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FUNGAL DISEASES OF FOREST TREE SEEDS AND CONTROL MEASURES: A GUIDEBOOK

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Foreword

This guidebook is based on the Manual on Forest Tree Seed Diseases and their Control, which is an offshoot of the author's project entitled, "Biochemical and physiological changes in microbially infected forest tree seeds", together with her other completed studies on forest tree seed pathology. The project was funded by the National Research Council of the Philippines of the Department of Science and Technology.

In this DENR Recommends series, the technologies derived from the project are herein presented for use by seed technologists, nurserymen, researchers engaged in forest tree seed research, forest tree seed users from the private industries, and students of seed pathology. With this guidebook, readers/users should be able to identify forest tree seeds infected with diseases; the causal fungal pathogens that can readily be seen on the seeds, or observed under a microscope; the possible measures to control infection on seeds; the host range or forest tree seed species where the pathogen is also isolated; and the negative economic repercussions of the pathogens. The geographical distribution of each fungus is also presented herein.

It is hoped that this guidebook will be useful to seed users in selecting seedlots of forest tree species which are free from pathogenic microorganisms, especially fungi, to be able to produce high quality planting stocks for reforestation and afforestation purposes.

ELSO P. DIAZ
Director

Scope and Limitations

This guidebook describes the different fungi as observed on seeds and under a microscope. Included are the cultural characteristics, i.e., color of the fungus on the potato dextrose agar (PDA) medium, growth of the mycelium, whether sparse or scanty, fluffy, or submerged. Absence (naked), or presence of the fruiting structures (acervulus, pycnidium, or collectively, “conidiomata”) is also indicated. Likewise, the morphological structure of each fungus, specifically conidiophore and conidia, is well-described with photomicrographs. The host range or forest tree seed species where the specific fungus was isolated is also noted and this was based on the author’s works from 1986 to 2003. The economic disadvantage of each fungus, that is, the damage on different species of forest tree seeds/seedlings as well as agricultural crops is also cited. Similarly, measures on how to prevent or eradicate each fungus once the seeds are infected are also included. Lastly, seed disease distribution, that is, the places where the seeds were collected and where the diseases occurred is also indicated.

This guidebook is limited only to fungal diseases on seeds as seen under the microscope since this is the group of microorganisms that are very common on forest tree seeds. Actual photographs of different fungi as seen on seeds with the naked eye were not taken since one fungal species could not be distinguished from the other fungus belonging to the same genera by just mere looking on the mycelial growth on seeds. Besides, an ordinary still camera without macro lens could not capture the real description of every fungus. Another limitation was the use of 100 seeds/sample instead of the International Seed Testing Association (ISTA) standard for agricultural crops, i.e., 200 seeds/sample. The absence of ISTA standard for seed health testing of forest tree seed species and the unavailability of seeds in large quantities led to the use of the only available resources during the conduct of the study.

Defining Diseases

As defined by Wheeler (1975), diseases include all malfunctions which result in unsatisfactory plant performance or which reduce a plant’s ability to survive and maintain its ecological niche. These may be either caused by biotic and abiotic agents. Biotic agents are those belonging to the fungal, bacterial, and viral group while abiotic are mainly due to environmental factors, nutrient deficiency, and chemical and physical agents. However, this guidebook focuses on diseases caused by fungal pathogens since these are the major group of microorganisms that are commonly observed on forest tree seeds.

Fungal (“amag”) Diseases of Seeds

There are three groups of fungi that are dominantly present on seeds. Those that attack the seeds in the field (field fungi) while the seed moisture content is still high. Other fungi continue to exist inside the seeds and remain dormant until the seeds germinate (seed-borne fungi). Still other fungi occur only in storage (storage fungi). The presence of these fungi on and inside the seeds causes malformation, discoloration, sunken seed coat, rotting of the endosperm and embryo, abortion, rotting of germinants, and postemergence damping-off of seedlings. These fungi occasionally reduce the quality of a seedling stand and percent survival in the nursery.

Diagnosing Diseases

Generally, four methods of diagnosing seed diseases are used: visual examination, blotter test, agar plate test, and seedling symptom test (ISTA, 1985). In this study, the blotter test was used. Seeds were placed at equal distances on three layers of moistened filter paper in sterile petri dishes, or four layers of moistened paper towel in plastic trays. Seeds were incubated for seven days in a germination chamber with light. Then these were examined on the eight day using a stereoscopic and compound microscope. A photomicrograph of each fungus as it occurred on seeds was taken. Isolation of every individual fungus was done by picking the spores and streaking in a plated potato dextrose agar (PDA). The mycelial growth of each fungus was taken and transferred aseptically in the PDA slants for identification. Each isolate was identified and the author based the identification on the different books and pamphlets on seed pathology and other literature on taxonomy of fungi (CMI, 1971; Neergaard, 1977; Booth, 1977; Ainsworth *et al.*, 1973; Quimio and Hanlin, 1999; and Sutton, 1980).

Fungal Diseases of Forest Tree Seeds and Control Measures

***Fusarium solani* (Mart) Sacc.**

On Seed

The fungus is very loose and dull. White mycelial growth is present with numerous shiny, milky white, oval droplets on simple erect sterigmata which are actually the microconidia of the species (Fig. 1a). In some seed species like narra, dagang, and mahogany, shiny white to dirty-white pionnotes containing numerous macroconidia are usually observed (Fig. 1b, 1c).

Fig. 1a. On amugis (*Koordersiodendron pinnatum*) seed (x25).

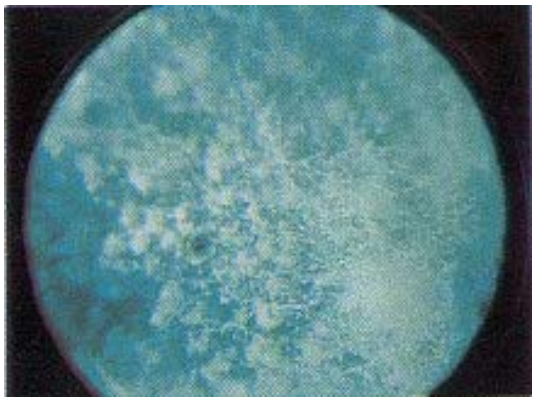

Fig. 1b. On neem (*Azadirachta indica*) seed (x25).

Fig. 1c. On dagang (*Anisoptera aurea*) seed (x25).

In culture

Dirty-white to orange growth on potato dextrose agar, later blue to bluish brown discoloration can be observed in the medium. Aerial mycelium is sparse and submerged in the medium (Fig. 1d).

Morphological structure

The microconidia are hyaline, broader, and more oval in shape, sometimes with septation, on the average 12 µ x 3.3 µ. The macroconidia are inequilaterally fusoid with rounded foot cell, apical cell pointed, 29.6 µ x 5.8 µ on the average (Fig. 1e).

