Streak

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Cause

At least three species of viruses of the genus *Mastrevirus*, family *Geminiviridae*, cause streak symptoms in sugarcane: *Sugarcane streak virus* (SSV), *Sugarcane streak Mauritius virus* (SSMV) and *Sugarcane streak Egypt virus* (SSEV) (Bigarré *et al.*, 1999).

Geographical distribution

Benin, Cape Verde, Côte d'Ivoire, Egypt, India, Kenya, Madeira, Malawi, Mauritius, Mozambique, Pakistan, Réunion, South Africa, Sudan, Uganda, Zimbabwe.

Symptoms

Infected leaves are covered with numerous small spots or streaks which are translucent, narrow and parallel to the veins (Figure 1). After infection, the streaks are irregularly distributed and observed mostly on the lower part of the leaf blade. These symptoms, however, tend to be uniformly distributed on all leaves once the virus is established in the plant (Storey and Thomson, 1961). The streaks are from 0.5 to 2 mm in width and vary in length from 0.5 mm to more than 2 cm. The streaks observed on young leaves that develop from an infected cutting can be relatively wide, they coalesce and sometimes form a pattern of mosaic (Storey and Thomson, 1961).

Diagnosis

Symptoms and transmission tests in maize or susceptible sugarcane varieties are useful to diagnose a potential mastrevirus infection in sugarcane. Symptoms are best observed on younger leaves as the streaks tend to become more diffuse and less marked as the leaf ages (Bock and Bailey, 1989). However, these techniques cannot be used to distinguish the different virus species causing streak disease.

Serological techniques using monoclonal antibodies prepared against *Maize streak virus* (MSV) isolates can be used to detect the pathogen (DEKKER *et al.*, 1988; PETERSCHMITT *et al.*, 1991). However, none of these antibodies allows the detection of all three species causing streak because the similarity of their coat protein peptide sequences is relatively low, ranging from 73 to 85% (BIGARRÉ *et al.*, 1999). An antiserum against a sugarcane streak isolate is available in South Africa (SASEX) but its efficiency against all three species causing streak in sugarcane has yet to be proven.

PCR tests could be developed for very sensitive and accurate diagnosis since an increasing number of sequences of streak causing mastreviruses are now available (BIGARRÉ *et al.*, 1999).

Nuclear viral aggregates, typically observed for viruses of the family *Geminiviridae*, were detected for sugarcane streak isolates from Egypt and Uganda in sugarcane plants by *in situ* observations using transmission electron microscopy (TEM) (AMMAR, 1994; BOCK and BAILEY, 1989). A simple light microscopy technique developed for the detection of such aggregates in dicotyledonous plants infected by geminiviruses may also be used for sugarcane showing streak symptoms (CHRISTIE *et al.*, 1986). However, in the case of sugarcane streak isolates from Mauritius and South Africa, these *in situ* microscopy techniques may not work because virions were found to be randomly dispersed within the nucleus (PINNER *et al.*, 1993). Alternatively, typical twinned quasi isometric geminivirus particles, approximately 20 × 30 nm in size, can be observed by TEM using purified virus extracts (BOCK and BAILEY, 1989).

Strains of the pathogen

Sugarcane streak disease is caused by at least three virus species, *Sugarcane streak virus* (SSV) isolated in South Africa, *Sugarcane streak Mauritius virus* (SSMV) isolated in Mauritius, Réunion and Nigeria, and *Sugarcane streak Egypt virus* (SSEV) isolated in Egypt (BIGARRÉ *et al.*, 1999). In about 10 years, understanding causal agents of sugarcane streak disease has evolved from several strains of *Maize streak virus* (MSV) to several distinct *Mastrevirus* species. This evolution can easily be explained by the improvement of identification and characterization techniques. Based on biological, physical and immunological techniques, the viruses were considered to be different strains or serotypes of MSV because the viruses causing streak in sugarcane and maize had the same morphology (twinned quasi-isometric particles), were transmitted by the same vectors (species of the genus *Cicadulina*), and were immunologically related (BOCK and BAILEY, 1989; DEKKER *et al.*, 1988; PETERSCHMITT *et al.*, 1991). Using molecular techniques (hybridization, RFLP and sequencing) it was proposed that the streak virus isolates of sugarcane from Mauritius and South Africa be considered as distinct mastreviruses (HUGHES, 1994; HUGHES *et al.*, 1993).

