Secondary Pests of Small Grains (Truncated Pest Datasheet)

Peronosclerospora philippinensis

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

Synonyms:
Pernosclerospora sacchari, Sclerospora indica, Sclerospora maydis, Sclerospora philippinensis

Common Name
Philippine downy mildew, Java downy mildew of corn, sugarcane downy mildew

Type of Pest
Fungus-like

Taxonomic Position
Phylum: Oomycota, **Class:** Oomycetes, **Order:** Sclerosporales, **Family:** Sclerosporaceae

Reason for Inclusion in Manual
CAPS Target: AHP Prioritized Pest List – 2009; Agricultural Bioterrorism Protection Act of 2002; Regulated Plant Pest List

Pest Description
Philippine downy mildew is confined to parts of Asia and has not been reported within the United States. This obligate pathogen causes a serious disease to two major crops, corn and sugarcane. Yield losses of 40-60% and 25% have been observed in corn and sugarcane respectively (USDA, 1986). Oat (*Avena* spp.) is considered a minor host for Philippine downy mildew.

Figure 1. Chlorotic symptoms of Philippine downy mildew. Photo courtesy of CIMMYT .

The mycelia are branched, slender (8 µm in diameter), irregularly constricted and inflated. The small haustoria (2 x 8 µm) are simple and vesiculiform to subdigitate. Erect conidiophores (15-26 x 150-400 µm) grow out of stomata and are dichotomously branched two to four times. Branches are robust. Sterigmata are ovoid to subulate, slightly curved, and 10 µm long. The conidia (17-21 x 27-39 µm) are elongate ovoid to round cylindrical, hyaline, and slightly rounded at the apex (Weston, 1920; White, 1999).

Oospores are rarely produced and are not produced in corn tissue (White, 1999).

Symptoms/Signs

Symptoms of the disease and signs of the pathogen are not listed specifically for oat.

On corn, the first symptoms typically appear as chlorotic stripes at the first leaves as early as 9 days after planting. All leaves on a plant may show characteristic symptoms of long chlorotic (yellow) streaks (Fig. 1). Weston (1920) reported the collapse of badly infected cells and the destruction of chloroplasts, resulting in the characteristic yellow color of diseased leaves.

A downy (grayish) covering primarily on the underside of the leaves is characteristic beginning at the two-leaf stage and is present until the appearance of tassels and silks. This covering is the site of spore production (conidia on conidiophores) and the source for secondary spread of the disease to other susceptible plants. As the plant ages, leaves may narrow, become abnormally erect, and appear somewhat dried-out. As the corn plant matures, tassels become malformed and produce less pollen, ear formation is interrupted, and sterility of seeds can result (Expert Panel, 2006). If infection occurs early, plants are stunted and may die (White, 1999).

There are no external symptoms on seeds. The fungus becomes established in the pericarp layer in the form of mycelium. The fungus is also present in the embryo and endosperm. There are no reports on the effect of *P. philippinensis* on seed quality (CABI, 2007).

Note: There is a synergistic relationship between downy mildew fungi and maize streak virus (MSV) on corn. Infection by MSV can mask symptoms of downy mildew infection. Reduction in height and biomass were significantly greater with pathogen combinations than with single pathogens (Damsteegt et al., 1993).

Figure 2. Downy growth on characteristic of downy mildews. Photo of downy mildew of tobacco. Photo courtesy of Tom Creswell, North Carolina State University.

Survey

CAPS-Approved Method: Use visual survey, sentinel plots, spore trapping or a combination of methods. For visual survey collect symptomatic plants. Spore traps,

similar to those used in soybean rust monitoring, can be used to detect spores. Unsprayed, susceptible plants (sentinel plots) that are scouted regularly can also be used for early detection.

Literature-Based Methods:
Visual survey: Surveys should occur in areas of the country that are at the greatest risk for establishment. Survey for Philippine downy mildew is conducted via visual survey of plants for symptoms of the disease (chlorotic stripes or streaks) and signs of the pathogen (downy growth on underside of leaves consisting of conidia and conidiophores). Survey for diseased plants by examining corn seedlings that have larger and larger yellow streaks on succeeding leaves. Grayish white down will be in the chlorotic areas although sun or low humidity may have dried the mildew to matted fragments (USDA, 1986).

Trapping: Spore trapping using Burkhard spore traps and sentinel plots (unsprayed, susceptible plants that are scouted regularly) are suggested for early detection and have been employed for resistance screening for other exotic downy mildews (Cardwell et al., 1997; Expert Panel, 2006).

Surveys should take place at areas of greatest risk. A recent risk analysis by USDA-APHIS-PPQ-CPHST indicates that portions of Illinois, Indiana, Kentucky, and Ohio have the greatest risk for *P. philippinensis* establishment based on host availability and climate within the continental United States. The remaining states have low to moderate levels of risk for establishment of *P. philippinensis*.

