Xanthomonas oryzae pathovar oryzicola

Scientific Name
Xanthomonas oryzae pv. *oryzicola* (Fang et al 1957) Swings et al 1990

Synonyms:
Xanthomonas campestris pv. *oryzicola* (Fang *et al*. 1957) Dye 1978
*Xanthomonas oryzicola (*Fang et al. 1956) Dowson 1943
Xanthomonas translucens f.sp. *oryzicola* (Fang *et al*. 1956) Bradbury 1971

Common Name(s)
Bacterial leaf streak, BLS (English), Xoc

Type of Pest
Bacteria

Taxonomic Position
Kingdom: Bacteria**, Phylum:** Proteobacteria**, Class:** Gammaproteobacteria, **Order:** Xanthomonodales, **Family:** Xanthomonodaceae**, Genus:** Xanthomonas (Dowson, 1939) (EPPO, 2007).

Reason for Inclusion in Manual
CAPS Target: AHP Prioritized Pest List – 2011

Pest Description
The bacterium is a gram-negative, non-spore forming rod, 1.2 X 0.3-0.5 µm, with a single polar flagellum. Colonies on nutrient agar are pale yellow, circular, smooth, and convex. Phenotypic characters of the bacterium useful in differentiating it from *X. oryzae* pv. *oryzae*, causal agent of bacterial blight, are listed in Table 1 below. A monoclonal antibody specific for *X. oryzae* pv. *oryzicola* has been developed. Isolates of the bacterium that differ in virulence have been identified. In the rice host, the bacterium is present in the parenchyma tissue (Compendium of Rice Diseases ,1992).

A pathovar is a bacterial strain (or set of strains) with similar characteristics that are usually distinguished by different host range. The *Xanthomomonas oryzae* has two pathovars (i.e. *Xanthomonas oryzae* pv. *oryzae* and *X. oryzae* pv. *oryzicola)* that affect the same host but have strong difference in symptomatology on the same host allowing different pathovar designations.

	X. oryzae pv. *oryzae*	*X. oryzae* pv. *oryzicola*
Acetoin production	-	+
Strong peptonization of litmus milk	-	+
Phenylalanine deaminase	-	+[a]
Utilization of L-alanine	-	+

Sensitive to 0.001% cupric nitrate (w/v)	+	-

[a] Positive response in 50% of strains.

Table 1: Phenotypic Characters useful in differentiating *Xanthomonas oryzae* pv. *oryzae* from *X. oryzae* pv. *oryzicola* (Reproduced by Compendium of Rice Diseases, The American Phytopathological Society, 1992)

Bottom and Top Left: Bacterial Leaf Streak which are symptoms of *Xanthomonas oryzae pv. oryzicola* in the field (Africa) Right: Symptoms of Bacterial Leaf Streak caused by artificial inoculations. (Valerie Verdier, Institut de Recherche pour le Developpement (IRD)).

Biology and Ecology

Xanthomonas oryzae pv. *oryzicola* causes bacterial leaf streak by colonizing the parenchyma and limited to the vascular regions of the plant (Niño-Liu *et al*., 2006). *X. oryzae* pv. *oryzicola* is seedborne and seed-transmitted and it is spreading geographically*. X.oryzae* pv. *oryzicola* survives largely on infested seed and straw and is known to infect all wild species of the genus *Oryza.* This wild rice species may also serve as reservoirs of inoculums. In addition, this bacterium may be able to survive in irrigation water.

The bacterium enters the host through stomates or wounds and multiplies then it spreads to the parenchymatous tissue in its early stages. In the parenchyma more multiplication takes place until the parenchymatous tissues are substituted with the bacterium (Ou, 1985).

X. oryzae pv. *oryzicola* severe cases are found in earlier stage growth of rice because younger rice is usually more susceptible to the disease. During moist conditions bacterial exudates are found on the surface of the leaf lesions however during dry conditions yellow beads are found on the surface of the leaf lesions (Ou, 1985). The bacterial exudates tend to spread rapidly from plant to plant from irrigation water that has residue of bacterial exudates, also from wind, rain and leaf to leaf contact. This allows to bacterium to even spread from field to field. Seeds are able to carry the bacterium as well (Compendium of Rice Diseases, 1992).

