Chapter 8

Miscellaneous Fungal Pathogens

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Introduction

Dry beans are exposed to many pathogenic fungi at various stages of their plant development, and infection may occur on seedlings and mature plants throughout the growing season or post-harvest. Some of the more prevalent and economically important plant pathogenic fungi have been described previously in this book. Unfortunately, very little information exists concerning the epidemiology and control of many other fungi generally considered to be of minor importance to bean production. However, in the tropics many of these minor pathogens can become very important in specific regions of bean production. Likewise, minor pathogens may become major pathogens in the future as agricultural practices are modified. This chapter will describe briefly some of these fungi and list others reported to be pathogens of beans.

Alternaria Leaf and Pod Spot

Alternaria leaf and pod spot is caused by various *Alternaria* species including *A. alternata* (Fr.) Keissler, *A. brassicae* f. *phaseoli* Brun., *A. fasciculata* (Cke. and E11.) L. R. Jones and Grout, and *A. tenuis* Nees (1, 15, 26, 28, 41, 46). These fungi are reported to occur in Brazil (31), Costa Rica (17), Colombia (13), Chile, Mexico, Venezuela (43), England (26), and the United States (1, 27, 28, 46). Severe epidemics may cause premature defoliation but yield losses usually are not significant. However, snap bean losses of 12% occurred in New York since infected pods were unacceptable for processing (1).

Common names frequently used for Alternaria leaf and pod spot in Latin America are mancha parda and mancha foliar por Alternaria.

Alternaria brassicae produces greenish-brown, septate and branched hyphae with erect conidiophores in culture. Conidia are smooth, long-

Fig. 1- Leaf lesions caused by Alternaria infection.

beaked, obclavate shaped with many transverse and longitudinal septations. Conidia are borne singly or in chains of two to three spores and measure 50-350 x 9-33 μ (41).

Alternaria spp. are considered to be wound parasites and usually form lesions only on older plant tissue during periods of high humidity for three or four days (1, 28), and at relatively cool temperatures such as 16°- 20°C (28). Saad and Hagedorn (27) reported that *A. tenuis* also could penetrate the leaf directly or through stomata. *A. tenuis* produces a toxin (tentoxin) in culture which induces plant chlorosis when applied to roots (11, 29). However, the fungus does not produce detectable quantities of tentoxin during natural infection of leaves or pods.

Leaf symptoms appear as small reddish-brown, irregular shaped spots or flecks which may be watersoaked and surrounded by a darker brown border. These lesions gradually enlarge and develop as concentric rings, which may become brittle and fall out, leaving a shot-hole appearance (Fig. 1). Lesions may coalesce and cover large areas of the leaf, resulting in partial or premature defoliation. *Alternaria* spp. can cause death of the central growing point of the plant or reduce plant vigor. The fungus also can blemish leaves (Fig. 2) and pods (Fig. 3) by producing a brown

Fig. 2- (left) Blemish on bean leaf caused by *Alternaria* species.

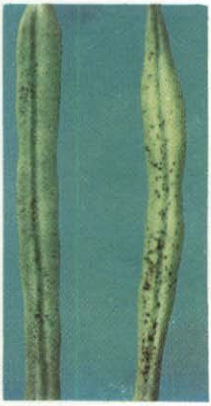

Fig. 3- (right) Blemish on bean pods caused by *Alternaria tenuis*.

discoloration on the surface and damage developing seeds (1, 17, 26, 28, 41, 46). The reddish to dark brown or black flecks may coalesce and produce streaks on infected pods (1). *Alternaria* spp. can be seed-borne (13).

Control measures seldom are warranted but wider plant and row spacing, chemicals, development of resistant cultivars (1) and crop rotation are suggested. Chemical control includes Chlorothalonil (1200 μg a.i./l) (1), Thiophanate (2 g/l) and Zineb (2.4 g/l). Workers report that *A. alternata* is insensitive to spray applications of Benomyl (1, 26).

