Pathogen of the month – May 2020

Cochliobolus heterostrophus (Drechsler) Drechsler,(1934)

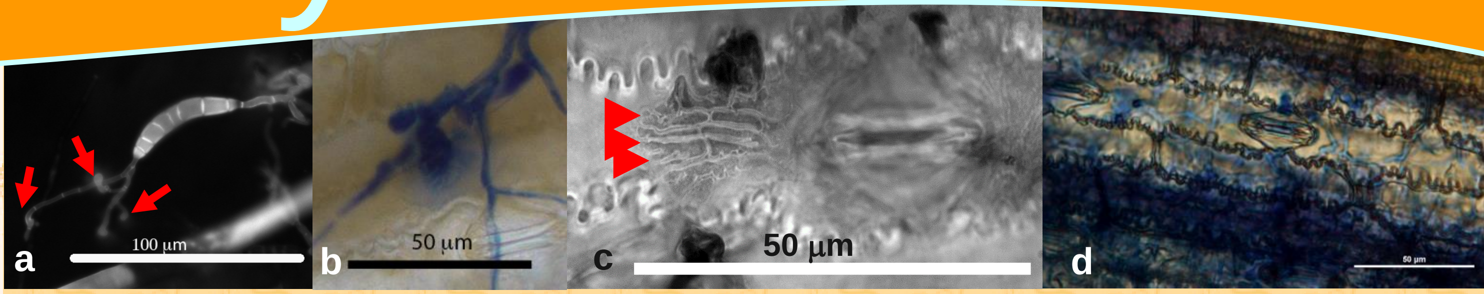

Fig. (a) Germinating conidium with appressoria (red arrows); (b) formation of an extracellular matrix around the appressorium and early formation of subcuticular hyphae; (c) subcuticular hyphal growth from a stomate (red arrowheads) and; (d) hyphal growth within the leaf mesophyll layer. Maize leaf lesions infected with *C. heterostrophus* were hand cut and cleared overnight in glacial acetic acid: ethanol solution. They were rinsed in water and then treated with Calcofluor White stain in (a) or Lactophenol Blue solution in (b) ,(c) and (d). Images were acquired with an Olympus BX50 and a Nikon Eclipse Ti microscopes on the Bioimaging platform, La Trobe University.

Common Name: Maydis leaf blight, southern leaf blotch
Disease: Southern corn leaf blight (SCLB) or leaf spot; leaf blotch
Classification: K: Fungi P: Ascomycota C: Dothideomycetes O: Pleosporales F: Pleosporaceae

Cochliobolus heterostrophus (anamorph, Bipolaris maydis) is a necrotophic, hetrothallic fungus which infects the leaves of maize. The species is subdivided into three races: race O, race T and race C. Race T is the most virulent to maize plants carrying the Texas cytoplasmic male sterile trait due to presence of approx. 1.2 Mb of DNA encoding genes for T-toxin production. Other members of the genus include the necrotrophic corn pathogen *Cochliobolus carbonum*, the oat pathogen, *Cochliobolus victoriae*, the rice pathogen, *Cochliobolus miyabeanus*, the sorghum pathogen, *Bipolaris sorghicola*, the sugarcane pathogen, *Bipolaris sacchari*, and the hemibiotrophic generalized cereal and grass pathogen, *Cochliobolus sativus*. All species mentioned above produce host selective toxins.

Biology and Ecology:
The asexual *C. heterostrophus* conidium is curved, fusiform, pale to golden brown, smooth and 5–11-distoseptate. If pairing compatible isolates are present, they can form ascomata but they are rarely observed in the field. Moisture triggers a very rapid adhesion mechanism allowing conidia to stick tightly to the surface of maize leaves and within 4hr conidia germinate from both ends. Germ tubes grow along the leaf surface until they reach depressions formed at the junctions between epidermal cells. At the ends of germ tubes, appressoria form. At such sites, extracelluar matrix which contain cuticle-eroding enzymes and cell wall degrading enzymes, aid in the direct penetration of corn leaves below the appressoria. Stomata are alternative sites of entry. By 12hr, the fungus produces visible lesions. Optimal leaf wetness duration and high humidity favor spore germination and disease development. Spore suspension between 10^5 to 10^6 spores/ml on maize seedlings at the 3 leaf formation stage developed symptoms 4 days after inoculation. Small chlorotic spots that enlarge to elongated, brown to grey necrotic lesions 2-6 mm wide by 3-22 mm long (Race O). Under conducive conditions and heavy infections, lesions can coalesce. Under ideal growth conditions, the disease cycles in about 60-70hrs and multiple disease cycles can occur during the growing season under conducive conditions.
Yield loss is due to reduction of photosynthetic area and carbohydrates available for grain fill. Increased lodging can also occur when canopy infections are severe. The fungus overwinters as conidia or mycelia on debris of dead corn plants.

Impact: Corn is the third most produced crop worldwide after wheat and rice and the crop is highly important for the livestock sector providing feed and forage. SCLB impacts the livelihoods of farmers, food and feed sectors, and trade in countries where maize is a staple.

Distribution: It is found in maize planting regions worldwide. Race O occurs worldwide while race C is restricted to China. Race T is no longer considered a threat.

Host Range: Apart from maize, it has a wide host range including sugar cane, sorghum, *Triticum* sp. and grasses.

Management options: Resistance is available in most commercially available materials and are highly effective in managing this pathogen. In the US, fungicides including strobilurins (FRAC group 11), SDHI's (FRAC group 7) and DMI's (FRAC group 3) are effective for managing this disease. Applications must follow label guidelines. The most effective disease control is achieved when fungicides are applied immediately prior to disease onset, at or near the tasseling stage of crop development.
Crop rotations and the planting of diseased-free seeds are some of the other practices used. Seeds from fields where *Bipolaris maydis* has been observed should not be used. Diagnostic procedures include PCR and microscopy for fungal morphology as symptoms caused by *C. heterostrophus* and *C. carbonum* are very similar on maize leaves at the early stages of infection.

Further Reading: Alabi and Isakeit (2015) https://agrilife.org/texasrowcrops/2015/10/05/southern-corn-leaf-blight-in-fall-corn/; Aregbesola et al. (2020) Eur J Plant Pathol 156, 133–145; Condon et al., (2013) PLoS Genet. 9(1): e1003233. Drechsler C (1934) Phytopathology. 24:953-983; Horwitz et al. (2013) In: Horwitz B., Mukherjee P., Mukherjee M., Kubicek C. (eds) Genomics of Soil- and Plant-Associated Fungi. Soil Biology, vol 36. Springer, Berlin, Heidelberg; Inderbitzin et al. (2010) Mol Plant Microbe Interact. 23(4):458-72; Kang et al. (2018) The Plant Pathology Journal, 34(4), 327–334; D.S. Manamgoda et al. (2014) Studies in Mycology 79: 221-288; Manamgoda et al. (2011) Fungal Diversity 51:3–42; Turgeon BG & Baker SE (2007), Advances in Genetics 57 :219-261, Tskiboshi et al. (1996) JARQ 30, 91-96; Wang et al. (2017) J Phytopathol. 2017;165:681–691; Wei et al (1988) Phytopathol 78:550-554; Wheeler H (1977) Physiological Plant Pathology (1977) 11, 171-178; Zhu et al. (1998)Genome, 41: 111–119. Refer to Crop Protection Network: https://cropprotectionnetwork.org/resources/articles/diseases/southern-corn-leaf-blight-of-corn

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