Host range

Mahogany (*Swietenia macrophylla*), rain tree (*Samanea saman*), bagtikan (*Parashorea malaanonan*), dagang (*Anisoptera aurea*), amugis (*Koordersiodendron pinnatum*), neem (*Azadirachta indica*), ipil (*Intsia bijuga*), giant and native ipil-ipil (*Leucaena leucocephala*), kupang (*Parkia roxburghii*), narra (*Pterocarpus indicus*), yemane (*Gmelina arborea*), *Acacia pera*, almaciga (*Agathis philippinensis*), achuete (*Bixa orellana*), golden shower (*Cassia fistula*), earpod (*Enterolobium cyclocarpum*), malaipil (*Intsia acuminate*), Benguet pine (*Pinus kesiya*), mayapis (*Shorea squamata*), kalumpit (*Terminalia microcarpa*), balakat (*Ziziphus talani*), dapdap (*Erythrina orientalis*), wattle

(*Acacia auriculiformis*), agoho (*Casuarina equisetifolia*), akleng parang (*Albizia procera*), *Albizia julibrisin*, fire tree (*Delonix regia*), petroleum nut (*Pittosporum resineferum*), palosanto (*Triplaris cumingiana*), Thailand acacia (*Acacia siamea*), batino (*Alstonia macrophylla*), aroma (*Acacia farnesiana*), limuran (*Calamusornatus*), and banuyo (*Wallaceodendron celibicum*) (Dayan, 1986; 1990; 1995; 2003).

Distribution

Mr. Makiling, Laguna; Pagbilao, Quezon; Angat, Bulacan; Puerto Princesa, Palawan; Mangatarem, Pangasinan; Diadi, Nueva Vizcaya.

Fig. 1d. Cultural characteristics on PDA (x½).

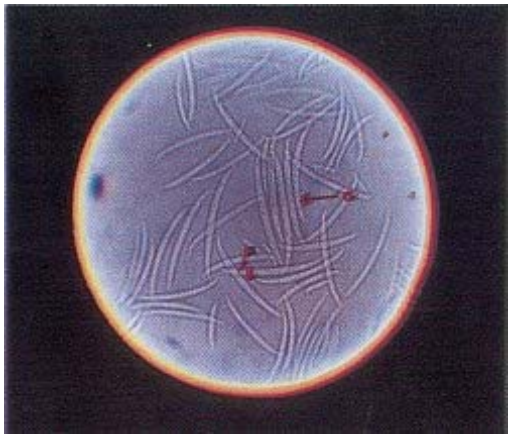

Fig. 1e. Morphological structure of *F. solani* showing numerous macroconidia (*a*) and few microconidia (*b*) (x600).

Economic disadvantage

This fungus causes postemergence damping-off of *Pinus* spp. (Quiniones, 1985) and giant ipil-ipil (Quiniones and Dayan, 1985). It also causes malapapaya stem rot (Dayan and Reaviles, 2002) and other diseases of agricultural crops in the nurseries and plantations (Dalmacio and Dayan, 1977).

Control measures

For seed dressing, apply Benlate, Captan, Anthracol, and Bayleton (2.5 g a.i./kg of seeds), and Folicur (1 ml/kg of seeds) using the slurry method. For orthodox species, dry the seeds to moisture content of 5-6% after treatment and store the seeds in a refrigerator. For recalcitrant species, sow the seeds immediately after treating with fungicides (Dayan, 2003).

***Lasiodiplodia theobromae* (*Botryodiplodia theobromae* Pat)**

On seed

The conidiomata are pycnidial, subepidermal, black, globose with ostiole. The mycelium is scanty. At first, when the conidiomata mature, a mass of hyaline spores oozes from the ostiole. This mass of spores turns to black two to three days after incubation (Figs. 2a, 2b).

In culture

Aerial mycelia appear at first white, fluffy, and then turn to black, five days after incubation. Black, irregular to globose,

Fig. 2a. Mass of black spores oozing from conidiomata on mahogany (*S. macrophylla*) seed (x25).

pycnidia develop seven days after continuous exposure under flurorescent lamps at room temperature (Fig. 2c).

Morphological structure
Immature conidia are hyaline, unseptated, double-walled, ovoid to elongate. Later, the conidia turn dark brown with septation, ovoid, thick, and single-walled which measure 19.0-31.2 µ x 12.5-15.7 µ (Fig. 2d).

Fig. 2b. Mass of black and white spores oozing from conidiomata on bagtikan (*Parashorea malaanonan*) xeed (x45).

Fig. 2c. Growth characteristics of *L. theobromae* on plated PDA (x½).

Control measures
In seed dressing, apply Anthracol, Bayleton, Benlate, and Captan at 2.5g/kg of seeds and Folicur fungicide at 1 ml/kg of seeds using the slurry method (Dayan, 2003).

Host range
Amugis (*K. pinnatum*), mahogany (*S. macrophylla*), dagang (*A. aurea*), bagtikan (*P. malaanonan*), fringon morado (*Bauhinia purpurea*), neem (*A. indica*), ipil (*I. bijuga*), native ipil-ipil (*L. leucocephala*), kakawate (*Gliricidia sepium*), white lauan (*Shorea contorta*); tuai (*Boscofia javanica*), achuete (*B. oerllana*), apitong (*Dipterocarpus grandiflorus*), mayapis (*S. squamata*), agoho (*C. equisetifolia*), akleng parang (*A. procera*), fire tree (*D. regia*), Spanish cedar (*Cedrela odorata*), and wattle (*A. auriculiformis*) (Dayan, 1986; 1990; 1995; 2003).

Distribution
College, Laguna; Pagbilao and Sariaya, Quezon;

Angat, Bulacan; Puerto Princesa, Palawan; Mangatarem, Pangasinan; Iba and Sta. Cruz, Zambales; Ternate, Cavite.

Economic disadvantage
This fungus causes seedling dry rot of mahogany and white lauan. It also causes seed rotting or ipil, bagtikan, and dagang (Dayan, 2003).

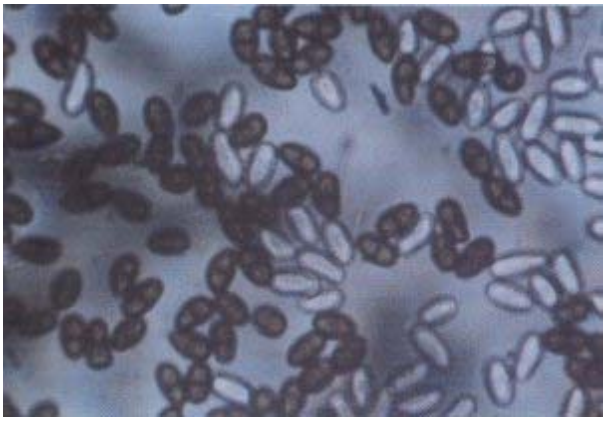

Fig. 2d. Morphological structures of *L. theobromae* showing the immature (white) and mature (brownish black) conidia (x600).

***Colletotrichum gloeosporioides* (Penz) Sacc.**

On seed
The coniniomata are acervular, subepidermal, gray to black in color. A mass of salmon-orange spores is often observed on seeds (Fig. 3a).

Fig. 3a. On dagang (*A. aurea*) seed (x25).

In culture
The mycelium is light brown to gray in color interspersed with orange and light gray mass of conidia. Often, zonation is present (Fig. 3b).

Morphological structure
The conidiophore is very short, not so distinct. The setae are scarce, septate dark brown, smooth, and tapered toward the apex, 88.4-108.68 µ x 3.9-5.7 µ (Fig. 3c). The conidia are hyaline, aseptate, straight, oblong to ellipsoidal, and measure 15.08-18.2 µ x 3.36-4.94 µ.