Ascochyta Leaf and Pod Spot

Ascochyta leaf spot of beans is caused by *Ascochyta boltshauseri* Sacc. and *A. phaseolorum* Saccardo (41, 46). The fungus occurs in many regions of Latin America, such as Brazil, Colombia, Costa Rica and Guatemala (7, 12, 22, 31); the United States and other regions of the world (46). *Ascochyta pisi* Lib. occurs in Venezuela (43). The common name frequently used for Ascochyta leaf spot in Latin America is mancha de Ascochyta.

Ascochyta spp. produce hyaline, septate submerged mycelium in culture, and spores usually are two-celled and 20 x 5 μ in size (46). Sporulation and germination is optimum at 21°C, while mycelial growth is optimum at 24°C. The fungus is inactivated by temperatures above 30°C (22). The fungus produces pycnidia which measure 60-150 μ in diameter (46).

Infection by *Ascochyta* spp. is favored by high humidity and cool to moderate temperatures (12). Symptoms initially appear on leaves as brown to black zonate lesions (Fig. 4) which may later contain small black pycnidia. Lesions also may appear on the peduncle, petiole (Fig. 5) and pod

Fig. 4- Upper and lower leaf surface lesions caused by *Ascochyta* species.

Fig. 5- Petiole and pod lesions caused by *Ascochyta* species.

(Fig. 6) and cause stem girdle and plant death. Premature leaf drop may occur during severe epidemics (41), and the fungus may be seed-borne.

Control measures include crop rotation, wide plant spacing, planting clean seed, chemical treatment of seed and foliar application of sulfur fungicides (33). Other chemical control measures include Benomyl (0.55 g/l), Zineb (2.4 g/l) and Chlorothalonil (2.24 kg/ha). Dry bean germplasm should be screened to identify sources of resistance, if available and practical as a control measure.

Ashy Stem Blight

Ashy stem blight of bean is caused by *Macrophomina phaseoli* (Maubl.) Ashby or *M. phaseolina* (Tassi) Goidanich (9, 41, 46). The fungus is a warm-temperature pathogen of beans *(Phaseolus vulgaris* and *P. lunatus),* soybeans, corn, sorghum and many other crops (40). It occurs in such regions of Latin America as Brazil (7, 10, 31, 36), Mexico, Peru, Colombia, Venezuela and in Central America (43), and in other parts of the world (46). Losses of 65% have occurred in beans grown in the United States (46). However, no loss estimates are available for Latin America.

Common names frequently used for ashy stem blight in Latin America include pudrición gris de la raiz, pudrición carbonoza de la raíz, tizón cenizo del tallo, podredumbre carbonosa and podridao cinzenta do caule.

The fungus produces one-celled fusiform conidia which are pointed at one end and rounded at the other end. The straight or slightly curved conidia are 15-30 μ long and 5-8 μ wide and are produced on nearly straight conidiophores which may have a truncate tip and measure 12-20 μ in width by 6-25 μ in length (46). Sclerotia and pycnidia also are produced on infected plants.

Symptoms may appear after soil-borne mycelia or sclerotia germinate and infect seedling stems near the soil line at the base of developing cotyledons (Fig. 7). The fungus produces black, sunken cankers which have a sharp margin and often contain concentric rings. The plant-growing tip may be killed or stem breakage can occur where the stem is weakened by the canker. Infection may continue to develop into the hypocotyl and root region or the primary leaf petioles. Older seedling and plant infections may cause stunting, leaf chlorosis, premature defoliation and plant death. The infection often is more pronounced on one side of the plant (Fig. 8) (7, 9, 36, 41, 46).

A few days after infection, the fungus produces small, smooth, black sclerotia (50-150 μ in diameter) in infected tissue (Fig. 9) and inside plant

stems. Small, submerged, black pycnidia also may form in this tissue and usually are present on a gray background which has a characteristic ashen appearance (Fig. 10). The fungus may produce air-borne conidia which cause leaf spots on mature plants (10). *Macrophomina phaseolina* can be seed-borne (13, 41, 46).

Fig. 6- Older pod lesion caused by *Ascochyta* species.

Fig. 7 - Seedling infection due to *Macrophomina phaseolina.*

Fig. 8- Initial infection by ashy stem blight fungus on one side of plant.

Fig. 9 - (above, left) Sclerotia of *Macrophomina phaseolina* on infected bean stem.

