
Tropical phytopathogens 2: *Pseudocercospora fuligena*

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Black leaf mold of tomato (*Lycopersicon esculentum*) is caused by *Pseudocercospora fuligena*, and the fungus and symptoms of the disease are illustrated and described. This cercosporoid disease causes leaf spots and spots on petioles, stems, and fruit peduncles (but not on the fruit itself). A detailed description of the lesion, morphological characters and partial sequence (273 bp) of the elongation factor 1-alpha (EF1a) gene of this species are provided.

Keywords – Anamorphic fungi – cercosporoid hyphomycetes – disease – morphology – tomato – South East Asia.

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Introduction

Pseudocercospora fuligena (Rodan) Deighton causes black leaf mold of tomato (*Lycopersicon esculentum* Mill.) (Halfeld-Vieira et al. 2006). The disease has primarily been reported from Asia (Hartman et al. 1991, Jain 1955, Mohanty & Mohanty 1955, Yamada 1951, Hsieh & Goh 1990, Petcharat & Kanjanamaneesathian 1989, Meeboon 2009). Major symptoms occur on the foliage but they may also occur on petioles, stems, and fruit peduncles (but not on the fruit itself) (AVRDC 2004). Hartman & Wang (1992) studied black leaf mold development and its effect on tomato yield, and concluded that there was a significant negative correlation between the area under the disease progress curve and total yield, fruit number and weight per fruit (fruit number and weight was reduced to 20% and 7%, respectively, as compared to the control).

As part of a programme to study cercosporoid fungi in Thailand and Laos, we commonly identified this species. In this paper we describe its role as an important tropical plant pathogen, with illustrations and description, and notes on host symptoms.

Host

Tomato (*Lycopersicon esculentum* ≡ *Solanum lycopersicum*) belongs to family Solanaceae. Plants typically grow to 1–3 metres in height but due to a weak stem, plants often sprawl over the ground or over other plants. Originating in South America, the tomato has spread around the world following the Spanish colonization of the Americas, and its many varieties are now widely grown, often in greenhouses in cooler climates (Wikipedia 2012).



Fig. 1 – Leaf spots caused by *Pseudocercospora fuligena*.

The tomato fruit is consumed in diverse ways, including raw, as an ingredient in many dishes and sauces, and in drinks. The fruit is rich in lycopene, which may have beneficial health effects. Tomatoes and tomato sauces and puree are said to help lower urinary tract symptoms (BPH) and may have anti-cancer properties (Polivkova et al. 2010).

Gleason & Edmunds (2006) studied tomato diseases and disorders, and concluded that various fungal taxa [*Alternaria solani*, *Cladosporium fulvum* (now *Passalora fulva*), *Colletotrichum coccodes*, *Fusarium oxysporum* f. sp. *lycopersici*, *Phytophthora infestans*, *Septoria lycopersici*], bacteria (*Pseudomonas syringae* pv. *tomato*, *Xanthomonas campestris* pv. *vesicatoria*) and viruses were the major biotic diseases.

There is limited information about black leaf mold (*Pseudocercospora fuligena*) and its causal agent. The disease was first described in the Philippines in 1938 and the pathogen described as *Cercospora fuligena* (Hartman & Wang 1992). Deighton (1976) transferred the fungus to the genus *Pseudocercospora*.

Symptoms

Symptoms appear as foliar spots, 2–8 mm diam., yellow on upper surface, and brown to dark brown on the lower surface; brown to dark brown in the centre, and with yellowish to yellowish brown margin (Fig. 1).

Taxonomy

***Pseudocercospora fuligena* (Roldan)**

Deighton, Mycol. Pap. 140: 144 (1976).

Figs 2, 3.

≡ *Cercospora fuligena* Roldan, Philipp. J. Sci. 66: 8 (1938).

Description – **Caespituli/Colonies** amphigenous, but chiefly hypophyllous. **Mycelium** internal; **hyphae** branched, 1–4 μm wide (\bar{x} = 2.86 μm , n = 21), septate, constricted at the septa, distance between septa 4–15 μm (\bar{x} = 9.14 μm , n = 21), subhyaline or hyaline, wall 0.3–0.5 μm wide (\bar{x} = 0.38 μm , n = 21), smooth. **Stromata** well developed, substomatal, subglobular, 15–25 μm diam. (\bar{x} = 0.38 μm , n = 10), brown to dark brown, stromatal cells oval, ellipsoidal to angular in outline, 3–6 μm wide (\bar{x} = 4.43 μm , n = 30),