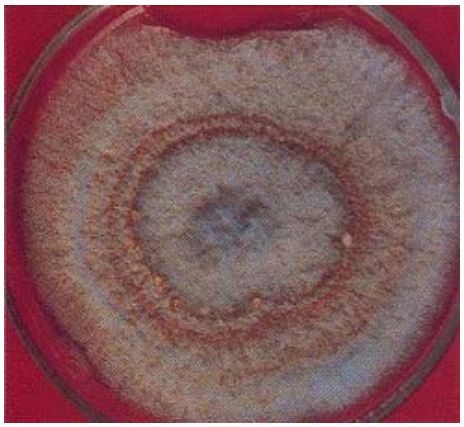

Fig. 3b. Cultural characteristics of *C. gloeosporioides* on PDS. Growth of isolates varies with species (x½).

Host range
Amugis (*K. pinnatum*), bagtikan (*P. malaanonan*), dagang (*A. aurea*), ipil (*I. bijuga*), giant and native ipil-ipil (*L. leucocephala*), kakawate (*G. sepium*), narra (*P. indicus*), wattle (*A. auriculiformis*), akleng parang (*A. procera*), fire tree (*D. regia*), fringon morado (*B. purpurea*), and agoho (Dayan, 1986; 1990; 2003).

Distribution
College, Laguna; Pagbilao and Sariaya, Quezon; Mangatarem, Pangasinan; San Mateo, Rizal; Carranglan, Nueva Ecija; Lagangilang, Abra; Batac, Ilocos Norte.

Economic disadvantage
This is a causal pathogen of malapapaya seedling blight/postemergence damping-off in the nursery (Dayan and Reavilles, 2002). It also causes anthracnose of stems and leaves, dieback, root rot, leaf spot, and seedling blight of many agricultural crops (Quimio and Hanlin, 1999), pasture, and forage crops.

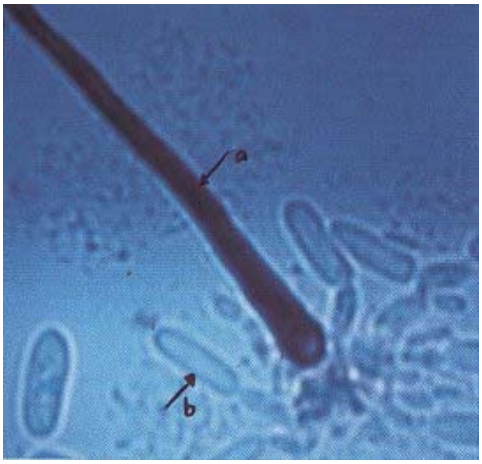

Fig. 3c. Morphological structures of *C. gloeosporioides* showing the setae (*a*) and unicellular spores (*b*) (x1500).

Control measures

For seed dressing, apply Benlate, Folicur, Captan, and Daconil at 2.5 g a.i./kg of seeds, using the slurry method. For orthodox seeds like

kakawate and ipil, air-dry the seeds to MC of 5-6% after treatment; store the seeds in sealed plastic bags at 7°C. For recalcitrant species like amugis, bagtikan, and dagang, air-dry the seeds for one day; sow the seeds immediately to ensure high viability (Dayan, 2003).

Phomopsis sp.

On seed

The conidiomata are pycnidial, immersed, brown to dark brown, separate, globose, multilocular. The mycelium is scarce, whitish droplets of spores oozing from the conidiomata (Fig. 4a).

Fig. 4a. On fringon morado (*B. purpurea*) seed (x45).

In culture

The dirty-white growth in the PDA is zonated, not fluffy. Irregular separate conidiomata immersed after seven days of incubation under light (Fig. 4b).

Morphological structure

Conidia are of two types: One is hyaline, fusiform, straight, and biguttulate (a) (Fig. 4c). The other is hyaline, filiform, straight, or curved in one end (b).

Fig. 4b. Cultural characteristics of *Phomopsis* sp. on PDA. Note the irregular sizes of conidiomata (pycnidia) (x½).

Host range

Fringon morado (*B. purpurea*), kakawate (*G. sepium*), narra (*P. indicus*), fire tree (*D. regia*), and Spanish cedar (*C. odorata*) (Dayan, 1990; 2003).

Distribution

College, Laguna and Sariaya, Quezon.

Economic disadvantage

The fungus causes seedling dieback of *Hevea* spp., canker of *Ficus* and *Abies*, blight of junipers and cypress species, and Araucaria leaf spot (Spaulding, 1961). It also causes fruit rot of eggplant and tomato, and stem blight of soybean (Neergaard, 1977).

Control measures

Resort to hot water treatment of seed at 60-70ºC for 5-10 minutes (Neergaard, 1977). For seed dressing, apply systemic fungicides, e.g., Benlate at 2.5 g a.i./kg of seeds, and Folicur at 1ml/kg of seeds using the slurry method (Dyana, 2003).

Fig. 4c. Alpha (fusiform) (*a*) and Beta (filiform) (*b*) conidia of *Phomopsis* sp. (x600).

***Macrophomina phaseolina* (Tassi) Goid**

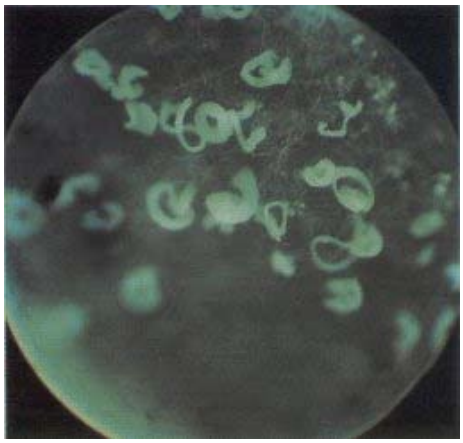

Fig. 5a. On dagang (*A. aurea*) seed (x45).

On seed
The mycelium is scarce; the conidiomata are separate, globose, dark brown, subepidermal. Upon pycnidial maturity, a mass of white spores oozes from the central ostiole forming a coil-like white shiny structures on seed (Fig. 5a).

In culture
The mycelium at first is white to gray, fast-growing, not fluffy. Separate, grayish black pycnidia, irregular in sizes, are formed later (Fig. 5b).

Morphological structure
The conidiophores are not distinct; the conidia are hyaline, one-celled, oval to broadly ellipsoidal, and measure 14.82-16.8 µ x 6.24-7.28 µ (Fig. 5c).

Host range
Dagang (*A. aurea*), kakawate (*G. sepium*), wattle (*A. auriculiformis*), akleng parang (*A. procera*), fringon morado (*B. purpurea*), and agoho (*C. equisetifolia*) (Dayan, 1986; 1990; 2003).

Distribution
Mangatarem, pangasinan; Pagbilao and Sariaya, Quezon; Occidental Mindoro; Rizal and Bangued, Abra; College, Laguna.

Economic disadvantage

It causes seed and seedling rot of fringon morado and kakawate (Dayan, 2003). The fungus also causes root rotting of many agricultural crops, especially legumes, and charcoal root rot of sorghum (Dalmacio and Dayan, 1977). It is a pathogen of root crops and other plantation crops such as cacao, coconut, and coffee (Browne, 1968). This fungus is seed-borne in soybean, peanut, string bean, and other leguminous seeds (Neergaard, 1977).

Control measures
For seed dressing, apply systemic fungicides, e.g., Benlate at 2.5 g a.i./kg of seeds and Folicur at 1 ml/kg of seeds using the slurry method. Or resort to soaking in solutions overnight at 3 g/L of water and 0.5 ml/L of water, respectively (Dayan, 2003).