Fig. 10 - (above, right) Pycnidia of *Macrophomina phaseolina* on infected bean stem.

Control measures include planting clean seed, treating seed with chemicals such as Ceresan, and using sanitation or deep plowing to bury plant debris containing pycnidia and sclerotia. Organic soil amendments (Carbon/Nitrogen ratio of 10-20) and high soil temperature (30°C) and moisture (60% moisture holding capacity) may reduce sclerotia levels (9). Sclerotia survival in soil can be reduced further by application of Benomyl (1 kg/ha) and Thiophanate-methyl (19), or by soil fumigation with Methyl Bromide and Chloropicrin (40). Resistant cultivars such as Negrito have been identified (9, 36, 46).

Cercospora Leaf Spot

Cercospora leaf spot and blotch of beans are caused by *Cercospora canescens* Ellis and Martin, and *C. cruenta* Saccardo, respectively. *C. phaseoli* Dearness and Bartholomew and *C. caracallae* (Speg.) Chupp also cause leaf spots of bean (15, 32, 41, 46). These fungi, primarily *C. canescens* and *C. cruenta,* occur in Brazil (31), Colombia (32), Puerto Rico, Trinidad, Jamaica, Venezuela, Argentina (43) and the United States (46). Yield losses are slight in the United States but can be serious in the Phillipines on *Phaseolus aureus* (46). There are no reports of serious losses in Latin America; however, defoliation has occurred in Colombia (23).

Common names frequently used for Cercospora leaf spot in Latin America include mancha de Cercospora, mancha vermelha and mancha blanca.

Cercospora spp. produce hyaline conidia with varying numbers of septations. Spores may be club, curved or straight-shaped. *C. cruenta* spores measure 50-150 μ in length by 6-9 μ in width, while *C. canescens* spores measure 50-100 μ in length by 3-4.5 μ in width (46).

Symptoms include brown or rust-colored lesions (Fig. 11) which may coalesce and vary in shape (circular to angular) and size (2-10 mm). *C.*

Fig. 11- *Cercospora* species lesions on infected bean leaves.

canescens produces irregularly-shaped light brown lesions with a gray center in leaves, pods, stems and branches (23). These lesions may contain a grayish center and be surrounded by a slightly reddish border. Lesions may dry and portions fall out, leaving a ragged appearance. Premature defoliation may occur, but vigorously growing leaves are seldom affected. *C. cruenta* may cause numerous lesions on primary leaves but seldom infect the trifoliates. Blemishes may occur on stems and pods, and the fungi can become seed-borne (23, 41, 46). A pink to purple discoloration occurred on bean seed inoculated with *Cercospora kikuchii* isolated from infected soybeans (21).

Control measures seldom are warranted but foliar applied copper fungicides are effective (46). Orozco (23) reported that Cundinamarca 116, Mexico 32, Mexico 275, Mexico 487, Mexico 507, Venezuela 42 and other cultivars were resistant to infection by *Cercospora canescens.*

Chaetoseptoria Leaf Spot

Chaetoseptoria leaf spot of beans is caused by *Chaetoseptoria wellmanii* Stevenson. It occurs in Mexico, Panama, Central America, Venezuela and the West Indies (43). The fungus has a wide host range within the Leguminoseae and may cause complete defoliation of beans with up to 50% yield reduction in regions with high humidity and moderate temperatures (42). The common name frequently used for Chaetoseptoria leaf spot in Latin America is mancha redonda.

Fig. 12- Leaf lesions caused by Chaetoseptoria leaf spot.

Chaetoseptoria wellmanii produces medium to large, circular lesions (Fig. 12) which may have a gray surface with black pycnidia in the center and be surrounded by a dark border (42). Infection is more common in

primary leaves in Mexico, and defoliation also may occur. The pathogen may be seed-borne (8).

Control measures include the development of resistant or tolerant cultivars (8). Benomyl (0.55 g/l) may provide sufficient chemical control.

