Red stripe (top rot)

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Cause

Acidovorax avenae subsp. *avenae* (Manns 1909) Willems *et al.* 1992, bacterium.

Geographical distribution

Argentina, Australia, Bangladesh, Barbados, Bolivia, Brazil, Cambodia, Cameroon, China, Colombia, Costa Rica, Côte d'Ivoire, Cuba, Democratic Republic of the Congo, Dominican Republic, El Salvador, Ethiopia, Fiji, Guadeloupe, Guam, Guatemala, Guyana, Hawaii, Honduras, India, Indonesia, Iran, Iraq, Jamaica, Japan, Kenya, Madagascar, Malaysia, Martinique, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Peru, Philippines, Puerto Rico, Réunion, South Africa, Sri Lanka, Surinam, Taiwan, Tanzania, Trinidad, Uganda, Uruguay, USA, Venezuela, Vietnam.

Symptoms

The disease is characterized by two forms: leaf stripe and top rot. These can occur individually or simultaneously (Martin and Wismer, 1961 and 1989).

Leaf stripes are often more prevalent in young, 4–6-months-old cane in both plant and ratoon crops. They first appear usually midway up young leaves and near the midrib, but may in some instances be concentrated toward the leaf base. They begin as water-soaked, green stripes that subsequently elongate up and down the leaf, turn reddish in colour, and finally become maroon or dark red. They are 0.5 to 4 mm wide, and from several centimetres long to the entire length of the leaf blade (Figures 1 and 2). Adjacent veins clearly delineate their borders. The stripe may extend in certain varieties into the sheath. Dried bacterial exudates may form small whitish flakes on the surface of the stripe.

Top rot can arise from leaf infections or directly from stem and bud infection. The pathogen may attack the unrolled leaves of the leaf spindle causing rotting of the leaf spindle (Figure 3). Spindle leaf infection may progress into the apical meristem resulting in top rot. Stem and bud infections may give rise to top rot without leaf symptoms being exhibited.

Plants affected by top rot may exhibit chlorosis and wilting of the older leaves, as well as red stripe symptoms (Figure 4). Affected internodes may exhibit sunken lesions which are at first water-soaked in appearance and later brown to red in colour. Reddish-brown disoloration may also develop within internodes and as the rotting progresses, large cavities may form. Upper internodes are usually affected. In the advanced stages, young spindle leaves die and are easily pulled out of the top of the stalk. The rotted spindle has a characteristic unpleasant odour which is often discernable from the edge of the field. Side shoots sometimes develop and their leaves may show red leaf stripes. Stalks affected by top rot usually die (Figure 5).

Unusual symptoms caused by *A. avenae* subsp. *avenae* have been described in specific cultivars. In Central America and Mexico, cultivar B4362 showed red stalk markings in the region of the root primordia, and shrunken watery nodes with several longitudinal cracks along the affected internodes (FORS, 1978 and 1980, cited by MARTIN and WISMER, 1989). In Australia, cultivar Trojan was affected by a rot that originated some distance from the growing point that subsequently extended in both directions (CROFT *et al.*, 1979). In Louisiana, a form of top rot in which the rot extended right through the stalk was reported (EDGERTON, 1955, cited by MARTIN and WISMER, 1989).

Diagnosis

The pathogen can be easily isolated from young lesions and the bacteria grown on various culture media, such as modified Wilbrink's medium used to isolate *Xanthomonas albilineans*, causal agent of sugarcane leaf scald. *Acidovorax avenae* subsp. *avenae* is a Gram-negative bacterium, rod shaped (0.7 × 1.6 µm), and motile with a single polar flagellum. Colonies on YDC medium are white-cream with tan to brown centres, convex, smooth, 2–3 mm diameter after 3 days at 30°C. Old colonies are firm and adhere to the agar. Optimum temperature for growth is 36°C (SADDLER, 1994). The absence of production of fluorescent pigments on King's medium B (KB) as well as the accumulation of poly-ß-hydroxybutyrate (PHB) granules intracellularly when grown on high carbon/low nitrogen media are important features of the species. Detailed descriptions of the morphological, cultural and physiological characteristics of the pathogen have been published by several authors (MARTIN and WISMER, 1989; SADDLER, 1994; WILLEMS *et al.*, 1992). The pathogen can also be identified by PCR using specific primers (SONG *et al.*, 1997).