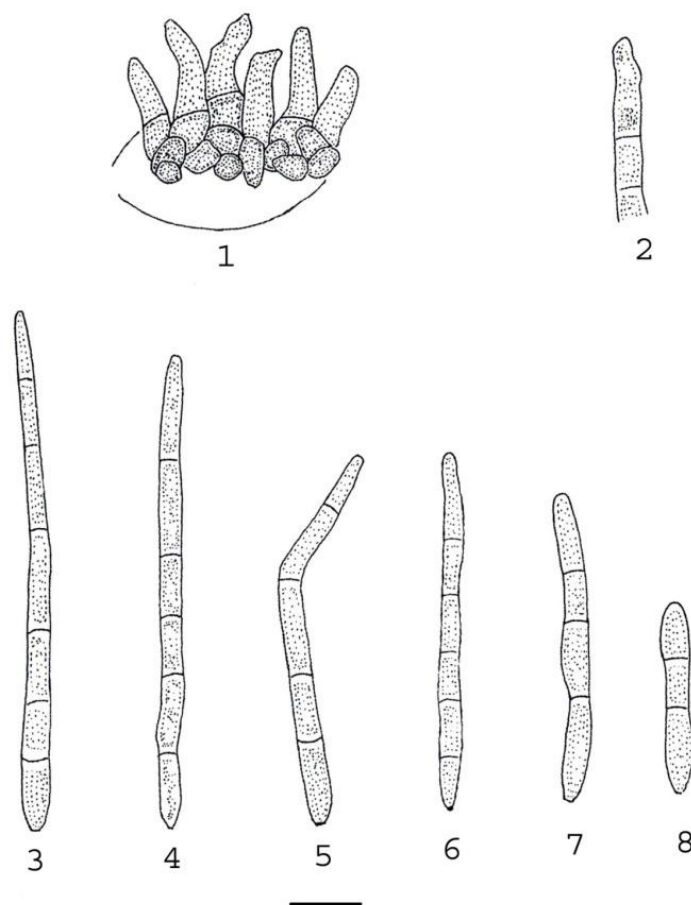


Fig. 2 – *Pseudocercospora fuligena*. **1** Stroma and conidiophores. **2** Conidiophore. **3–8** Conidia. Bar = 10 μ m.

brown, wall 0.5–1 μ m wide (\bar{x} = 0.68 μ m, n = 30), smooth. **Conidiophores** fasciculate, arising from stromata (4–18 per fascicle), erect, straight or curved, not branched, 8–31 \times 4–5 μ m (\bar{x} = 16.1 \times 4.32 μ m, n = 30), 0–2-septate, distance between septa 4–23 μ m (\bar{x} = 9.43 μ m, n = 30), pale to moderately olivaceous-brown, paler and narrower towards the apex, wall 0.5–0.8 μ m wide (\bar{x} = 0.67 μ m, n = 30), smooth. **Conidiogenous cells** integrated, terminal or conidiophores reduced to conidiogenous cells, straight, cylindrical to conical or somewhat geniculate-sinuuous, 8–19 \times 3–5 μ m (\bar{x} = 12.9 \times 4.12 μ m, n = 30), pale olivaceous or brown; **conidiogenous loci** inconspicuous or subdentate, but wall always unthickened and not darkened. **Conidia** solitary, cylindrical to cylindrical-obclavate, straight to moderately curved, 21–76 \times 2.5–4 μ m (\bar{x} = 49.67 \times 3.12 μ m, n = 30), 1–6-septate, slightly constricted at the septa, pale olivaceous, wall 0.3–0.5 μ m wide (\bar{x} = 0.4 μ m, n = 30), smooth, rounded at the apex, base obconically truncate, hilum

neither thickened nor darkened.

Known hosts – Solanaceae) *Capsicum annuum* L., *C. baccatum* L., *C. chinense* Jacq., *C. frutescens* L., *Lycopersicon chilense* Dunal, *L. chmielewskii* C.M. Rick, Kesicki, Fobes & M. Holle, *L. esculentum* Mill., *L. glandulosum* C.H. Mull., *L. parviflorum* C.M. Rick, Kesicki, Fobes & M. Holle, *L. pennellii* (Correll) D'Arcy, *L. peruvianum* Mill., *L. pimpinellifolium* L., *Solanum indicum* L., *S. melongena* L. and *S. nigrum* L. (Crous & Braun 2003).

Known distribution – **Africa:** Gabon, Gambia, Ivory Coast, Nigeria, Senegal, Somalia, Tanzania, Togo, Uganda; **Asia:** Bangladesh, Brunei, Cambodia, China, Hong Kong, India, Japan, Laos, Malaysia, Philippines, Taiwan, Thailand, Vietnam; **Europe:** Belarus; **North America:** Mexico, USA (FL); **Caribbean:** Cuba, Netherlands Antilles; **Oceania:** Australia, Cook Islands, New Caledonia, New Zealand, Palau, Papua New Guinea, Solomon Islands, Vanuatu; **South America:** Brazil, Chile.

