CAPS Datasheets provide pest-specific information to support planning and completing early detection surveys.

Peronosclerospora philippinensis (W. Weston) C.G. Shaw

Scientific Name
Peronosclerospora philippinensis (W. Weston) C.G. Shaw 1978

Synonyms:
Sclerospora philippinensis W. Weston, *Sclerospora indica* E.J. Butler, *Sclerospora maydis* Reinking

Common Names
Philippine downy mildew of maize, Java downy mildew of corn, and sugarcane downy mildew

Type of Pest
Fungal-like organism (Oomycete)

Taxonomic Position
Phylum: *Oomycota*, **Class:** *Oomycetes*, **Order:** *Peronosporales*, **Family:** *Peronosporaceae*

Pest Recognition
This section describes characteristics of the organism and symptoms that will help surveyors in the following manner: recognize possible infestations/infections in the field, select survey sites, and collect symptomatic material. For morphological descriptions, see the Identification/Diagnostic resources on the AMPS pest page on the CAPS Resource and Collaboration website.

Symptoms
Peronosclerospora philippinensis, the Philippine downy mildew pathogen, infects plants and causes chlorotic symptoms on leaves; these appear as vivid green and yellow stripes. A downy gray to white fungal-like covering may grow on the leaf surfaces (CIMMYT, 2020; Smith and Renfro, 1999).

Corn: Leaves on a corn plant, if infected, may show characteristic symptoms of long chlorotic (yellow) streaks (Fig. 1). A downy (grayish) covering, primarily on the underside of the leaves, is typical and begins at the two-leaf stage. This downy covering is present until the appearance of tassels and silks and is the primary site of spore production. It also is the source for spread of the disease to other susceptible plants (CIMMYT, 2020). As the plant ages, leaves may narrow and become abnormally upright; it appears somewhat dried-out. As the corn plant matures, tassels become

Figure 1: Corn plants infected by *P. philippinensis*. Courtesy of Bob Kemerait, University of Georgia, Bugwood.org

malformed; it produces less pollen, interrupting ear formation and causing seed sterility (Magill et al., 2013). If infection occurs early, plants may be stunted and die (Smith and Renfro, 1999).

Sugarcane: Infection of sugarcane by *P. philippinensis* causes whitish discoloration at the base of young leaves. Older leaves have a mosaic or mottled appearance and turn brick red as the leaves age (Fig. 2). Infected plants produce thin canes (Baer and Lalusin, 2013).

Figure 2. Classic leaf streak symptoms in the early stages of *P. philippinensis* infection on sugarcane (top image); brick red leaf symptoms develop as leaves age (bottom image) (Courtesy of Sugar Research Australia (2013)).

Easily Mistaken Species

Field symptoms alone cannot be used for accurate identification of *P. philippinensis* since other indigenous downy mildews such as *P. maydis* and *P. spontanea* cause similar symptoms (Magill et al., 2013). In addition, many plant pathogens and various abiotic stresses can cause similar symptoms in corn (Magill et al., 2013). Molecular identification is necessary to confirm the presence of *P. philippinensis*.

Biology and Ecology

Infection by *P. philippinensis* occurs via air- and water-borne spores from an infected crop or weed species; the highest rates of infection occur at temperatures greater than 61°F (Bonde et al., 1992). Spores are produced nocturnally on any part of the plant, except the roots, but are most common on the leaves and leaf sheaths (Weston, 1920). Wide variations in spore shape and size can be found due to differences in developmental stage and environmental conditions (Weston, 1920). Spore production

requires high humidity and water on the infected leaf surface. Germinating spores grow into the stomata and invade the leaf mesophyll. The pathogen spreads intercellularly through the mesophyll cells. The pathogen grows mainly downward through the leaf sheath to the stem where it moves into and persists in the shoot apex. When the pathogen invades the meristematic tissues, chlorotic streaks appear on the leaves; this is followed by the pathogen sporulating in these areas when conditions are favorable (Dalmacio and Exconde, 1969).

Movement of infected plant tissue can also introduce *P. philippinensis* to new locations (CABI, 2021). Seed-borne transmission may occur in corn, but there are no external symptoms on the seed. If seeds are harvested at a moisture content lower than 14%, however, the pathogen is unlikely to survive in the seed (Magill et al., 2013). Although oospore production has been reported (Acedo and Exconde, 1967), these structures appear to be rare and their role as a source of overwintering inoculum in the disease cycle is not known.

Known Hosts

Corn is the main host of importance for *P. philippinensis*. Weeds and other cultivated crops also play a major role in the perpetuation of P*. philippinensis.*

The host list below includes cultivated and wild plants that 1) are infected or infested by the pest under natural conditions, 2) are frequently described as major, primary, or preferred hosts, and 3) have primary evidence for feeding and damage documented in the literature. Economically important plants are highlighted in bold.

Preferred hosts

Avena sativa* L**. (oats)*, ***Euchlaena mexicana* Schrad.** (= *Zea mays* L. *mexicana)* (teosinte)*, ***Euchlaena mexicana X *Zea mays* hybrids*, *Miscanthus japonicus* Andress (ornamental grass)*, ***Saccharum officinarum* L**. (sugarcane)*, Saccharum *spontaneum* L. (Kans grass), and ***Zea mays*** L. (corn)* (Bonde and Peterson, 1983).