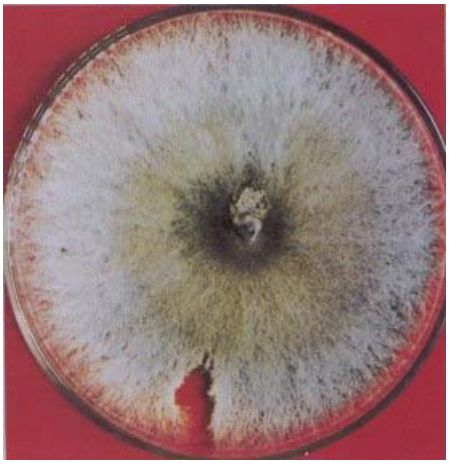

Fig. 5b. Growth characteristics of *M. phaseolina* on PDA (x½).

Fig. 5c. Part of the conidiomata with spores of *M. phaseolina* (x600).

***Pestalotia* spp.**

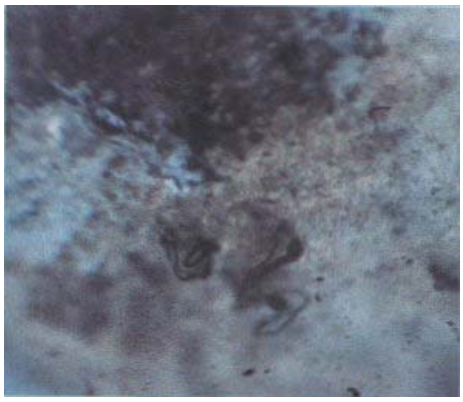

Fig. 6a. On dagang (*A. aurea*) seed (x25).

On seed
The mycelium is scarce; the conidiomata are acervular, dark, which released dark mass of spores upon exposure to light (Fig. 6a).

In culture
The mycelium at first is white then it turns to grayish white, zonated (Fig. 6b). In some species, black acervuli are developed at the early stage of development.

Morphological structure
The conidiophores are short, hyaline, and septate. THe conidia are fusiform, thin-walled, straight, or slightly curved, five-celled of 3-4 septated median, three-celled, and darker in color. The two-end cells are hyaline, bearing dichotomously branched appendages (Fig. 6c).

Host range
Dagang (*A. aurea*), fringon morado (*B. purpurea*), *A. mangium*, almaciga (*A. philippinensis*), *Eucalyptus grandiflorus*, agoho (*C. equisetifolia*), akleng parang (*A. procera*), and bagras (*E. deglupta*) (Dayan, 1990; 1995; 2003).

Distribution
College, Laguna; Pagbilao, Quezon; Mangatarem, Pangasinan; Iba, Zambales; Bangued and Langangilang, Abra; and

Occidental Mindoro.

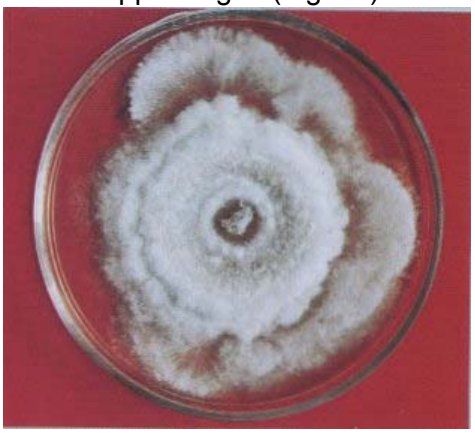

Fig. 6b. Growth characteristics of *Pestalotia* sp. on PDA one week after transplanting. The acervulus is not yet formed (x½).

Economic disadvantage
The fungus is usually associated with leaf blight of Grevillea, leaf blight of oak in India, blight of conifers and hardwood species, leaf spot of palm in tropical countries. It is also associated with stem girdling of various conifers and hardwood species (Spaulding, 1961).

Control measures
For seed dressing, apply systemic fungicides, i.e., Benlate at 2.5 g a.i./kg of seeds, and Folicur at 1 ml/kg of seeds using the slurry method. Or resort to soaking in fungicide solutions at 3g/L of water and 0.5 ml/L of water, respectively, for five hours (Dayan, 2003).

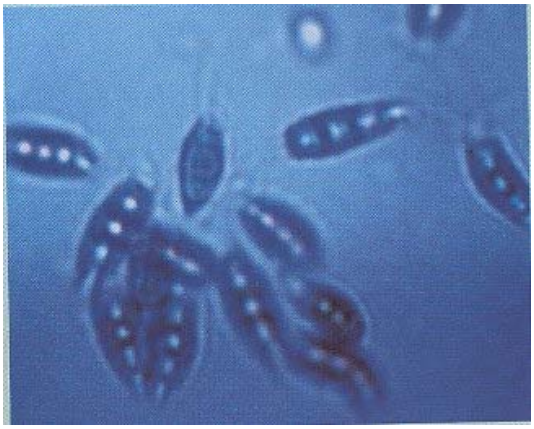

Fig. 6c. Conidia of *Pestalotia* spp. (x1500).

***Aspergillus flavus* Link**

On seed
The conidial heads are bright yellow-green when young, but become brown with age, globose, radiating, or splitting (Fig. 7a).

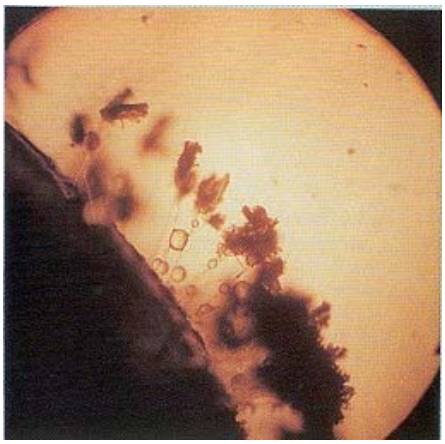

Fig. 7a. On kakawate (*G. sepium*) seed (x45).

In culture
The mycelium is scarce, yellowish green to green on PDA (Fig. 7b). White globose to subglobose sclerotial bodies develop one week after exposure under fluorescent lamps. These later turn to brown and hard sclerotial bodies.

Morphological structure
The conidiophores are hyaline to yellow, simple, straight, and unbranched. The vesicle is globose; the conidia are globose to subglobose, echinulate, and measure on the average 3-6 µ (Fig. 7c).

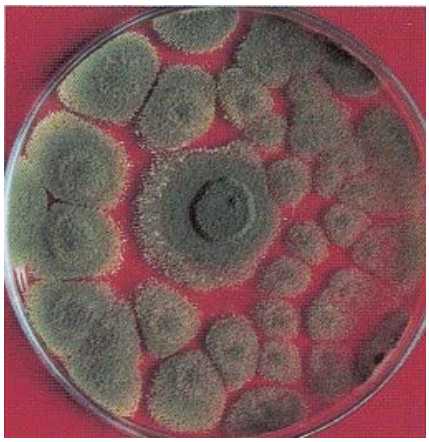

Fig. 7b. Growth characteristics of *A. flavus* showing the initial formation of whitish sclerotial bodies (x½).

