scovillei</i>
Sri Lanka	<i>C. truncatum</i>
Taiwan	<i>C. acutatum</i> , <i>C. truncatum</i> , <i>C. gloeosporioides</i>
Thailand	<i>C. acutatum</i> , <i>C. truncatum</i> , <i>C. gloeosporioides</i>
USA	<i>C. gloeosporioides</i> , <i>C. acutatum</i> , <i>C. truncatum</i> , <i>C. coccodes</i>
UK	<i>C. acutatum</i> , <i>Glomerella cingulata</i>
Vietnam	<i>C. acutatum</i> , <i>C. truncatum</i> , <i>C. gloeosporioides</i> , <i>C. nigrum</i>
Zimbabwe	<i>C. nymphaeae</i>

3. Pathogen:

This disease is caused by a species of the genus *Colletotrichum*, which belongs to the Ascomycetes. Several species of *Colletotrichum* have been reported to cause, cases of pepper anthracnose worldwide (Table 1). In India, among the various species known to cause this disease, there are mainly three important species: *Colletotrichum capsici* Syd. Butler and Bisbee, *C. C. acutatum* and *C. gloeosporioides* have been reported to be associated with this disease, but *C. truncatum* causes more damage during the mature fruiting stage of the plant.

Diagnosis:

Identification of *Colletotrichum* species based on morphological characteristics (size and shape of conidia, presence of setae) and colony characteristics is commonly used by several researchers. It is widely used in seed health testing laboratories to detect *C. capsici* in the germplasm to preserve Chile seeds in pest-free conditions. Because this pathogen is transmitted through seeds, there is a risk of introducing this pathogen with imports of germplasm (including chili peppers) from different countries. Therefore, when importing from other countries, samples must be tested very rigorously, including sensitive molecular diagnostic tools, to prevent the introduction of this germplasm-associated pathogen. Additionally, molecular methods are primarily adapted for accurate identification of pathogens at the species level. Loop-mediated isothermal amplification (LAMP) assay was used for accurate and sensitive detection of *C. capsici*. LAMP primer (based on the β -tubulin gene sequence) was developed and reported to be able to detect *C. capsici* pathogens as low as 10 fg/ μ L, whereas detection of *C. capsici* using polymerase chain reaction was up to 1 ng/ μ L. The SCAR marker (sequence characterized amplified region) was developed for the specific and sensitive detection of *C. Chili* pepper seeds and fruit *capsici*. These markers performed amplifications of 250 bp fragments expected from genomic DNA. These markers were very sensitive, as they were reported to be able to recognize *C. capsici* DNA template purified to 1 pg and DNA from infected with *C. capsici* Chili fruit has up to 25 ng. These two markers are very sensitive and are therefore very useful for plant quarantine stations to detect pathogens in imported germplasm. COL1/COL2 primers were used to identify the *Colletotrichum* species tested (*C. acutatum*, *C. truncatum* and *C. gloeosporioides*) with a specific

band of 60 base pairs. Using this primer, *C. gloeosporioides* were detected from a small amount of 1,000 conidia on chili pepper leaves and fruits. Another primer set based on the sequence of the ribosomal internal transcription spacer region (ITS1 and ITS2) of *C. truncatum* was developed and standardized for detection of *C. truncatum*. Analysis of *truncatum* in infected plant tissues using PCR assays.

Management Strategies:

Various strategies are applied to the management of chili pepper anthracnose. These include environmentally friendly measures such as the use of cultural practices, chemical control, the use of biological control agents, plant extracts, and the use of resistant varieties. Generally, it is recommended to use a combination of different strategies to treat the disease. Condensed information about the treatment of this disease is collected from all over the world.

Cultural Practices:

Depending on the specific etiology of the pathogen, several cultural practices have been reported to control chili pepper anthrax. These precautions are taken even before the fruit is ripe and harvested to reduce infection rates and minimize inoculation pressure. Tan et al. and Ali et al., in a review of, reported that different cultural practices were adopted in chili pepper cultivation, such as disease-free seeds, weeding, crop rotation, proper drainage, and removal of crop residues. It was suggested that disease-free chili pepper seeds should be planted, that weed removal should be carried out in chili pepper fields, and that chili pepper crops should be rotated with other crops that do not provide alternative hosts for *Colletotrichum*. Teeth. Every two to three years is very effective in controlling this disease. Good drainage systems on the field to drain wastewater during irrigation, disinfection of fruit on the farm such as washing fruit in packing houses, and removal of plant residues that may ultimately serve as sources of inoculum are other practices for clean harvest and sanitation. If the disease has occurred in a particular field in the past, other crops should be grown in isolation from other Solanaceae plants for at least years. At the end of the growing season, it is recommended to use a deep plow to completely cover diseased plants or remove infected plant debris from the field. It is also recommended to plant chili peppers early and to plant varieties that bear fruit with a short ripening period to avoid fungal infections of the fruit.