Diaporthe Pod Blight

Diaporthe pod blight of beans is caused by *Diaporthe phaseolorum* (Cooke and Ellis) Saccardo (41). *D. arctii* (Lasch) Nits. is known to be pathogenic to bean stems (46). *D. phaseolorum* has a conidial stage known as *Phomopsis subcircinata* Ell. and Ev. (34). No estimates of its prevalence or importance are currently available, although Wellman (43) reports that it is a weak parasite in Honduras. Common names frequently used for Diaporthe pod blight in Latin America are añublo de vaina and tizón de la vaina.

Diaporthe phaseolorum produces hyaline, oblong ascospores with one septation and measure 10-12 μ by 2-4 μ. The ascospores are produced within black perithecia, 300 μ in diameter. Pycnidiospores are produced in the black pycnidia, and the oval spores measure 6-9 μ by 2-5 μ (41).

Symptoms appear first on leaves as irregularly-shaped, brown lesions surrounded by a distinct border. Black pycnidia and occasionally perithecia form in a zone or are scattered throughout lesions. Pod infections then may occur, and pods become discolored with pycnidia present in the lesions (41). The fungus can be seed-borne in soybeans and in beans (13).

Control measures include crop rotation, planting clean seed, and use of foliar fungicides such as Benomyl (0.55 g/l). Resistant cultivars have been developed for soybeans. Dry bean germplasm should be screened to identify sources of resistance, if available and practical as a control measure.

Downy Mildew

Downy mildew is caused by *Phytophthora parasitica* Dast. (46) and *P. phaseoli* Thaxter (8). The pathogen has caused yield losses in Mexico, Puerto Rico (8, 46), El Salvador, Venezuela, Peru and Panama (43). Infection is favored by low temperatures and high humidity. Common names frequently used for downy mildew in Latin America are mildeo velloso and mildiu velloso.

Fig. 13- Pod infection caused by *Phytophthora* species.

Fig. 14- Leaf lesions caused by *Entyloma* species.

Symptoms first appear on the petioles as white spots which enlarge and eventually may cause the leaf to wilt and die. Blossoms, buds and other plant parts may be killed by the fungus. White patches of mycelium are visible on green pods, especially those in contact with the soil surface (Fig. 13). This patch usually is surrounded by a reddish-brown border. If low temperatures and high humidity persist, the entire pod may be infected, shrivel and dry up (8).

Control measures include crop rotation for three years; chemicals such as Zineb, Maneb, Nabam or Captan (8); production of pods free from soil contact (46); and development of cultivars with an upright plant architecture and open plant canopy to improve air circulation. Dry bean germplasm also should be screened to identify sources of resistance, if available and practical as a control measure.

Entyloma Leaf Smut

Entyloma leaf smut of beans is caused by a species of *Entyloma* (30, 35, 42). Entyloma leaf smut occurs in bean production regions of Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras and Nicaragua (30, 35). *Entyloma petuniae* Speg. occurs on beans in Argentina (43). The common name frequently used for smut in Latin America is carbón.

Entyloma spp. cause a blister smut which is evident as dark-colored swellings on the upper leaf surface. The swellings are filled with mycelia and teliospores of the fungus (42). Lesions are round or oval, first appear watersoaked but become gray-brown in color on the upper leaf surface and gray-blue on the lower leaf surface (Fig. 14). Lesions may coalesce and be delimited by leaf veinlets (30). Infection usually occurs only on the primary

leaves, or first and second sets of trifoliate leaves, and severe foliage infection of 40-60% may occur (35).

Chemical control may be achieved by applying a seed treatment of Carboxin (5 g/kg seed) or a foliar spray of Benomyl (0.55 g/l). Dry bean germplasm should be screened to identify sources of resistance, if available and practical as a control measure.

Floury Leaf Spot

Floury leaf spot of beans is caused by *Ramularia phaseoli* (Drummond) Deighton (41). The fungus occurs in Brazil (Minas Gerais and Espirito Santo), Nicaragua, Colombia and Venezuela (4, 5, 36, 38, 39), Ecuador, Honduras, Panama, Guatemala and the Dominican Republic (43). No estimates of yield losses caused by it are available.

Common names frequently used for floury leaf spot in Latin America include mancha harinosa, mancha farinhosa and mofo branco da folha.