Host range
Amugis (*K. pinnatum*), neem (*A. indica*), fringon morado (*B. purpurea*), ipil (*I. bijuga*), giant ipil-ipil (*L. leucocephala*), kakawate (*G. sepium*), mahogany (*S. macrophylla*), yemane (*G. arborea*), *A. mangium*, *Acacia pera*, saging-saging (*Aegiceras corniculatum*), almaciga (*A. philippinensis*), lumbang (*Aleurites moluccana*), pili (*Canarium ovatum*), bahai (*Ormosia calavensis*), taluto (*Pterocymbium tinctorium*), kalumpang (*Sterculia foetida*), mangkono (*Xanthostemon verdugonianus*), balakat (*Z. talani*), igyo (*Dysoxylum decandrum*), wattle (*A. auriculiformis*), *A. julibrissin*, akleng parang (*A. procera*), batino (*A. macrophylla*), bagras (*E. deglupta*), fire tree (*D. regia*), narra (*P. indicus*), rain tree (*S. saman*), Spanish cedar (*C. odorata*), moluccan sau (*A. falcataria*), kulibangbang (*Bauhinia acuminate*), alibangbang (*Piliostigma malabaricum*), petroleum nut (*P. resineferum*), palosanto (*T. cumingiana*), Thailand acacia (*A. siamea*), Benguet pine (*P. kesiya*), akle (*Serialbizia acle*), katurai (*Sesbania grandiflora*), banaba (*Lagerstroemi speciosa*), binayuyo (*Antidesma ghaesambilla*), limuran (*C. ornatus*), langil (*Albizia lebbek*), and banuyo (*W. celebicum*) (Dayan, 1986; 1990; 1995; 2003).

Distribution
Occidental Mindoro; Carranglan, Nueva Ecija; Iba, Zambales; Diadi, Nueva Vizcaya; College, Laguna; Toledo City and Talisay, Cebu; Malabalay, Bukidnon; Santiago, Isabela; Rizal and Bangued, Abra; Batac, Ilocos Norte; Mangatarem, Pangasinan; Pagbilao and Sariaya, Quezon.

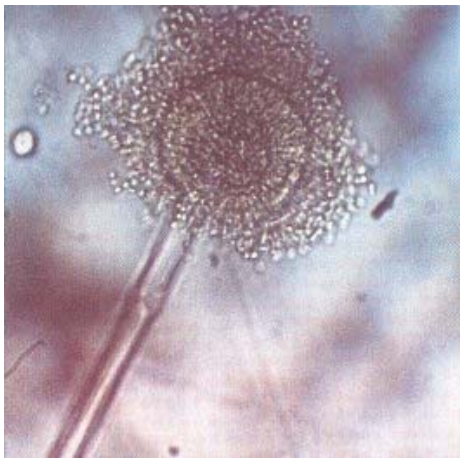

Fig. 7c. Conidiophore and round vesicle of *A. flavus* with attached phialides and spores (x600).

Economic disadvantage
The fungus causes seed rotting of forest tree species and agricultural crops stored for months, especially seeds with a moisture content above 10% (Neegaard, 1977; Dayan, 1986; 1990; 1995; 2003). It reduces the seed quality and produces aflatoxin which is fatal to animals (Raper and Fennell, 1965).

Control measures
For seed dressing, apply Anthracol, Benlate, Captan, Bayleton, Daconil at 2 g a.i./kg of seeds, and Folicur at 1 ml/kg seeds. Use the slurry method of application and steep treatment or soak in fungicide solutions overnight (Dayan, 2003).

Aspergillus niger Van Tieghem

On seed
Brown to black in color, the conidial heads are globose, splitting into columns (Fig. 8a).

In culture
The mycelium is scarce; the conidia are brown to black in color on the PDA (fig. 8b).

Morphological structure
The conidiophores are roughened, hyaline to faintly brownish in the apical portion bearing rounded vesicle where long metulae and short phialides arise. The conidia are brownish black, rough and globose, and measure 4.2 µ – 5.2 µ in diameter (Fig. 8c).

Host range
Rain tree (*S. saman*), fringon morado (*B. purpurea*), ipil (*I. bijuga*), kakawate (*G. sepium*), kupang (*P. roxburghii*), mahogany (*S. macrophylla*), yemane (*G. arborea*), mangium (*A. mangium*), lumbang (*A. moluccana*), dagang (*A. aurea*), neem (*A. indica*), golden shower (*C. fistula*), anchoan dilaw (*C. spectabilis*), earpod (*E. cyclocarpum*), *Eucalyptus grandis*, bahai (*O. calanensis*), kalumpang (*S. foetida*), balakat (*Z. talani*), dapdap (*E. orientalis*), bagras (*E. deglupta*), prickly narra (*P. vidalianus*), Spanish cedar (*C.*

Fig. 8a. On neem (*A. indica*) seed (x45).

Fig. 8b. Growth characteristics of *A. niger* on PDA (x½).

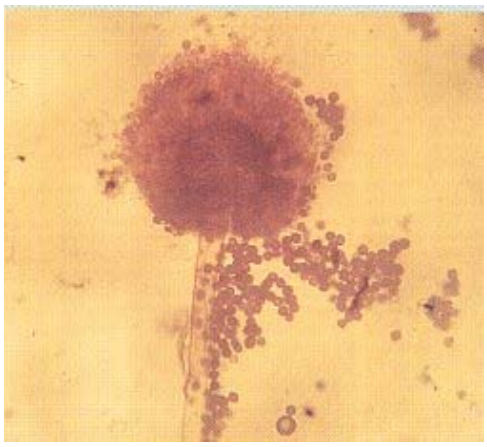

Fig. 8c. Conidiophore and round vesicle bearing numerous roughened spores (x600).

odorata), agoho (*C. equisetifolia*), moluccan sau (*P. falcataria*), kulibangbang (*B. acuminate*), alibangbang (*P. malabaricum*), akleng parang (*A. precera*), petroleum nut (*P. resineferum*), palosanto (*T. cumingiana*), wattle (*A. auriculiformis*), Thailand acacia (*A. siamea*), *A. julibrissin*.

Distribution
Occidental Mindoro; Carranglan, Nueva Ecija; Iba, Zambales; Diadi and Solano, Nueva Vizcaya; Toledo City; Malaybalay, Bukidnon; Benguet; College, Laguna; Antipolo, Rizal; Lagangilang, Abra; Batac, Ilocos Norte; Puerto Princesa, Palawan; Pagbilao and Sariaya, Quezon; and Angat, Bulacan.

Economic disadvantage
The fungus causes black mold of forest tree species like fringon morado, kakawate, mahogany, neem, and petroleum nut (Dayan, 1986; 2003); and agricultural crops such as onion, garlic, cashew kernel rot (Raper and Fennell, 1965). It also causes crown rot of ground nut by invading the hypocotyls and radicle of the germinating seedlings at conditions above 30ºC (Commonwealth Mycological Institute, 1971).

Control measures
For seed dressing, apply Anthracol, Benlate, Captan, Bayleton, and Daconil at 2 g a.i./kg seeds, and Folicur at 1 ml/kg seeds. Use the slurry method of application and steep treatment, or soak in fungicide solutions overnight (Dayan, 2003).

***Clavaria* sp.**

On seed
Light to yellow fruiting bodies or basidiocarp, straight and pointed at the tip, emerge from the apical portion of the seeds. Some are bending at the upper portion while some have 2-3 branchlets resembling those of ordinary roots of plant emerging from the dorsal and apical portions of the seeds (Fig. 9a).

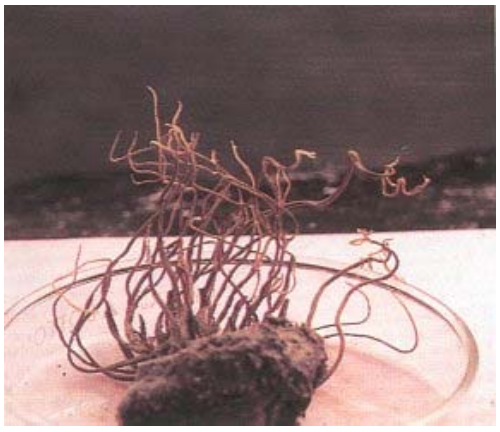

Fig. 9a. Growth of *Clavaria* sp. on kamagong (*Diospyros philippensis*) seed previously sown in plastic trays with fine sand (x¼).