Other alternative hygiene measures, such as weeding and removal of infected or damaged fruit, should be carried out regularly to prevent pathogens from using such wounds as a source of infection.

Chemical Control:

Various approaches for handling the illness are suggested, with chemical methods being the most effective and feasible option. The time needed to manage the disease using chemical techniques is significantly shorter compared to the duration necessary for creating resistant plant varieties. The application of protective fungicides such as manganese ethylene bis dithio carbamate, commonly known as Maneb, is frequently advised for the control of this illness. In addition, other dithiocarbamate fungicides, including Mancozeb (0.2%), ziram (0.1%), copper oxychloride (Blitox 50), and Bordeaux mixture (at concentrations of 0.5 or 1% using copper sulfate), have proven effective in managing this condition. It is also recommended to treat seeds with benzimidazole fungicides (such as Benlate and Delsene M) and the strobilurin fungicide azoxystrobin. Furthermore, soaking chili seeds for 12 hours in a 0.2% solution of Thiram, a dithiocarbamate fungicide, has been shown to be effective in enhancing disease control.

Biological Control:

Trichoderma species serve as fungal antagonists that are widely used to manage Colletotrichum species in chili peppers. These species are also thought to have the ability to compete effectively for surface area, which helps to diminish the success of pathogen infections. The chloroform extracts from the nonvolatile antibiotics (NVAC) of *T. viride*, when incorporated into culture media containing *C. truncatum*, resulted in reduced biomass along with decreased RNA, DNA, and protein synthesis. It has been noted that antifungal substances at a concentration of 100 mg/L produced by the *Trichoderma harzanium* Rifai strain T-156co5 significantly inhibited *C. truncatum* obtained from *C. annum*. In laboratory tests, *T. viride* and *P. fluorescens* proved to be highly effective at suppressing the mycelial growth of the pathogen. It is recommended to employ *T. viride* and *P. fluorescens*, whether separately or in combination, as a significant means of reducing anthracnose disease incidence, serving as an alternative to chemical methods.

Plant Extract:

Secondary metabolites from plants with antimicrobial properties are among the most effective methods for managing plant diseases. In chili crops, various studies have demonstrated the effectiveness of plant extracts against *Colletotrichum* species. Of the plant extracts tested, *Allium sativum* at a concentration of 10% and *Azadirachta indica* at 10% showed the greatest suppression of the mycelial growth of *C. gloeosporioides*. *A. indica*, *Datura stramonium*, *Ocimum sanctum*, *Polyalthia longifolia*, and *Vinca rosea* were utilized against *C. truncatum*. From five fermented leaf extracts evaluated for their impact on *C. truncatum*, *A. indica* at a concentration of 20% significantly limited the growth of the fungus under laboratory conditions. Additionally, applying the fermented leaf extract of *A. indica* in real-life scenarios led to a reduction in fruit rot incidence (3%) and significantly improved plant height, fruit quantity, and overall yield. An experimental trial involving botanical extracts from *Catharanthus roseus*, *Coleus aromaticus*, *Manilkara zapota*, and *A. indica* against fungal pathogens found that these extracts exhibited antifungal properties affecting the radial mycelial expansion of *C. truncatum*. Organic pesticides were made using extracts from neem leaves, soursop leaves, lemongrass, tuba root, and kenikir/*Cosmos caudatus*. The findings suggest that neem leaves are the most potent organic pesticide for controlling chili pepper diseases, particularly in Indonesia.

Resistant Cultivars:

Utilizing resistant or tolerant cultivars stands out as the most economical approach for management. Given the absence of resistance within the *C. annum* genetic pool, no commercially viable resistant types have been produced for *C. annum*. The transfer of the resistance gene from *C. baccatum* to *C. annum* presents challenges. Some research has explored the integration of anthracnose resistance into *C. annum* to create a new cultivar. Among the promising lines yielding well and showing tolerance to anthracnose are five *C. annum* varieties from AVRDC in Taiwan, specifically AVPP1102-B, AVPP0513, AVPP0719, AVPP0207, and AVPP1004-B. Additionally, two chili cultivars from IVEGRI in Indonesia, named Lembang-1 and Tanjung-2, have been noted for their moderate resistance.