Strains of the pathogen

No significant variation of pathogenicity between isolates of *A. avenae* subsp. *avenae* has been found so far (RAMUNDO and CLAFLIN, 1990). However, symptom expression of sugarcane cultivars can vary with the isolate of the pathogen (ALMEIDA *et al.*, 1988).

Transmission

Inoculum arises mostly from bacterial exudates on the surface of leaf lesions developing during periods of moist warm weather. The bacteria are readily transmitted from plant to plant in wind-blown rain. Leaf infection is favoured by injuries caused by the marginal spines of one leaf scraping another; however, leaves may also become infected through stomatal cavities on both their upper and lower surfaces. All parts of the plant can be infected through injury, especially the youngest stalk internodes and leaves.

The pathogen is rarely transmitted by mechanical equipment, cane knifes, work animals or cuttings.

Host range

The bacteria can naturally infect different cultivated gramineaceous plants such as maize, sorghum and millet. However, these hosts play an insignificant role in the epidemiology of the disease in sugarcane. The pathogen was also isolated in Mauritius from several grasses such as *Paspalum nutans*. Strains of *A. avenae* subsp. *avenae* appeared to be more virulent to sweet corn than to maize or sugarcane, and only weakly virulent or avirulent to oats (HU *et al.*, 1997).

Epidemiology

High relative humidity due to high rainfall and high temperature are generally considered ideal for red stripe development. In Queensland, variations of the top-rot stage of the disease are often related to variations in the water-holding capacity of the soil; the lower the capacity, the greater the amount of disease (EGAN and HUGHES, 1958, cited by MARTIN and WISMER, 1989). An abnormal dry spring and early summer before the wet season also favours disease development in Queensland (MARTIN and WISMER, 1989).

Economic importance

The disease can cause significant economic losses when susceptible cultivars are affected. The top-rot form of the disease is the most economically damaging. However, clones that are highly susceptible to the disease are normally eliminated during the varietal selection process.

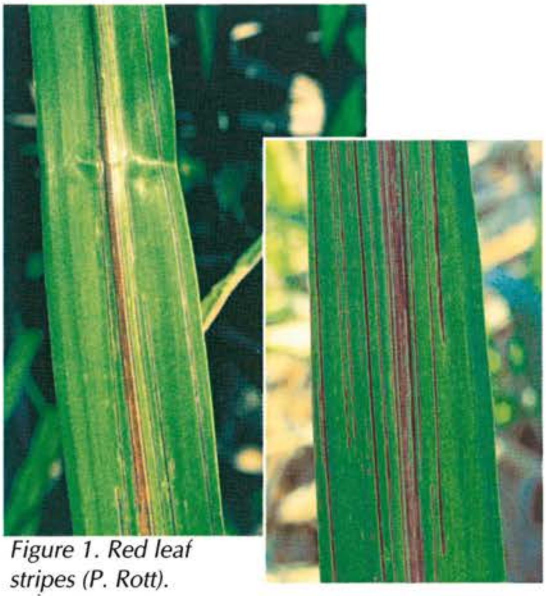

Figure 1. Red leaf stripes (P. Rott).

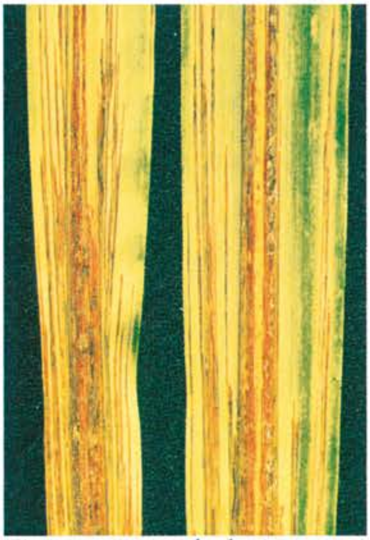

Figure 2. Maroon leaf stripes (ISSCT).

Figure 3. Top rotting of the leaf spindle (ISSCT).

Figure 4. Stool affected by red stripe (ISSCT).

Figure 5. Sugarcane row affected by the top rot form of the disease (ISSCT).

Control

Use of resistant varieties is the most effective means of control and, therefore, susceptible cultivars should be eliminated in breeding programmes. Top rot can be reduced considerably by altering the planting date of moderately resistant cultivars to avoid periods when infection of young plants is more likely.

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