Disease development is favored by rain, high humidity, and high temperatures (28-30°C, 82-86°F) (Compendium of Rice Diseases, 1992).

Symptoms/Signs

Bacterial leaf streak can occur at any growth stage and initially appears as small, interveinal, water-soaked streaks. The streaks are at first dark green and later become translucent. The streaks enlarge and coalesce and eventually become light brown. Numerous tiny yellow beads of bacterial exudates are common on the surface of lesions. Eventually, entire leaves turn brown and then grayish white and die. The latter stage of the disease can mimic bacterial blight (Figure 1) (Compendium of Rice Diseases, 1992).

Pest Importance

Bacterial leaf streak was thought to be first spotted in Philippines in 1918 but the bacterium was not identified. It was not until 1957 in China that the bacterium causing bacterial leaf streak was properly named (Ou, 1985). Bacterial leaf streak is widely distributed in tropical Asia and in West Africa in both lowland and upland rice-growing areas. Recently, the disease has been reported in epidemic proportions in southern China (Compendium of Rice Diseases, 1992). Yield losses have been estimated from 5%-30% (Soto-Suárez et al., 2010).

Known Hosts

Major Hosts: *Oryza sativa* (rice).

Minor Host: *Oryza Perennis, Oryza glaberrima* (African rice)

Additional Host Listed by CABI 2011:
Leptochloa filiformis (mucronate sprangeltop), Cited as Paspalum orbiculare but known as *Paspalum scrobiculatum* (kodomillet), Zizania aquatica (annual wildrice), Zizania palustris (northern wildrice), Zoysia japonica (Korean lawngrass)
Minor: *Poaceae* (grasses).

Host from artificial Inoculations:
Alopecurus aequalis (shortawn foxtail)
Cited as Commelina nudiflora known as *Murdannia nudiflora* (nakedstem dewflower)
Echinochloa Crus-galli (barnyardgrass)
Oryza barthii (barth's rice)
Oryza latifolia (broadleaf rice)
Oryza malampuzhaensis

Oryza officinalis
Cited as Zizania *caduciflora* known as Zizania *caduciflora* (Manchurian wildrice)

Note: The level of susceptibility and symptom expression varies significantly among host tested by artificial inoculation and minor host.

(Reddy and Nayak, 1975; Chang et al., 1977; Bradbury et al., 1984; Zhong et al., 1988).