Ramularia phaseoli produces hyaline, generally non-septate conidia which are oval to lemon-shaped and measure 7-18 x 4-6 μ (41).

Ramularia phaseoli produces a white growth (1-1.5 cm in diameter) of conidiophores and conidia on the lower surface of leaves (Fig. 15). It

Fig. 15- Lower leaf lesions caused by *Ramularia phaseoli*.

should not be confused with powdery mildew *(Erysiphe polygoni)* infections, which usually are present only on the upper leaf surface. Chlorosis may occur on the upper leaf surface corresponding to the lower leaf lesions. Infection generally appears first on older leaves and then progresses onto new foliage. Severe infections may cause premature defoliation (5, 41); however, this is not commonly observed, especially in Brazil.

Chemical control results by applying Benomyl (0.55 g/l) or Thiophanate (2 g/l). Dry bean germplasm should be screened to identify sources of resistance, if available and practical as a control measure.

Gray Mold

Gray mold of beans is caused by *Botrytis cinerea* Pers. *ex* Fries which has the perfect stage *Botryotinia fuckeliana* (de Bary) Whetz. (25). The fungus can be a serious problem during periods of high moisture and low temperatures in various regions of the United States and Europe (25, 46). It is a minor pathogen in Brazil and seldom causes any significant damage (7). It also is reported in Peru, Trinidad, El Salvador (43) and Colombia (13).

Common names frequently used for gray mold in Latin America are moho gris, podredumbre gris and bolor cinzento.

The fungus produces light brown mycelium and hyaline, oval conidia 12-20 x 8-12 μ in size (41). Apothecia (Fig. 16) and ascospores are formed by the perfect stage of the fungus, which provides for variability in virulence of different strains and mating types (25).

Infection usually occurs from senescent blossoms colonized by the fungus or at wounds on plant parts such as leaves, stems or pods (Fig. 17)

Fig. 16 - Apothecium and conidia produced by *Botryotinia fuckeliana*.

Fig. 17- (right) Blossom colonization and pod infection by gray mold.

and penetration occurs from an infection cushion (16). Symptoms appear as a water-soaked gray-greenish area on the affected tissue which subsequently wilts and dies. Seedlings also may become wilted and die, but damage usually is limited to a watery soft rot of pods (41, 46). Black stroma and sclerotia (up to 4 mm in diameter) may be produced in infected tissue (25), and resemble those formed by *Sclerotinia sclerotiorum*. The fungus can be seed-borne (13).

Control measures include reduced plant density, row width and irrigation frequency (20), and application of foliar fungicides. However, some strains of the fungus are resistant to fungicides (3, 25). Dry bean germplasm should be screened to identify sources of resistance, if available and practical as a control measure.

Gray Leaf Spot

Gray leaf spot of beans is caused by *Cercospora vanderysti* P. Henn. which occurs in Venezuela, Central America (43), Brazil (Minas Gerais and Espirito Santo) (31, 36, 37, 39) and Colombia, usually at elevations greater than 1000 m where high moisture and low to moderate temperature conditions persist (32). No estimates of yield losses are available. The common name frequently used for gray leaf spot in Latin America is mancha gris.

Symptoms appear on the upper leaf surface as light green to slightly chlorotic angular lesions (2-5 mm in diameter), usually delimited by the veins and veinlets (Fig. 18). Lesions may coalesce and later become covered by a fine powdery, grayish-white growth of mycelium and spores. A dense gray mat of mycelium and spores subsequently forms on the lower leaf surface (Fig. 19) and is very diagnostic for the pathogen (32, 36). Severe

Fig. 18- Upper leaf lesions caused by *Cercospora vanderysti*.

Fig. 19- Mycelium and spores produced on lower leaf surface by gray leaf spot.

Fig. 20- Severe plant infection by the gray leaf spot fungus.

infections (Fig. 20) may cause premature defoliation. Symptoms may resemble those of white leaf spot, especially during early stages of infection.

Chemical control consists of Benomyl (0.55 g/l) and Copper Hydroxide (2.24 kg/ha). Other control measures include resistant or tolerant cultivars such as Rico 23, B.H. 4935 and Porto-Alegre-Vagem-Roxa (36).