Pest Importance

Peronosclerospora philippinensis is one of seven plant pathogens that is listed as a select agent because it has the potential to pose a serious threat to plant health (CDC USDA, 2021). *Peronosclerospora philippinensis* can cause substantial losses in corn production (CABI, 2021). Yield losses from *P. philippinensis* range from 40–60% under normal growing conditions to as high as 80–100% when conditions are favorable for the pathogen (Exconde and Raymundo, 1974). In sugarcane, losses incurred from the disease (tons of cane per hectare) can reach from 9–38% (Husmillo, 1982). Reductions in the amount of sugar yield in the crop can also occur. Losses in picul (133 lbs or 60 kg) of sugar per hectare can range from 10–58% (Husmillo, 1982).

The main host plants affected by *P. philippinensis* are widely grown in the United States. Corn is the most widely produced feed grain in the United States and was grown

* Hosts with known U.S. distribution

on over 90 million acres nationwide in 2020 (USDA ERS, 2021a). The estimated annual value of the U.S. corn harvest is $52.7 billion (National Corn Growers Association, 2019). Sugarcane was planted on more than 838,000 acres in the United States from 2010–2018, primarily in Florida, Texas, and Louisiana (USDA ERS, 2021b). The estimated value of the U.S. sugarcane harvest was $962 million in 2016–2017 (USDA ERS, 2021b).

Several countries list *P. philippinensis* as a harmful organism including: Colombia, Ecuador, French Polynesia, Guatemala, Honduras, Indonesia, Japan, Republic of Korea, Mexico, Morocco, Namibia, New Caledonia, New Zealand, Peru, and South Africa (USDA PPQ, 2021). If this pathogen were introduced into the United States, there is the potential that it could disrupt trade with these nations.

Known Vectors (or associated insects)

This species is not a known vector. It is not known to be vectored and does not have any associated organisms.

Known Distribution

Asia: India (Bains and Jhooty, 1982; Gattani, 1950), Indonesia (Ekawati and Gusnawaty, 2018; Muis et al., 2016; Pakki et al., 2019), Pakistan (Ali, 1959), Philippines (Bonde et al., 1984),

Africa: Democratic Republic of the Congo (Watson, 1971); South Africa (Doidge, 1950). *Peronosclerospora philippinensis* appears to be endemic in Asia (CABI, 2021).

Status of pathogen in the United States

There have been reports of *P. philippinensis* in the United States, but these reports have not been confirmed.

Pathway

The primary source of inoculum of the pathogen is infected hosts such as corn, sugarcane, and susceptible weed species growing nearby. The pathogen spreads locally through spores by water and wind.

The potential for long-distance transmission of *P. philippinensis* is not well known. Spread through infected seed is possible, although only when the moisture content of the seed is more than 14 percent (Magill et al., 2013). However, seed from infected areas are rarely exported (CABI, 2021). There are no other known long-distance pathways for *P. philippinensis*. Long-distance transmission through infected host planting material is unlikely because oospores are rarely reported (Acedo and Exconde 1967).

Use the PPQ Commodity Import and Export manuals listed below to determine 1) if host plants or material are allowed to enter the United States from countries where the organism is present, and 2) what phytosanitary measures (e.g., inspections,

phytosanitary certificates, post entry quarantines, mandatory treatments) are in use. These manuals are updated regularly.

Fruits and Vegetables Import Requirements (FAVIR) Online Database: The FAVIR database lists all import requirements for fruits and vegetables. To search by commodity, select 'Approved Name' at the top left of the page. Then, select the commodity from the drop-down menu and click 'Search'. Finally, click on the 'Commodity Summary' tab for details.
https://epermits.aphis.usda.gov/manual/index.cfm?action=pubHome

Plants for Planting Manual: This manual is a resource for regulating imported plants or plant parts for propagation including buds, bulbs, corms, cuttings, layers, pollen, scions, seeds, tissue, tubers, and like structures.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/plants_for_planting.pdf

Cut Flowers and Greenery Import Manual: This manual is a resource for regulating imported fresh, cut plants used for decoration and for protecting plants from extinction due to trade.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/cut_flower_imports.pdf

Miscellaneous and Processed Products Import Manual: This manual is a resource for regulating imported processed plant and non-plant products that may introduce exotic pests.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/miscellaneous.pdf

Treatment Manual: This manual provides information about treatments applied to imported and domestic commodities to limit the movement of agricultural pests into or within the United States.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment.pdf

Potential Distribution within the United States

Based on the known distribution of *P. philippinensis* in the world, this pathogen may become present in plant hardiness zones 1-14 (Takeuchi, 2018). Therefore, in the United States and its territories, this pathogen could become established in any of these zones where susceptible host plants are grown under conducive environmental conditions.

Corn is grown commercially in most of the United States with production concentrated in the Midwest, including in Illinois, Iowa, Indiana, eastern portions of South Dakota and Nebraska, western Kentucky and Ohio, and the northern two-thirds of Missouri (USDA ERS, 2021a). Sugarcane is grown commercially in Florida, Louisiana, Texas, and Hawaii (USDA ERS, 2021b).

Survey and Key Diagnostics

Approved Methods for Pest Surveillance:

For the current approved methods and guidance for survey and identification, see Approved Methods for Pest Surveillance (AMPS) pest page on the CAPS Resource and Collaboration website, at https://caps.ceris.purdue.edu/approved-methods.

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Versions

August 2010: Datasheet completed (Version 1)

September 2021: Revised entire datasheet and added it to the newest datasheet template (Version 2)

Reviewer(s)

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