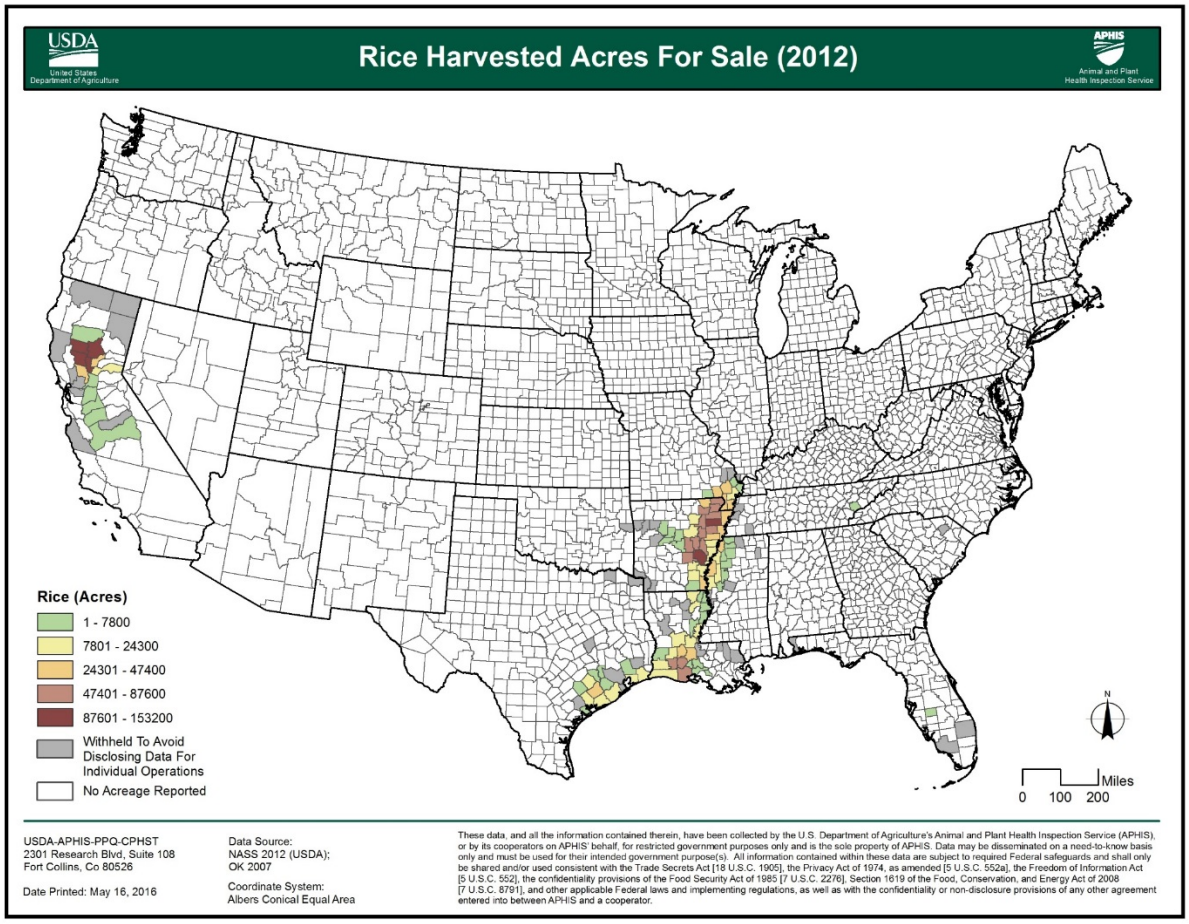

Figure 2: Rice commodity acreage map. Map courtesy of USDA-APHIS-PPQ-CPHST.

Pathogen or Associated Organisms Vectored

Bacteria may also be disseminated in irrigation water, as well as by humans, insects and birds (Niño-Liu *et al.,* 2006).

BLS is worse when excessive amounts of N are applied to the crop (IRRI, 2010 and 2004).

Known Distribution

Bacterial leaf streak is widely distributed in tropical Asia and in West Africa in both lowland upland rice-growing areas (Compendium of Rice Diseases, 1992). In 2014, it was found in Uganda and Burundi (Afolabi et al., 2014ab).

Tropical and subtropical Asia, including southern China, Thailand, Malaysia, India, Vietnam, the Philippines and Indonesia, parts of West Africa, northern Australia. In the United States,

although an apparent mild outbreak of BB was reported in the late 1980s, it was later determined that the bacterium associated with the disease was not Xoo (Niño-Liu *et al*., 2006).

Pathway

Outbreaks of both bacterial leaf streak (BLS) are more likely to occur during the monsoon season of the south-east Asian and Indian oceans (from June to September) than at other times of the year (Niño-Liu *et al*., 2006; Mew *et al*., 1993).

Wind and rain disseminate bacteria from infected rice plants and other hosts, as well as contaminated rice stubble from previous crop seasons – the most important source of primary inoculums. Severe epidemics often occur following typhoons, the fierce winds, wind-blown rain and hail of which both wound rice plants and disperse bacteria.
Along with irrigation water and leave to leave contact (Niño-Liu *et al*., 2006).

Potential Distribution within the United States

Surveys should be focused where the greatest risk for pest establishment occurs.

Figure 2 shows a recently developed risk map by USDA-APHIS-PPQ-CPHST, indicating low to moderate risk for establishment of *X. oryzae* pv*. oryzicola* in parts of California, Texas, Louisiana, Arkansas, Missouri, Mississippi, Alabama, Georgia, South Carolina, Florida, Tennessee, and North Carolina. The highest risk for establishment with a medium risk is in parts of Texas, Louisiana, and Arkansas.

Survey

CAPS-Approved Method:

Visual: Collect symptomatic leaf samples.

For a preliminary indications of seed infection, look for bacterial streaming (Singh and Rao, 1977).