Phyllosticta Leaf Spot

Phyllosticta leaf spot is caused by *Phyllosticta phaseolina* Saccardo which is favored by high moisture and moderate temperature conditions (18, 31, 36). The fungus occurs in Brazil (15), Costa Rica, Nicaragua, El Salvador, Guatemala, Peru, Argentina, Puerto Rico (43) and the United States (18, 46). No reports are available concerning yield losses. Common names frequently used for Phyllosticta leaf spot in Latin America include mancha de Phyllosticta and queima da folhagem.

Phyllosticta phaseolina produces hyaline, one-celled pycnidiospores which are 4-6 x 2-3 μ in diameter. Pycnidia are 90 μ in diameter (42).

Symptoms generally appear only on mature leaves as small water-soaked spots which may coalesce and enlarge to 7-10 mm in diameter. Lesions have a light-colored necrotic center and are surrounded by a rusty-brown margin. The center of old lesions may fall out and leave a shot-hole appearance. Small, black pycnidia may develop throughout the lesion and along the margin. Lesions may occur on petioles and stems and turn flower buds brown. Small lesions (1 mm in diameter) with dark centers and reddish margins may develop on pods (18, 46).

Control measures consist of foliar fungicides (46). Dry bean germplasm should be screened to identify sources of resistance, if available and practical as a control measure.

Powdery Mildew

Powdery mildew of beans is caused by *Erysiphe polygoni* DC *ex* Merat. and is distributed worldwide. Infection is favored by moderate temperatures and humidity. However, it can be prevalent within a wide range of environmental conditions (46). The pathogen seldom causes extensive damage in Latin American countries such as Brazil and Costa Rica (12, 31, 36) but can seriously reduce yields in Peru (12).

Common names frequently used for powdery mildew in Latin America include oidium, oidio, mildeo polvoso, cinza, ceniza and mildio pulverulento.

The fungus produces hyaline conidia in chains on the leaf surface. The spores are ellipsoid, one-celled and measure 26-52 x 15-23 μ in size. Spherical black perithecia (120 μ in diameter), uncommon in the tropics, contain asci and ascospores which are 24-28 x 11-13 μ (41).

Symptoms first appear as slightly darkened mottled spots on the upper leaf surface, which subsequently become covered by circular growths of white, powdery mycelium (Fig. 21). The entire leaf and plant may become covered by mycelium (Fig. 22), malformed, yellow and senesce prematurely. Stems and pods can be infected (Fig. 23), resulting in yield loss and seed transmission. Pods may be stunted, malformed or killed during severe epidemics. The fungus can be seed-borne (46), probably as spores on the seed coat surface.

Control measures include planting clean seed and using foliar chemicals such as sulfur, Dinocap (1.2 g/l) or lime-sulfur (10 ml/l). Concepcion (6) did not observe significant yield increases with chemicals such as Benomyl. Resistant cultivars exist, but resistance is complicated by the existence of different physiologic races (45, 46). Sources of non race-specific resistance should be sought and utilized if practical.

White Leaf Spot

White leaf spot of beans is caused by *Pseudocercosporella albida* (Matta & Belliard) comb. nov. and recently has been observed in Guatemala (47) and in Colombian (H.F. Schwartz, personal observation) highland sites at elevations greater than 1500 m. No estimates of yield losses are available. The common name frequently used for white leaf spot in Latin America is mancha blanca.

Symptoms appear first on the lower leaf surface of older leaves as white angular spots (2-5 mm in diameter) restricted by the leaf veins.

Fig. 21 - Powdery mildew lesions on bean leaf.

Fig. 23 - Pod infection by *Erysiphe polygoni.*

Fig. 22 - Severe plant infection by *Erysyphe polygoni.*

Fig. 24 - (above) Leaf lesions caused by the white spot fungus.

Fig. 25 - (left) Mixed leaf infection by gray and white spot fungi.

Angular white spots (Fig. 24) also may occur on the upper leaf surface and eventually enlarge and coalesce. Leaf necrosis and defoliation may occur (47). Symptoms closely resemble those of gray leaf spot, especially during the early stages of infection. Mixed infection by white and gray leaf spot has occurred in Colombia (Fig. 25).