In culture
On the PDA, yellow to dark yellow fruiting structures appear (Fig. 9b) similar to the growth on seeds five days after incubation under fluorescent lamps.

Morphological structure
A cross-section of the young basidiocarp shows a tubular hyphal growth arising from the lateral

side of the section (Fig. 9c). Later, 2-3 phialides similar to *Penicillium* spp. are formed from the hypha where four basidiospores emerge.

Host range
This is isolated and identified only in kamagong (*Diospyros philippensis*) seeds.

Distribution
Isolated from kamagong sees collected from the Los Baños Experiment Station in Mt. Makiling; the Department of Animal Science Compound; and the Forestry Campus in UP Los Baños, College, Laguna.

Economic disadvantage
It causes a great reduction in the germination of kamagong, that is, from 96% to 68% (Dayan, 1999).

Fig. 9b. Growth characteristics of *Clavaria* sp. on the PDA (x½).

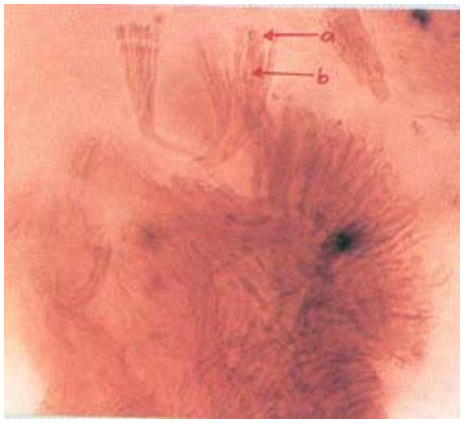

Fig. 9c. Cross-section of basidiocarp showing basidiospores (*a*) and basidia (*b*) of *Clavaria* sp. (x600).

Control measures
Soak the newly extracted seeds in a solution of a systemic fungicide such as Benlate, at 2.5 g/L of water (Dayan, 2003).

***Fusarium moniliforme* Sheldon**

On seed
White, dry powdery mycelial growth together with the dirty-white pionnotes can be seen under the microscope (Fig. 10a).

In culture
On the PDA, growth at first is white which later turns to cream and lilac-felted aerial mycelium. The reverse side is dark purple (Fig. 10b).

Fig.10a. On mahogany (*S. macrophylla*) seed (x25).

Morphological structure
The microconidia in chain are fusiform to clavate, one septate, and measure 5.2-12.5 µ x 1.4-2.4 µ. The macrocondia are fusoid with sharply curved pedicillate basal cells, 3-6 septations, and mesure 2.7 µ x 3.2 µ.

Fig.10b. Growth characteristics of *F. moniliforme* (x600).

Host range
Mahogany (*S. macrophylla*), smooth narra (*P. indicus*), mangium (*A. mangium*), almaciga (*A. philipinensis*), neem (*A. indica*), achuete (*B. orellana*), golden shower (*C. fistula*), kakawate (*G. sepium*), igyo (*D. decandrum*), Spanish cedar (*C. odorata*), akleng parang (*A. procera*), petroleum nut (*P. resineferum*), palosanto (*T. cumingiana*), Thailand acacia (*A. siamea*), Benguet pine (*P. kesiya*), and batino (*A. macrophylla*) (Dayan, 1986; 1990; 1995; 2003).

Distribution
Diadi, Nueva Vizcaya; Iba and Sta. Cruz, Zambales; College, Laguna; Malaybalay; Bukidnon; Santiago, Isabela; Lagangilang, Abra; Ternate, Cavite; Maasin, Leyte; Angat, Bulacan; Baguio City; Tuba, Benguet; and Pagbilao, Quezon.

Economic disadvantage
This fungus causes seedling blight and root rot of narra, and dry rot of mahogany and Spanish cedar seedlings (Dayan, 1990; 1995). It also causes seedling blight, root rot, and rice shoot hypertrophy (Dalmacio and Dayan, 1977).

Control measures
For seed dressing, apply Benlate, Captan, Bayleton, and Anthracol at 2.5 g a.i./kg seeds using the slurry method (Dayan, 2003).

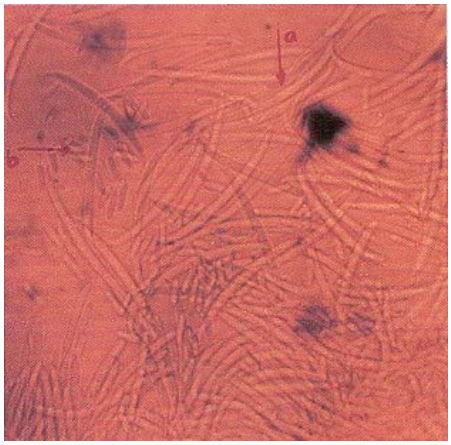

Fig.10c. Macro (*a*) and micro (*b*) conidia of *F. moniliforme* (x600).

***Colletotrichum truncatum* (Schul) and Moore**

On seed
The conidiomata are acervular, dry, dull white to yellowish. A mass of spores is commonly seen under the microscope arising from the disc-shaped acervuli. The mycelium is scarce (Fig. 11a).

Fig.11a. Conidiomata of *C. truncatum* showing the release of dry, dull white to yellowish mass of spores (x45).

In culture and morphological structure
The mycelium is scarce and immersed, orange to reddish brown. The spore masses are dark orange interspersed with black spines or setae (Fig. 11b). The conidia are falcate or sickle-shaped, hyaline, one-celled, and measure 26-28.6 µ x 2.6-4.4 µ. The setae are abundant, dark brown, tapered toward the apex, and measure 143-249.6 µ x 3.38-8.84 µ (Fig. 11c).

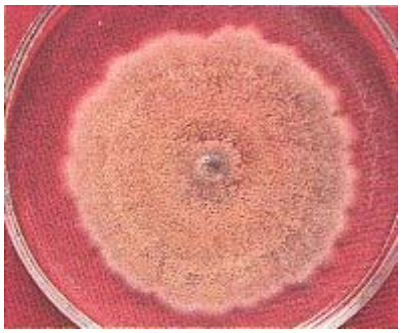

Fig.11b. Growth characteristics of *C. truncatum* on PDA (x½).

Fig.11c. Setae (*a*) and sicle-shaped conidia (*b*) of *C. truncatum* (x600).

Host range
This is identified only in native ipil-ipil and giant ipil-ipil (*L. leucocephala*).

Distribution
College, Laguna; Angat, Bulacan;

Sariaya, Quezon; Mangatarem, Pangasinan.

Economic disadvantage
This is a seed-borne fungus that causes preemergence and potemergence damping-off of seedlings of native and giant ipil-ipil (Quiniones and Dayan, 1985). It also causes stem anthracnose of lima bean and soybean (Neergaard, 1977).

Control measures
Soak the seeds in solutions of Captan and Benlate at 2.5 g/L of water for five hours (Quiniones and Dayan, 1985).

***Penicillium* sp.**

On seed
The mycelium is abundant, bearing macronematous penicilliate conidiophore with verticillate phialides where metulae are attached. A group of conidia in chain, which are dark green, often arise from these metulae (Fig. 12a).

