

# Brown Stripe Downy Mildew of Corn

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## INTRODUCTION

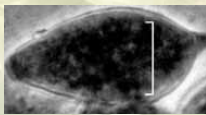
Corn (*Zea mays*) is the most widely produced grain in the United States. Approximately 80 million acres of land are planted to corn. In India, where the Brown Stripe Downy Mildew (BSDM) pathogen was first discovered, yield losses from BSDM range from 20-70%. If BSDM were to cause comparable damage in the U.S., it would translate to a \$4.6-16.1 billion financial loss<sup>1</sup>.

Because of this potential impact, BSDM has been designated a Select Agent. Early diagnosis and expedited reporting are necessary to minimize damage should BSDM be found in the United States. The National Plant Diagnostic Network's Diagnostic Subcommittee plays an essential role in early detection of diseases by offering Standard Operating Procedures (SOPs) for the diagnosis, identification, and reporting of Select Agents. This poster summarizes the pathogen and disease information in the SOP for brown stripe downy mildew.

## THE PATHOGEN

BSDM is caused by *Sclerophthora rayssiae* var. *zeae*, a member of an economically important group of organisms which includes plant pathogens such as *Phytophthora*, *Pythium*, and other downy mildews. *S. rayssiae* var. *zeae* is an obligate parasite and will not grow on artificial media. Diagnosis depends on microscopic examination of diseased tissue; the pathogen is identified on the basis of its morphology. There are no published serological or molecular methods of detection.

The mycelium of *S. rayssiae* var. *zeae* is found in the leaf mesophyll; the hyphae are irregular in shape and are lobulate rather than tubular.



Sporangia of *Sclerophthora rayssiae* var. *zeae*. Used with permission of *Phytopathology*. From: Payak, M.M., and B.L. Renfro. 1987. A New Downy Mildew Disease of Maize. *Phytopathology* 57:394-397. Sporangia (left) and sporangium (above). Bar above = 20 microns.

## Asexual spores

•Sporangia are produced sympodially in groups of between two and six in a basipetal succession on sporangiophores which arise from hyphae in substomatal cavities; sporangial production occurs superstomatally. Sporangia measure 29-66.5 x 18.5-26 µm, are hyaline, ovate to elliptic or cylindrical, smooth-walled, have a projecting apex and a persistent, straight or wedge-shaped peduncle.

•Four to eight zoospores are formed within a sporangium, which may encyst within or outside the sporangium.

## Sexual spores

•Oogonia are found scattered in the leaf mesophyll or the substomatal cavities, but never in the vascular bundles.



Advanced symptoms of Brown Stripe Downy Mildew. Image courtesy C. De Leon. Reproduced, with permission, from Compendium of Corn Diseases, 3<sup>rd</sup> ed., 1999, American Phytopathological Society, St. Paul, MN, USA.

## DETECTION

•Sporangia production may be stimulated by placing chlorotic symptomatic tissue into a moist chamber and incubating at 22°-25° C. Sporangia should be produced within three to nine hours.

•Necrotic tissue will not produce sporangia.

•Oogonia and oospores are produced in necrotic tissue and may be visualized by clearing the leaf tissues in 2% sodium or potassium hydroxide solution at 45°-50° C, washing in several changes of distilled water, then staining with 0.1 % methyl blue in 50% glycerin for up to 20 min at 45°-50° C. Oospores measure 30-37 µm in diameter.

***Sclerophthora rayssiae* var. *zeae* differs from other downy mildew pathogens of corn in the following:**

•Unlike the BSDM organism, *Sclerophthora macrospora* causes leaf or floral malformation or distortion. Oospores are significantly larger (45-75 µm dia.), and develop mainly in vascular bundles or in their parenchymatous sheath cells. Sporangia do not form on intact leaves.

•*Peronosclerospora philippinensis* causes long chlorotic streaks of a lighter color on maize, and causes stunting when infection is early. Oospores are 15-22 µm in diameter (average ~19 µm).

•*Peronosclerospora sorghi* systemically infects plants. Affected leaves always have chlorosis of the base of the leaf blade. No purpling or reddish color to affected tissues. Oospores are 25-43 µm in diameter (average ~36 µm).

## SYMPTOMS

*Sclerophthora rayssiae* var. *zeae* causes only leaf lesions; the pathogen is not systemic within the plant.

•In early stages of infection the leaves will show narrow chlorotic or yellowish stripes 3-7 mm wide.

•At later stages of infection, the chlorotic stripes take on a reddish or purple color. Chlorotic striping of maize leaves may be due to both abiotic and biotic factors, but few agents produce the purplish-red vein-limited striping of leaves.

•The disease first appears on the lowermost leaves. Severely affected leaves may be shed prematurely, but affected leaves remain intact and do not shred, even after severe storms.

•When disease occurs prior to flowering, seed development is adversely affected, and early plant death may result.

## EPIDEMIOLOGY

Primary inoculum comes from oospores that overwinter in soil or plant debris, or from infected seed. Oospores in air dried leaf tissue remain viable for four years. Oospores or mycelium may also be present in or on the seed, however, infected seed dried to 14 % moisture or less and stored for four or more weeks will not be capable of transmitting the disease.

•Secondary spread occurs after oospores produce sporangia that are dispersed in wind and water splash. The sporangia contain 4-8 zoospores that may initiate new infections.

•In a favorable environment, one generation of sporangia requires no more than 10 days to mature, leading to rapid spread of the disease throughout a crop.

•Moisture is the most important environmental factor affecting disease development. Sporangia require at least a 12-hour moisture period. Sporangia are produced most abundantly at moderate temperatures of 22°-25° C. Losses due to *S. rayssiae* var. *zeae* are greatest in regions of high rainfall (100-200 cm annually) where susceptible cultivars are grown.

•Warm soil temperatures (28-32.5° C) are required for disease development.

•Young plants are most susceptible to infection, with susceptibility decreasing as the plants age.

<sup>1</sup> based on 2004 annual estimated earnings of \$23 billion. (2005 Corn Annual <http://www.corn.org/CRAR2005.PDF>).