Yoshii and Aamodt (47) report that the following cultivars were resistant to infection in Guatemala: Mexico 114, Puebla 40-4, Puebla 41-1, Puebla 138, Puebla 151-B, Puebla 199, Aguascalientes-79, Michoacan 31, Arrox I-565 and R20 Antioquia 18. No other disease control methods have been investigated.

Yeast Spot

Yeast spot or seed pitting of beans is caused by *Nematospora coryli* Pegl. and can be a seed production problem in Brazil (7, 36), Costa Rica, Ecuador, Peru, the West Indies (43) and the United States (46). Its economic importance varies from 10-100% yield loss due to its effect on seed quality and commercial appeal, which may be greatly reduced, especially in lima bean production (46). Common names frequently used for yeast spot in Latin America are mancha de levadura and pústula bacteriana.

Insects, such as the southern green stinkbug *(Nezara viridula* (L.), and lygus bugs *(Lygus hesperus* Kngt. and *L. elisus* Van Duzee), transmit the causal organism and also may damage seeds directly from toxins secreted during the feeding process (46). Galli *et al.* (15) reported in 1963 that *Nematospora coryli* also persists in weeds such as *Cassia occidentalis, Momordica charantia, Bauhinea purpurea* and *Crotalaria* sp.

The yeast organism produces a variable morphology in culture as elliptical cells 6-10 μ wide by 8-14 μ long predominate initially, followed by mature spherical cells 20 μ in diameter and mycelium-like strands which measure 2.5-3.5 μ in width by 90-140 μ in length. *Nematospora coryli* grows in culture at temperatures between 15°- 40°C, but 25°- 30°C is more favorable for infection (46).

Symptoms appear after insects feed on pods, puncture the developing seeds and transfer fungal propagules to the wound sites. The spores germinate and infect the seeds, including the embryonic cotyledonary leaves, thereby producing irregular, slightly sunken lesions about 1 mm in diameter. The lesions may be rose, tan or brown (7, 36, 41).

Control measures consist of eliminating weed hosts and controlling insect populations (46).

Additional Pathogens

Other fungi are reported to be pathogens of beans (*Phaseolus* species) and are not discussed in this book. Some of these organisms are listed in Table 1.

Table 1. Additional fungal pathogens of beans.

Pathogen	Plant Symptoms	Lit. Cited
Acrostalagmus spp.	-	13
Aristostoma oeconomicum Sacc.	Leaf Spot	46
Asteroma phaseoli Brun.	Leaf, Pod Spot	46
Botryodiplodia theobromae	Seed Decay	13
Brachysporium pisi Oud. (perhaps a *Curvularia* sp.)	Leaf Spot	34
Cephalosporium gregatum Allington and Chamberlain	Stem Rot	46
Ceratophorum setosum Kirchn.	-	46
Chaetomium indicum Cda.	-	46
Chephalosporium gregatum All. & Chamb.	Stem Rot	42
Cladosporium album Dows.	-	46
Cladosporium herbarum Pers. *ex* Fr.	Pod, Seed, Leaf Spot	34
Colletotrichum truncatum (Schw.) Andrus and Moore	Pod, Stem Spot	41
Corticum salmonicolor Berk. & Br.	Plant Rot	42
Curvularia spp.	Leaf Spot, secondary	42
Dendrophoma spp.	-	2
Dimerium grammodes (Kze.) Garman (*Parodiella perisporioides* (Berk. & Curt.) Speg.)	Leaf Spot, secondary	42
Diplodia natalensis P. Evans	Seed contaminant	46
Diplodia phaseolina Sacc.	Pod Spot	46
Elsinoe dolichi Jenkins, Bitanc, and Cheo	Leaf Spot (Scab)	41