Signs:

Amber colored bacterial exudates on surface of lesions with bacterial leaf streak.

Symptoms:

Bacterial leaf streak (*X. oryzae* pv. *oryzicola*) is seen as narrow, dark-greenish, water-soaked, interveinal streaks of various lengths on the leaf blades. The lesions enlarge and turn yellow orange to brown and coalesce. The lesions then turn grayish white and die.

There are no symptoms on seeds with bacterial leaf streak

Literature-Based Methods:

Same as CAPS-Approved method (see above).

Key Diagnostic/Identification

CAPS-Approved Method:

Morphological:

Colony morphology: The pathogen is difficult to isolate directly from seed due to slow growth of bacterium and overgrowth by other organisms.

Yuan, 1990 developed a semi-selective medium, called XOS, to isolate both pathovars from rice seed.

Gnanamanickam *et al.*, 1994 tested three strains for growth on TZC, WF-P, YCM, YAT, MXO, and XOS semi-selective media. Results varied for each isolate used, but worked best when using monoclonal antibodies to confirm the genus and pathovar.

Serological: Monoclonal antibodies: Genus and pathovar specific antibodies can be used in an ELISA reaction (Alvarez *et al.*, 1985; Benedict *et al.*, 1989).

Literature-Based Methods:

Inoculations: Niño-Liu *et al.,* 2005 dipped plants in bacterial mixture and then incubated in a growth chamber. Symptoms developed over in 4 days.

Xie and Mew, 1998 used inoculums that came from seed and leaves sediments that had the bacterium with a wash step. The leaves were then placed on water agar and pricked with a needle that was dipped in the tissue sediments.

Molecular:

PCR/BIO-PCR: Vera Cruz *et al.*, 1995, 1996 compared Rep-PCR using repetitive DNA sequences with RFLPS.

Leach *et al.*, 1990 used a repetitive DNA sequence (pJEL 101) to distinguish *X. oryzae* pv. *oryzae* from other pathovars and species of *Xanthomonas*.

Kang *et al.*, 2008 developed a specific PCR detection system (targets a membrane fusion protein gene) for *X. oryzae* pv. *oryzicola*.

Real-time PCR: Zhao *et al.*, 2007 developed a real-time PCR to detect *X. oryzae* pv. *oryzae* and can distinguish it from *X. oryzae* pv. *oryzicola*.

Liao *et al.*, 2003 developed a real-time PCR that can distinguish the two pathovars.

Computational Genomics/Multiplex PCR: Lang *et al.*, 2010 used a computational genomics pipeline to compare sequenced genomes of *Xanthomonas* species to identify regions for development of highly specific diagnostic markers. A suite of primers were selected to monitor diverse loci and to distinguish the rice bacterial blight and leaf streak pathogens. A subset of primers were combined into a multiplex PCR to accurately distinguish the two rice pathogens in a geographically diverse collection from other xanthomonas and other plant pathogenic and plant-or seed associated bacteria.

Easily Confused Species

In the early stage of disease, the symptoms are similar to narrow brown leaf spot.

At the later stage, when the streaks have coalesced, symptoms of bacterial blight and bacterial leaf streak are similar. The shape of the edges of the lesions differs; straight in leaf streak and wavy in leaf blight.

X. oryzae pv. *oryzicola* may be distinguished from *X. oryzae* pv. *oryzae* by colony morphology in typical isolates, strong starch and gelatin hydrolysis, and by biochemical and molecular methods.

Glossary

Parenchyma (adjective: parenchymatous): The primary tissue of higher plants, composed of thin-walled cells and forming the greater part of leaves, roots, the pulp of fruit, and the pith of stems (Reproduced from D'Arcy, C. J., D. M. Eastburn, and G. L. Schumann. 2001. Illustrated Glossary of Plant Pathology. The Plant Health Instructor. DOI: 10.1094/PHI-I-2001-0219-01)

Stomate (also known as: stoma plural: Stomata): A small opening on the surface of a leaf through which gaseous exchange takes place (Harrington, 1957)

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Draft History

2011: Initial draft competed.

November, 2014: Added Uganda and Burundi to distribution list.

2016: Reviewed literature for new information, added new host map.