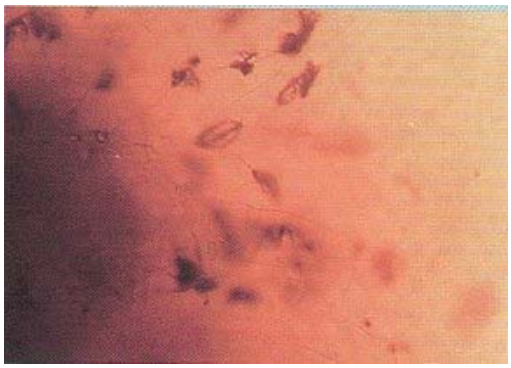

Fig.12a. On yemane (*G. arborea*) seed (x45).

In culture
The mycelium is a sparse colony of isolates, dark green or moss green in color, restricted. The reversed is light green (Fig. 12b).

Morphological structure
The conidiophores are macronematous, branched, bearing small subhyaline conidia (Fig. 12c).

Host range

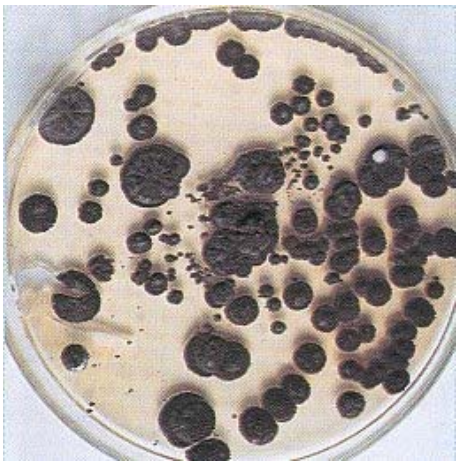

Fig.12b. Colonies of *Penicillium* sp. on PDA (x½).

Amugis (*K. pinnatum*), neem (*A. indica*), bagtikan (*P. malaanonan*), dagang (*A. aurea*), fringon morado (*B. purpurea*), ipil (*I. bijuga*), giant ipil-ipil (*L. leucocephala*), mahogany (*S. macrophylla*), yemane (*G. arborea*), mangium (*A. mangium*), saging-saging (*A. comiculatum*), almaciga (*A. philippinensis*), lumbang (*A. moluccana*), pili (*C. orvatum*), anchoan dilaw (*C. spectabilis*), tuba (*Croton tigilium*), earpod (*E. cyclocarpum*), kakawate (*G. sepium*), Benguet pine (*P. kesiya*), kalumpang (*S. foetida*), dapdap (*E. oerintalis*), wattle (*A. auriculiformis*), fire tree (*D. regia*), akleng parang (*A. procera*), rain tree (*S. saman*), Spanish cedar (*C. odorata*) agoho (*C. equisetifolia*), moluccan sau (*P. falcataria*), alibangbang (*B. acuminate*), kulibangbang (*P. malabaricum*), petroleum nut (*P. resineferum*), palosanto (*T. cumingiana*), Thailand acacia (*A. siamea*), *A. julibrissin*, kupang (*P. roxburghii*), akle (*S. akle*), batino (*A. macrophylla*), katurai (*S. grandiflora*), and banaba (*L. speciosa*) (Dayan, 1986; 1990; 1995; 2003).

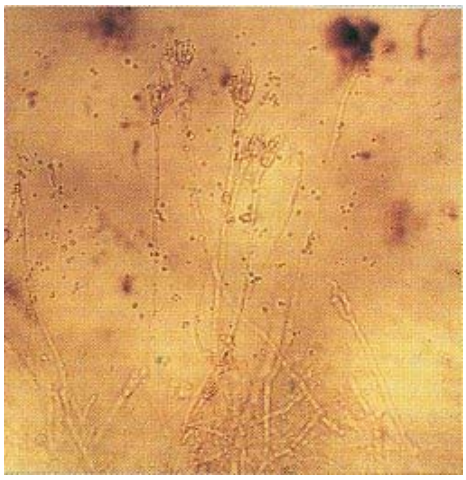

Fig.12c. Conidiophores and conidia of *Penicillium* sp. (x600).

Distribution

Occidental and Oriental Mindoro; Iba, Zambales; Diadi, Nueva Vizcaya; College, Laguna; Malaybalay, Bukidnon; Tuba, Benguet; Solano, Isabela; Toledo City, Cebu; Magat, Nueva Vizcaya; Rizal and San Jose, Nueva Ecija; Lagangilang, Abra; Batac, Ilocos Norte; Ternate, Cavite; Maasin, Leyte; Sipocot, Camarines Sur; Pagbilao and Sariaya, Quezon; Mangatarem, Pangasinan; Puerto Princesa, Palawan; Angat, Bulacan.

Economic disadvantage

It is a common storage fungus of almost all forest tree seed species, as well as agricultural crops with moisture content of 10-25% (Dayan, 2003; 1996; 1995; 1990; 1986; Quimio and Hanlin, 1999). It also causes soft rotting of fruits, bulbs, and corms (Neergaard, 1971). In some cases, it also causes mummification of fruits and seeds of forest tree species, i.e., fire tree, fringon morado, and Spanish cedar (Dayan, 2003; 1990).

Control measures

For seed dressing, apply systemic and contact fungicides, i.e., Benlate, Captan, Daconil, Bayleton, and Anthracol at 2.5 g a.i./kg of seeds using the slurry method. Or resort to soaking in solutions of these fungicides at 3 g/L of water for 17 hours (Dayan, 2003).

***Curvularia lunata* (Walker) Boed**

On seed
The conidiophores are straight, brownish in color, bearing solitary or three groups of conidia, triseptated, and curved. Some ellipsoidal, midcells are dark brown, two-end cells usually paler than the midcells, smooth, second and third septation darker than the rest. The conidia measure 18.98-22.88 µ x 9.1-11.96 µ (Fig. 13a).

Fig.13a. On fringon morado (*B. purpurea*) seed (x45).

In culture
Gray to dark brown in color and hairy, the mycelium is immersed, not markedly zonate on the PDA (Fig. 13b).

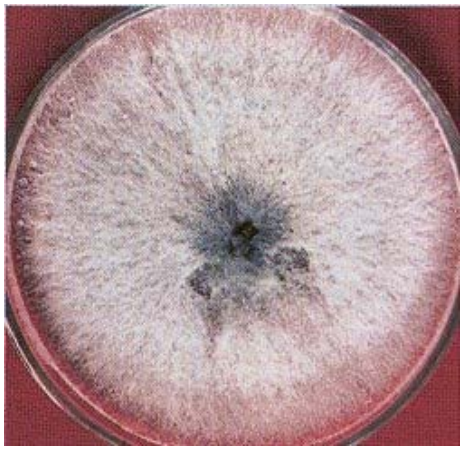

Fig.13b. Growth characteristics of *C. lunata* on PDA (x½).

Host range
Fringon morado (*B. purpurea*), yemane (*G. arborea*), tuai (*B. javanica*), achete (*B. orellana*), Benguet pine (*P. kesiya*), agoho (*C. equisetifolia*), fire tree (*D. regia*), bagras (*E. deglupta*), and Spanish cedar (*C. odorata*) (Dayan, 1986; 1995; 2003).

Distribution
San Jose, Occidental Mindoro; College, Laguna; Mangatarem, Pangasinan; Angat, Bulacan; and Tuba, Benguet.