Figure 1. Sugarcane leaves with small spots and narrow streaks (P. Baudin, P. Rott, B. Vercambre).

This new classification was further confirmed by the complete sequences of five more clones showing that sugarcane streak disease is caused by at least three distinct virus species (BIGARRÉ *et al.*, 1999). Nucleotide similarities within the complete sequences of four SSEV clones and between partial sequences of a SSMV clone from Mauritius and one from Réunion are higher than 97% suggesting that intraspecies variability is low (BIGARRÉ *et al.*, 1999). A slightly higher variability was obtained with a SSMV strain isolated from millet in Nigeria since it showed only 92% nucleotide identity in the CP gene when compared to the Réunion and Mauritius SSMV isolates which are 99% similar for this gene. The suggested low intraspecies variability is supported by the fact that SSV isolates generally do not lose their ability to be vector-transmitted, although this function is not required for their survival due to the vegetative propagation of their host. This is, however, consistent with the fact that the coat protein of mastreviruses is not only responsible for insect transmission, but also for movement in the host plant (PALMER and RYBICKI, 1998).

Golden Bantam maize plants infected by SSMV isolates showed milder symptoms than plants infected by SSV and SSEV isolates (BIGARRÉ *et al.*, 1999; PINNER *et al.*, 1988).

Transmission

The sugarcane streak mastreviruses cannot be transmitted mechanically from plant to plant or through seed (BOCK and BAILEY, 1989). They are transmitted through cuttings taken from infected plants and by leafhopper species of the genus *Cicadulina*, particularly by *C. mbila* and *C. bipunctella*.

Host range

The sugarcane streak mastreviruses can be transmitted to maize by *Cicadulina mbila*, and infection results in a pattern of fine streaks resembling those caused by the pathogen in sugarcane (PINNER *et al.*, 1988). The symptoms are, however, milder than those caused by MSV isolates. *Saccharum officinarum* and *S. sinense* are susceptible to streak, whereas *S. barberi* and *S. spontaneum* are relatively resistant. In Mauritius, *Cenchrus echinatus* and *Coix lacryma-jobi* were described as hosts of streak virus isolates (presumably SSMV isolates). In Réunion, however, *Coix lacryma-jobi* did not show streak symptoms after insect transmission of the virus, whereas *Cenchrus echinatus* did (PETERSCHMITT *et al.*, 1991).

Epidemiology

Natural infection occurring in *Cenchrus echinatus* is believed to constitute a natural reservoir of streak mastreviruses in Mauritius (BOCK and BAILEY, 1989).

Economic importance

Streak had a considerable impact on sugarcane production in South Africa in the 1920s and 1930s when the Natal sugar industry relied almost entirely on the susceptible variety Uba (BOCK and BAILEY, 1989; STOREY and THOMSON, 1961). The disease was shown to cause yield losses between 8 and 11% for several crops in experimental fields established with diseased planting material. Streak declined between 1935 and 1945 with the replacement of the Uba variety by resistant varieties. Similarly, the decline of the disease in Egypt coincided with the extensive cultivation of variety C9 (BIGARRÉ *et al.*, 1999). Varieties grown in the countries where the disease is reported to occur have some resistance, and streak is presently considered of little importance.

Control

Use of resistant varieties is the most effective means of control and, therefore, susceptible cultivars should be eliminated. Resistance of sugarcane to streak can be screened in breeding programmes by planting varieties between rows of diseased plants. When necessary (quarantine etc.), virus-free plants can be obtained from infected sugarcane by tissue culture (PEROS *et al.*, 1990).

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