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Review Article

PATHOGENECITY OF ASPERGILLUS NIGER IN PLANTS

***Ruchi Sharma**
Department of Microbiology, Mahatma Jyoti Rao Phoole University, Jaipur
**Author for Correspondence*

ABSTRACT
Aspergillus niger is a member of the genus *Aspergillus* which includes a set of fungi that are generally considered asexual, although perfect forms (forms that reproduce sexually) have been found. Aspergilli are ubiquitous in nature. They are geographically widely distributed and have been observed in a broad range of habitats because they can colonize a wide variety of substrates. *Aspergillus niger* is commonly found as a saprophyte growing on dead leaves, stored grain, compost piles and other decaying vegetation. Microscopically, its conidiophores are smooth-walled, hyaline or turning dark towards the vesicle. Conidial heads are biseriate with the phialides borne on brown, often septate metulae. Conidia are globose to subglobose (3.5-5.0 um in diameter), dark brown to black and rough-walled. It is known to create increased amount of pathogenecity in various species of plants, which can be treated by antibiotics, chemicals and antibiosis. Biological control however is the best and most effective treatment.

INTRODUCTION
Aspergillus niger is a fungus and one of the most common species of the genus *Aspergillus*. It causes a disease called black mold on certain fruits and vegetables such as grapes, onions and peanuts and is a common contaminant of food. It is ubiquitous in soil and is commonly reported from indoor environments. *Aspergillus niger* is a member of the genus *Aspergillus* which includes a set of fungi that are generally considered asexual, although perfect forms (forms that reproduce sexually) have been found. Aspergilli are ubiquitous in nature. They are geographically widely distributed and have been observed in a broad range of habitats because they can colonize a wide variety of substrates. *Aspergillus niger* is commonly found as a saprophyte growing on dead leaves, stored grain, compost piles and other decaying vegetation. The spores are widespread and are often associated with organic materials and soil. *Aspergillus niger,* a worldwide distributed member of ascomycotina, has been isolated from numerous habitats. *Aspergillus niger* is one of the fungi that has been labeled with the GRAS (generally recognized as safe) status from the US Food and Drug Administration. This dull or dark black looking fungus has several important products in fermentation industry. But due to cosmopolitan nature, human beings gets frequently exposed to spores and vegetative forms of *A. Niger* present in air, on foodstuffs and others stored consumables products and suffers with allergic problems. *Aspergillus niger* may also produce certain mycotoxins which are heptocarcinogenic, nephrogenic immunological in nature. In addition, this fungus is also causative agent for many rot diseases in plants. So, the present review article is an important step to understand the diversity, pathogenicity and toxicology of this important spoilage *Aspergillus niger*. *Aspergillus niger* (black mold), a filamentous ascomycete having ability of fast growth and pH tolerance is most important cosmopolitan fungi associated with postharvest decay of different substrates (Pitt and Hocking, 1997; Perfect *et al*., 2009; Perrone *et al.,* 2007). This organism is a soil saprobe with a wide array of hydrolytic and oxidative enzymes involved in the breakdown of plant lignocelluloses. Because of their ability to produce extracellular organic acid**s** some of them are commonly used in food industry. These features of *Aspergillus Niger* enable them to cause decay of various organic substances including fruits, vegetables, nuts, beans, cereals, herbs, wood and herbal drugs. *Aspergillus niger* also plays a significant role in the global carbon cycle (Baker, 2006). Moreover,

Aspergillus niger is one of the fungi that has been labelled with the GRAS (generally recognized as safe) status from the US Food and Drug Administration (Powell *et al*., 1994). But instead of the safe categorization, *Aspergillus niger* has been found to be a opportunistic reason for infections of humans. If inhaled, in sufficient quantity it can cause severe lung problems i.e., aspergillosis in humans. It is also associated with various plant diseases resulting in huge economic loss. Beside animal and plant pathogen, *Aspergillus niger* is also reported to produce ochratoxin A and fumonisin B2 and aflatoxins (Abraca *et al*., 1994; Schuster *et al*., 2002; Noonimabc *et al*., 2009; Al-Abdalall, 2009) in stored commodities, which seems to be very inevitable. Mycotoxins produced by *A. niger* are not only linked to discoloration, quality deterioration, reduction in commercial values but can also cause several ailments of liver, kidney, nervous system, muscles, skin, respiratory organs, digestive tract, genital organs etc. (Muntanola, 1987; Purchase, 1974; Durakovic *et al*., 1989; Rai and Mehrotra, 2005; Truckesses and Scott, 2008). Therefore, the purpose of this review is to summarize the current knowledge like diversity, pathogenicity and toxicology about this important spoilage fungus

MATERIALS AND MATHODS

Isolation and In Vitro Cultivation

Most common procedure of isolating this fungus is from a nearby garden soil which after collection (1gm) can be diluted in 10 ml of sterilized distilled water, to make 1/10 dilution. Further, simple PDA is prepared which is considered as the best medium for fungal culture. The preparation is done according to standard laboratory protocol (39 gms PDA powder per liter of sterilized distilled water). Autoclaving was carried out at 121^{o}C for 15-20 minutes. This destroys nearly all living cells and spores in the medium. Pouring of the PDA Plate is performed by steps according to laboratory manual. 20 ml of sterilized simple PDA is poured in petriplates. 1 ml inoculation (spread plate method) of 1/10 diluted soil sample is carried out in petriplates, alongwith keeping of specific controls to check contamination in laminar air flow, where the inoculation is performed. Further, the plates are incubated at 30C.