Economic disadvantage
This fungus causes rotting and mummification of fringon morado seed (Dayan, 2003). It also causes leaf spot of corn, rice, wheat, and other species of Graminae (Neergaard, 1971).

Control measures
For seed dressing, apply fungicides, i.e., Benlate, Captan, Daconil, DM-45, Anthracol, and Bayleton at 2.5 g a.i./kg of seeds. Or resort to soaking in solutions of these fungicides at 3 g/L of water for five hours (Dayan, 2003).

***Fusarium equiseti* (Corda) Sacc.**

On seed
The mycelium is sparse. Dark orange pionnotes or a mass of orange spores are commonly observed on seed (Fig. 14a).

Fig.14a. Dark orange pionnotes or mass of spores of *F. equiseti* on seed of mahogany (*S. macrophylla*) (x45).

In culture
The mycelium is white to light orange tinged with peach. Droplets like light orange pionnotes develop in culture which is a mass of macroconidia (Fig. 14b).

Morphological structure
The spores are falcate, four to seven septations with a well-developed pedicillate foot cell and an attenuated apical cell which is bent inward (Fig. 14c).

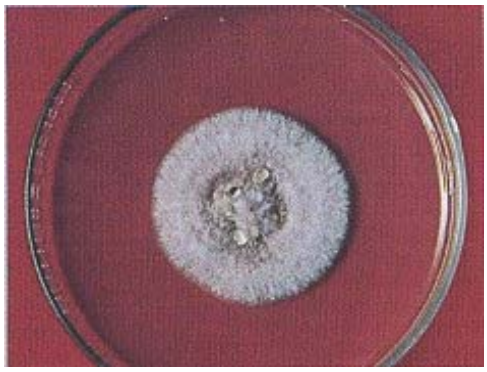

Fig.14b. Growth of *F. equiseti* on PDA. Note the light range droplets of pionnotes (x½).

Host range
This is identified only in yemane (*G. arborea*) and mahogany (*S. macrophylla*) seeds (Dayan, 2003).

Distribution
College, Laguna and Angat, Bulacan.

Economic disadvantage
This fungus causes seed rotting of mahogany stored for six months (Dayan, 2003). It also causes stem rot of maize, root rot of wheat. It likewise causes rotting of avocado fruit, bean, cabbage, cotton, cucurbits, ground nut, hemp, onion, potato leaves and tubers, tomato, and soybean (Neergaard, 1971).

Control measures
For seed dressing, apply any systemic and contact fungicides, i.e., Benlate, Captan, Daconil, Anthracol, DM-45 at 2.5 g/kg of seeds, and Folicur at 1 ml/kg of seeds. Or resort to soaking in solutions of these fungicides at 3 g/L of water for 17 hours.

Fig.14c. Macroconidia of *F. equiseti* (x600).

***Pleurotus* mushroom**

On seed
The mycelium is cottony, white, hard, and glued heavily on seed coat (a). Tiny white structures emerge one week after incubation under the light, forming fingerlike structures which, later, form a fanlike basidiocarp (b) (Fig. 15a).

Fig.15a. On bagtikan (*P. malaanonan*) seed (x1).

Morphological structure
When dissected longitudinally, very small basidiospores, hyaline in color, are seen attached to a short basidium (Fig. 15b).

Host range
This is identified only in bagtikan seeds.

Distribution
Quezon National Park in Pagbilao, Quezon.

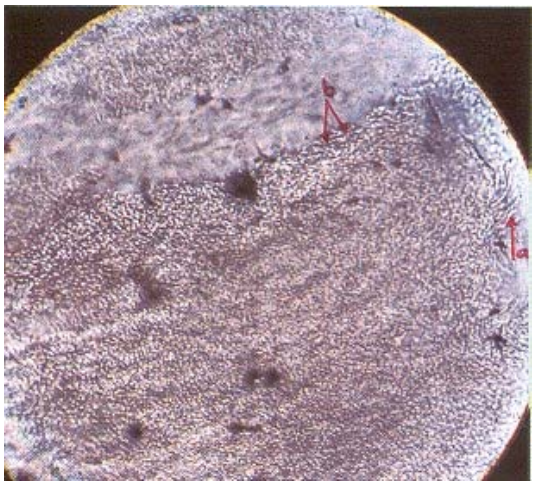

Fig.15b. Longitudinal section of *Pleurotus* basidiocarp showing the minute basidia (*a*) and basidiospores (*b*) (x600).

Economic disadvantage
It is a wound parasite of hardwood species like bagtikan, white lauan, and palosapis. It causes white rot disease of trees (Browne, 1968).

Control measures
For seed dressing, apply systemic fungicides like Folicur at 1 ml/kg of seeds using the slurry method. Other fungicides such as Benlate and Bayleton can also be applied at 2.5 g a.i./kg of seeds. However, sowing of the treated seeds should be done right after treatment (Dayan, 2003).

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Glossary

Acervulus	A cushion-like mass of hyphae and palisade-like conidiophores and conidia, characteristic of Melanconiales
Attenuated	Narrowed
Basidiocarp	A structure producing basidia and basidiospores, characteristic of Basidiomycetes
Biotic	Related to organic life, to living organisms
Clavate	Club-shaped
Conidiomata	Collective term for fungi bearing fruiting structures of acervulus, pycnidium, and perithecium
Conidiophore	Main axis or branch bearing the spores or conidia
Damping-off	A disease of seeds and seedlings which causes decay and collapse of seedling usually due to fungal attack
Echinulate	With spiny ornamentation
Ellipsoidal	Elliptical in optical section
Falcate	Curved like the blade of a scythe or sickle
Filiform	Threadlike
Fusiform	Spindlelike narrowing toward the ends
Fusoid	Somewhat fusiform
Hyaline	No pigmentation
Hypertrophy	A state of excessive growth or development of tissue, or a cell
Macronematous	When the conidiophores are very different from the mycelium
Metulae	Specialized branches of conidiophore bearing sporogenous cells as in Penicillium
Mummification	A state wherein a seed is fully covered by hyphal mass which hardens through time

Orthodox	Type of seeds which can be dried at low moisture contend and can be stored for a long period of time
Ostiole	Opening of a true perithecium or a conidiomata ending in a pore
Ovoid	Egg-shaped
Pedicillate	Small stalk having a pedicel
Phialides	Sporogenous cell in which the spores are produced in basipetal succession for an open group point
Pionnotes	A slimy or gelatinous, effuse sporodochium, especially of *Fusarium* spp.
Pycnidium	An asexual hollow, fruiting body on which conidia are produced, characteristic of Sphaeropsidales
Recalcitrant	Type of seeds which cannot be dried at low moisture content and can be stored only for a short period of time
Sclerotum	Hard resistant mass of hyphae or psuedoparenchyma usually for survival under adverse condition
Septate	Having cross walls
Seta	A rigid often thick-walled and dark-colored hair which is a characteristic of *Collectotrichum* spp.
Slurry	Method of fungicide application wherein a small amount of water is added to the fungicide to form a soaplike slurry to ensure coating without undue wetting
Spore	A minute reproduction unit as of fungi which may germinate and develop into a new individual
Steep	Method of fungicide application wherein seed is soaked in fungicidal liquid solution for a definite period of time
Sterigmata	A small projection on which a conidium, a sporangium or a basidiospore is borne
Systemic fungicide	Kind of fungicide with systemic action wherein fungicide is taken by the plant and spread throughout the whole plant
Verticillate	Having parts in rings; or whorled
Vesicle	Swollen or bladderlike part of a conidiophore or sporogenous cells