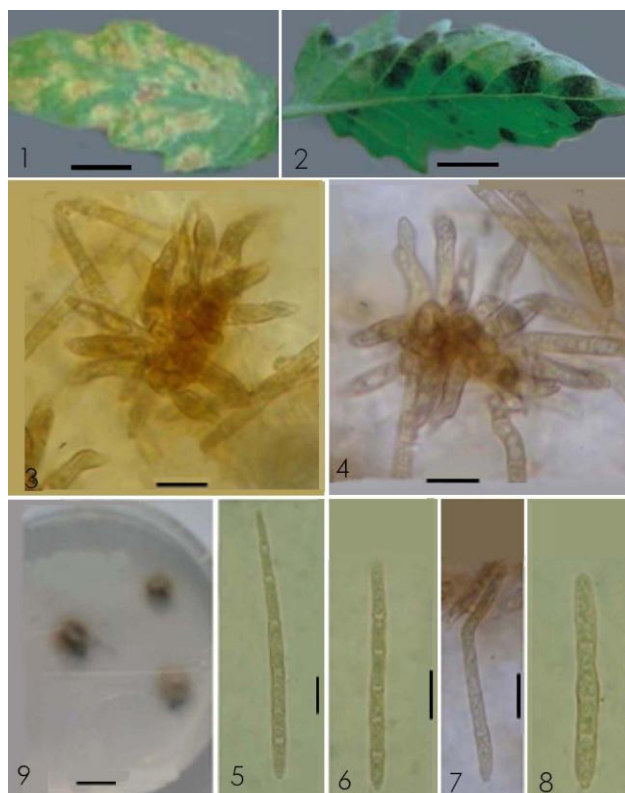


Fig. 3 – *Pseudocercospora fuligena* from leaf spots on *Lycopersicon esculentum*. **1–2** Lesions on host leaves (1. upper surface, 2. lower surface). **3–4** Stromata and conidiophores. **5–8** Conidia. **9** Culture. Bars 1, 2 = 10 mm, 3–8 = 10 μ m, 9 = 10 mm.

Material examined – Thailand, Chiang Rai Province, Tasud Meuang District, Sri Pangsang Village, on leaf of *Lycopersicon esculentum*, 3 June 2010, P. Phengsintham, MFLU 12-0001. Culture = MFLUCC 12-0001, GenBank accession no JQ837455; Laos, Vientiane Capital, Xaythany District, Xay Village, on leaf of *Lycopersicon esculentum*, 14 May 2006, P. Phengsintham, NUOL P49.

Cultural characteristics – **Mycelial colonies** on PDA after 3 weeks at 25°C 10–13 mm diam., grey-brown, surface ridged and smooth, hyphae 2–11 μ m wide (\bar{x} = 4.77 μ m, n = 30), septate, constricted at the septa, distance between septa 5–16 μ m (\bar{x} = 10.97 μ m, n = 30), brown, wall 0.3–1 μ m wide (\bar{x} = 0.54 μ m, n = 30), smooth. **Conidiophores** and **conidia** not formed in culture.

Remarks – Chupp (1954) mentioned that *Cercospora canescens*, *C. physalidis* and *C. diffusa* have been reported on tomato, but it is probable that there was a mistake in species identify. The conidial septation and size of *Pseudocercospora fuligena* as reported by various authors are shown in Table 1.

Tomato leaf mould caused by *Passalora fulva* (syn. *Cladosporium fulvum*,

Fulvia fulva), causes similar symptoms to that caused by *Pseudocercospora fuligena*. The two diseases can be distinguished with certainty only by a microscopic examination of the sporulating mould growth (McKenzie 1983).

The partial sequences of the internal transcribed spacer 1, 5.8S ribosomal RNA gene, internal transcribed spacer 2, and 28S ribosomal RNA gene, complete sequence of *P. fuligena* was 5531 bp, GenBank number (GU 214675) (<http://www.ncbi.nlm.nih.gov/nucleotide/?term=Pseudocercospora%20fuligena>).

We also describe here a partial sequence of the elongation factor 1-alpha (EF1a) gene (EF728f and EF986R) of the elongation factor 1-alpha (EF1a) gene of *P. fuligena*. For this, the genomic DNA from fungal mycelium was extracted from mycelia following the protocols as outlined by Cai et al. (2006). The incomplete sequence of the EF1a gene was then amplified using the primers EF728f and EF986R and sequenced using the same primers by SinoGenoMax Company limited, China. The sequence obtained was 273 bp and is deposited in GenBank (JQ837455). This sequence information may be useful for phylogenetic study in future work.

Table 1 Reported conidial size and septation of *Pseudocercospora fuligena*.

Septa	Conidia Size (μm)	References
Multiseptate	15–120 \times 3–5.5	Chupp (1954)
3–9-septate	20–120 \times 4–5	Ellis (1976)
2–9-septate	20–90 \times 2.5–4	Hsieh & Goh (1990)
3–10-septate	20–100 \times 3–6	Guo & Hsieh (1995)
1–6-septate	21–76 \times 2.5–4	Present study

Management of the Disease

Management of tomato diseases requires multiple tactics:

- select best possible site,
- improve soil quality,
- practice appropriate rotations,
- manage water properly,
- choose varieties with best resistance available.

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