Colony and Micro-Morphology

On potato dextrose agar medium, colonies arise after 3-4 days usually which consist of a compact white or yellow basal felt covered by a dense layer of dark-brown to black conidial heads. Conidial heads are large (up to 3 mm x 15-20 um in diameter), globose, dark brown, becoming radiate and tending to split into several loose columns with age. Conidiophores are smooth-walled, hyaline or turning dark towards the vesicle. Conidial heads are biseriate with the phialides borne on brown, often septate metulae. Conidia are globose to subglobose (3.5-5.0 um in diameter), dark brown to black and rough-walled.

Causes of Contamination by Aspergillus Niger

Aspergillus niger is basically soil borne non-ligninolytic fungus. Contamination may occur by dispersal of its spores through wind and their transportation to water bodies, food, plants, human and animals. Spores can be easily inhaled by human and animals whereas in plants the spores exist and germinate by absorbing nutrition from the site of infection viz. fruits, stem, leaves, flowers etc. thus, we can say that this fungal contamination is possible via air, water and soil.

RESULTS AND DISCUSSIONS

Pathogenecity in plants

Aspergillus niger has been isolated from 37 genera of plants (Farr *et al.*, 1989). There are reports of *Aspergillus niger* being a plant pathogen in peanuts (Jackson, 1962). Apparently, *Aspergillus niger* can induce a crown rot of peanuts due to *Aspergillus niger*-infected seed under specific hot, humid growth conditions. The mycotoxins described above, namely oxalic acid, malformin A and malformin C, have been shown to cause significant growth effects such as root curling and top deformation in plants (Anderegg *et al.*, 1976). *Aspergillus niger* also causes the rotting of numerous fruits, vegetables and other

food products, thus causing substantial economic losses due to spoilage. For example, black rot of onions associated with *Aspergillus niger* is responsible for serious losses of onion bulbs in the field and in storage. Clusters of black spores of *Aspergillus niger* generally form along veins and on or between the outer papery scales of onion bulbs (Rao and Rajasab 1992). There are also reports of *Aspergillus niger*-induced spoilage of mangos (Prakash and Raoof, 1989), grapes (Sharma and Vir, 1986) and tomatoes (Sinha and Saxena, 1987). *Aspergillus niger* is generally regarded as a strict saprophyte (Farr et al., 1989, Commonwealth Mycological Institute, 1966). As with effects on animals, the rare adverse plant effects seen appear to be strain specific. Black mold is a very serious disease to affect plants in general and vegetables in particular (Sneh et al. 1991). This disease is a limiting factor for vegetable production effecting both their quality and quantity (Larkin and Fravel 2000, Iannou 2000). It is also known to cause stem rot of *Dracaena* (Abbasi and Aliabadi, 2008); root stalk rot of Sansevieria; and boll rot of Cotton; spoilage of cashew kernels, dates, figs, vanilla pods and dried prune (Bobbarala *et al*., 2009).

Fruit or nut trees such as pistachio often develop a fungus known as *Aspergillus* blight due to irrigation practices in which a drip irrigation line is buried in the soil. Nut growers often use buried drip irrigation lines to irrigate these trees because it reduces the chances that the tree develops alternaria late blight, a fungal infection caused by flood irrigation. The trees develop *Aspergillus* blight due to the presence of *Aspergillus niger* in the soil. Nuts that develop Aspergillus blight have shells that are stained bright yellow.

The following Table 1, illustrates the various diseases caused by *Aspergillus niger* in different plants.

Table 1: Plant diseases caused by *Aspergillus niger*

Name of disease	Host	Reference
Black rot of onions	*Allium cepa* L. (Onion)	Narayana *et al.* (2007)
Crown rot of peanuts	*Pisum Sativum* L. (Peanut)	Anderegg *et al.* (1976)
Tuber rot of yam	*Dioscorea* sp. (Yam)	Awuah and Akrasi (2007)
Stem rot of *Dracaena*	*Dracaena sanderiana* Mast.	Abbasi and Aliabadi (2008)
Black mold rot of cherry	*Prunus avium* L.(Cherry)	Lewis *et al.* (1963)
Kernel rot of maize	*Zea mays* L. (Corn)	Palencia *et al.* (2010)
Fruit rot of grapes	*Vitis* sp. (Grape)	Sharma and Vir (1986)
Fruit rot of banana	*Musa* sp. (Banana)	Adebesin *et al.* (2009)
Rot of Tomatoes	*Solanum lycopersicum* L. (Tomato)	Sinha and Saxena (1987)
Mango rotting	*Mangifera indica* L. (Mango)	Prakash and Raoof (1989)

Treatments

Some chemical fungicides like Metalaxyl, a phenylamide reduces the mycelial growth of this fungus. Fravel et.al. (2005) found subdue (Mefenoxam) to be effective in reducing the mycelia growth of fungi. Antibiotics like cycloheximides offer effective control for certain diseases caused by *A. niger*.

In case of biological control, some antagonists produce antibiotics that kill or reduce the number of closely related pathogens; these antibiotics are 2,4-diacetylphloroglucinol, Phenazines, Cyclic lipopeptides. CBF-2606 is a proprietary blend of macro and micro nutrients, amino acids, enzymes, proteins, vitamins and Beneficial Microorganisms (BM) formulated to control a wide range of fungi. It is natural and does not contain chemicals, hence is a biocontrol agent. Cultural practices like incorporation of green manure, such as alfalfa, into the soil and use of suppressive soils are also carried out. Antibiosis,

a biocontrol method provided by marigold (*Tagetes* species) roots, which release terthienyls, chemicals are toxic to *A. niger*.

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