Elsinoe phaseoli Jenkins	Leaf Spot (Scab)	41
Epicoccum neglectum Desm.	Leaf Spot	46
Fusarium culmorum (W. G. Sm.) Sacc.	Stem Rot	42
Fusarium equiseti (Cda.) Sacc.	Damping off	42
Fusarium lateritium Nees	Stem Canker	42
Fusarium macroceras Wr. and Reinking	Pods	46
Fusarium roseum Lk.	-	46
Fusarium semitectum Berk. & Rav.	Pod Decay	42
Fusarium vasinfectum Atk.	-	46
Gleosporium corallinum (Peyl.) Sacc. and Trav.	-	46
Glomerella cingulata (Ston.) Spauld and Schrenk.	-	46
Helminthosporium victoriae Meehan and Murphy	Pod Spot	46
Heterosporium spp.	Sooty Leaf Spot	46
Hypochnus centrifugus (Lev.) Tul.	-	46
Hypochnus cucumeris Frank.	Damping off	46
Leptosphaeria phaseolorum Ell. and Ev.	Stem Disease	46
Macrosporium commune Rab.	-	46
Macrosporium consortiale Theum.	-	46
(Stemphylium consortiale Theum.)	-	46
Macrosporium leguminis phaseoli P. Henn.	-	46
Macrosporium phaseoli Faut.	-	46
Microsphaera diffusa Cke. and Pk.	Leaf Spot	34
Microsphaera euphorbiae (Pk.) Berk. and Curt.	Leaf Spot	46
Monilia spp.	-	13

(continued)

Pathogen	Plant Symptoms	Lit. Cited
Mycena citricolor (Berk. & Curt.) Sacc.	Leaf Spot	42
Mycorrhizal fungi	Root Parasitism	46
Mycosphaerella phaseolicola (Desm.) Ideta.	Leaf Spot	46
Myrmaecium roridum Tode	Pod Disease	42
Nectrea spp.	-	42
Nigrospora spp.	Pod Decay	14
Periconia pycnospora Fr.	Pod Disease	42
Pestalotiopsis spp.	-	13
Peyronellaea spp.	-	13
Phakopsora vignae (Bres.) Arth.	Leaf Rust (Soybean Rust)	46
(Phakopsora pachyrhizi Sydow)		
(Physopella concors Arth.)		
Phoma terrestris Hans.	Secondary Root Rot	46
Phyllachora phaseoli (P. Henn.) Th. and Syd.	Leaf Spot (Tar Spot)	34
Phyllosticta noackiana All.	Leaf Spot	42
Phyllosticta phaseolorum Sacc. and Speg.	Leaf Spot (Ochraceous Spot)	46
Physarum cinereum (Batsch) Pers.		
Phytophthora cactorum (Leb. and Cohn) Schroet.	-	46
Phytophthora capsici Leon.	-	46
Pleiochaeta setosa (Kirchn.) Hughes	Leaf and Pod Spot (Brown Spot)	24
Pleospora herbarum (Ders. and Fr.) Rab. *(Stemphylium botryosum* Wallr.)	Leaf Spot	34

Pullularia pullulans (de By) Berkhout.	Seed Spot	34
Pythium anandrum Drechs.	-	34
Pythium arrhenomanes Drechs.	Root Rot	34
Pythium helicoides Drechs.	Root Rot	34
Pythium oligandrum Drechs.	Root Rot, Pod Rot	34
Pythium rostratum Butl.	Root Rot	34
Pythium vexans d By	-	34
Rhizoctonia dimorpha Matz.	Plant Rot	42
Rhizoctonia ferrugena Matz.	-	46
Rhizopus nigricans Ehrenberg	Pod Rot	41
Rhizopus stolonifer (Ehr. *ex* Fr.) Lind	Soft Rot	34
Rhizopus tritici K. Saito	Soft Rot	34
Sclerophoma phaseoli Karak	Pod Spot	46
Septoria phaseoli Maubl.	Leaf Spot	42
Sphaerotheca humuli var. *fuliginea* (Schlecht.) Salmon.	-	46
Stagonospora phaseoli Dearn.	Leaf Spot	34
Stagonospora hortensis Sacc. and Malbr.	Leaf Spot	34
Stemphylium botryosum Wallr.	Leaf Spot	42
Uromyces fabae (Pers.) D by	Rust	46
Vermicularia polytricha Cke.	-	46
Verticillium albo-atrum Reinke & Berth.	Root, Shoot Disease	42

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