In India, a few lines resistant to anthracnose include LLS, PBC932 (VI047018), Breck-2, PBC80 (VI046804),

Breck-1, Jaun, and PBC81 (VI046805). Furthermore, nine other resistant varieties such as BS-35, BS-20, BS-28, Punjab Lal, Bhut Jolokia, Taiwan-2, IC-383072, Pant C-1, and Lankamura Collection were recognized that could serve as a basis for the creation of effective resistant cultivars through breeding efforts. The data on resistant varieties against *Colletotrichum* spp. may also assist in analyzing the inheritance of resistance, as well as in mapping and examining quantitative trait loci (QTLs) associated with that resistance. Additional research should be conducted to explore the significance of these various genes in controlling chili anthracnose. However, the genetic processes linked to chili's resistance to anthracnose remain inadequately understood, primarily due to a lack of data regarding the defense signaling pathways involved in this resistance mechanism.

CONCLUSION

Anthracnose of chilli is main constraint for its production in the India as well as worldwide. Detection this pathogen in the seed by the morphological features and with the developed molecular markers are very important especially in quarantine laboratories. The accurate detection of pathogen also helps in choosing the best management strategy for the control of this disease. Involvement of many *Colletotrichum* species in the disease and absence of resistance gene in *C. annum* makes breeding for resistance is more challenging. Moreover, injudicious use of chemicals for the control of this disease leaves residue in the chilli fruit poses threat to the export. Combining the use of resistance cultivars with other disease 7 *Capsicum* control measures would enhance the efficiency in integrated management of chilli anthracnose. Moreover, more research is required to find better alternative methods to control chilli anthracnose by involving vigorous evaluation and identification of resistant cultivars of chilli against this disease.

Conflict of interest

The authors declare no competing interests.

Data Availability Statement: Not applicable.

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REFERENCES

- Dev U, Akhtar J, Chaudhury R, Kandan A, Chand D, Kumar J, et al. Survival of *Colletotrichum capsici* (Syd.) Butler & Bisby in decade-long cryo preserved chilli seeds. *Seed Research*. 2012;40(1):92-94
- Díaz J, Pomar F, Bernal A, Merino F. Peroxidases and the metabolism of capsaicin in *Capsicum annum* L. *Phytochemistry Reviews*. 2004;3(1-2):141-157
- FAOSTAT. 2020. Available from: <http://www.fao.org/faostat/en/#home>
- Heiser CB Jr. Peppers *Capsicum* (Solanaceae). In: Smartt J, Simmonds NW, editors. *Evolution of Crop Plants*. 2nd ed. UK: Wiley; 1995. pp. 265-268
- Isaac S. *Fungal-Plant Interactions*. London: Chapman and Hall Press; 1992. p. 115
- MacNeish RS. Ancient mesoamerican civilization. *Science*. 1964;143(3606):531-537
- Marín A, Ferreres F, Tomás-Barberán FA, Gil MI. Characterization and quantitation of antioxidant constituents of sweet pepper (*Capsicum annum* L.). *Journal of Agricultural and Food Chemistry*. 2004;52(12):3861-3869
- Osuna-García JA, Wall MM, Waddell CA. Endogenous levels of tocopherols and ascorbic acid during fruit ripening of new Mexican-type Chile (*Capsicum annum* L.) cultivars. *Journal of Agricultural and Food Chemistry*. 1998; 46(12):5093-5096
- Pathirana R. Peppers: Vegetable and spice capsicums. In: Bosland PW, Votava EJ, editors. *Crop Production Science in Horticulture Series 22*. 2nd ed. Wallingford, UK: CAB International; 2012. p. 248
- Raghavan S. *Handbook of Spices, Seasonings, and Flavorings*. Boca Raton, USA: CRC; 2007. pp. 87-91.
- Singh RS. *Disease of Vegetable Crops*. 2nd ed. New Delhi: Publishing Company Pvt. Ltd; 1987. p. 362
- Tong N, Bosland PW. *Capsicum tovarii*, a new member of the *Capsicum baccatum* complex. *Euphytica*. 1999;109(2):71-77.

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