Key Diagnostics

CAPS-Approved Method: Confirmation of *P. philippinensis* is by morphological identification. Pathogen may be identified morphologically by conidiophore structure and dimension and spore (conidia) shape and size. Isozyme comparisons have been used to identify *Peronosclerospora* spp., including *P. philippinensis*

Literature-Based Methods: *Peronosclerospora* spp. and other downy mildew genera (including *Sclerospora* and *Sclerophthora*) are primarily differentiated by pathogen morphology, including conidiophore structure and dimension and spore (conidia) shape and size. However, these characteristics can vary considerably under different culture conditions, at different developmental stages, and on different hosts. Identification of *Peronosclerospora* species often is difficult. They may be easily divided into three categories according to the shape of conidia: globose, ovoid to slightly elongate, and long or slipper-shaped, but within each group there are usually only minor morphological differences. Species are differentiated by only variations in the size and shape of their conidia and conidiophores, and sometimes differences in host ranges, presence or lack of oospores, and differences in morphology (Bonde et al., 1992). Characters for downy mildew pathogens are listed in Table 1.

Isozyme comparisons have been used to identify *Peronosclerospora spp.*, including *P. philippinensis* (Bonde et al., 1984; Micales et al., 1988). *P. philippinensis* and *P.*

sacchari can not be separated based on isozyme analysis. These species are believed to be conspecific (Yao et al., 1991b).

Some DNA-based approaches have been reported for other *Peronosclerospora* spp., which indicates that a molecular method for identification may be available in the future. Yao et al. (1991a) created a DNA clone that could be used as a species-specific hybridization probe for the detection and identification of *P. sorghi*. Yao et al. (1991b) then developed a DNA probe from a *P. maydis* genomic library to detect *P. sacchari* in maize leaves and seeds. Ladhalakshmi et al. (2009) used a DNA sequence characterized amplified region (SCAR) marker for identification of isolates of *P. sorghi* from maize using PCR. There has been some work on SSR markers for *P. sorghi* and related species that include this pathogen and will be helpful for identification and future PCR primer development (Perumal et al., 2008).

Table 1: Characteristics of the downy mildew fungi found on corn and other hosts
Taken from White (1999)

PATHOGEN	***PERONOSCLEROSPORA***				***SCLEROSPORA***	***SCLEROPTHORA***	
	philippinensis (Philippine downy mildew)	*maydis* (Java downy mildew)	*sacchari* (sugarcane downy mildew)	*sorghi* (sorghum downy mildew)	*graminicola* (Graminicola downy mildew)	*macrospora* (crazy top)	*rayssiae var. zeae* (brown stripe downy mildew)
Conidiophores	Hyaline, length 150-400 µm, bloated, widening abruptly, dichotomously branched 2-4 times, ephemeral	Hyaline, length 150-550 µm, bloated, dichotomously branched 2-4 times, ephemeral	Hyaline, length 160-170 µm, bloated, widening gradually, dichotomously branched 2-3 times, ephemeral	Hyaline, length 180-300 µm, bloated, often dichotomously branched 2-3 times, septate near base, ephemeral	Hyaline, length av. 268 µm, bloated, non-septate, irregularly dichotomously branched ephemeral	Hyaline, length av. 13.8 µm, simple, hyphoid, determinate	Hyaline, short, hyphoid, determinate
Asexual spores	Conidia hyaline, elongate-ovoid to round-cylindrical, apex slightly rounded, 17-21 x 27-39 µm	Conidia hyaline, spherical to subspherical, 17-23 x 27-39 µm	Conidia hyaline, elliptical, oblong or conical, apex round, 15-239 x 25-41 µm	Conidia hyaline, oval to almost spherical, 15-26.9 x 15-28.9 µm	Sporangia hyaline, broadly elliptical, operculate, papillate, 12-21 x 14-31 µm	Sporangia hyaline, lemon-shaped, operculate, papillate, 30-60 x 60-100 µm	Sporangia hyaline, ovate to almost cylindrical, operculate, 18.5-26 x 29-66.5 µm
Asexual spores germinate by	Germ tube	Germ tube	Germ tube	Germ tube	Zoospores	Many zoospores	Zoospores

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	philippinensis (Philippine downy mildew)	*maydis* (Java downy mildew)	*sacchari* (sugarcane downy mildew)	*sorghi* (sorghum downy mildew)	*graminicola* (Graminicola downy mildew)	*macrospora* (crazy top)	*rayssiae var. zeae* (brown stripe downy mildew)
Oospores	Rare or nonexistent; spherical, smooth walled, 22.6 µm in diameter	Unknown	Yellow to yellow brown, globular to slightly angular; 40-50 µm in diameter	Usually brown to subhyaline spherical, diameter 25-42.9 µm	Pale brown, spherical, usually smooth-walled, diameter 22.5-35 µm	Hyaline to pale yellow, mainly in vascular bundles, diameter 45-75 µm	Brown, spherical, 29.5-37 µm in diameter
Sexual spores germinate by	Side germ tube	-	Germ tube	Wide germ tube	Germ tube or by sporangia	Sporangia	Sporangia
Geographical Distribution	Philippines, Indonesia, India, Nepal, China, Thailand, Pakistan	Australia, Indonesia	Australia, Fiji Islands, Japan, Nepal, New Guinea, India, Philippines, Taiwan, Thailand	North America (including the U.S.), Central America, Asia, Africa, South America, Australia, Europe	Worldwide, but on corn found only in Israel and the United States	North America (including the U.S.), Mexico, South America, Europe, Africa, Asia	India, Nepal, Pakistan, Thailand

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