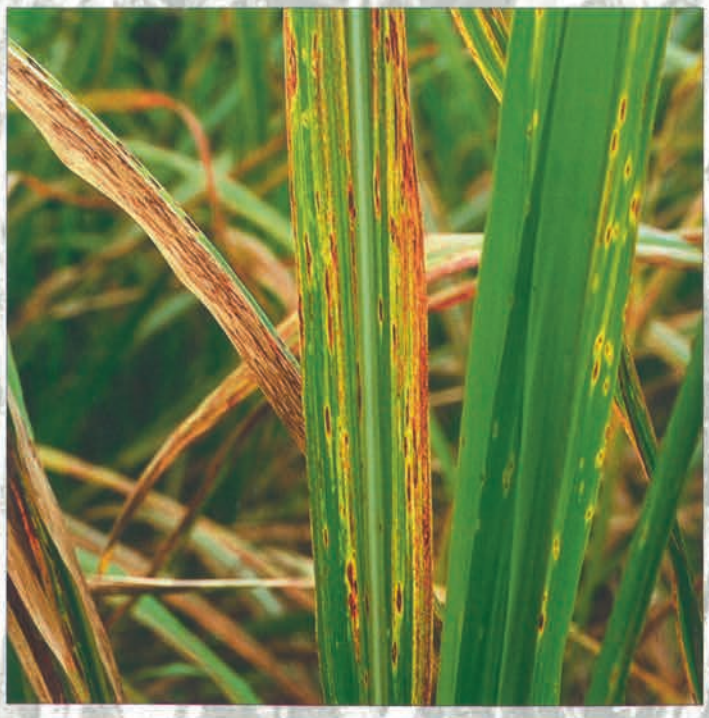
REPÈRES

A guide to sugarcane diseases

Philippe Rott, Roger A. Bailey,
Jack C. Comstock, Barry J. Croft,
A. Salem Saumtally
Editors



CIRAD ISSCT

THE EDITORS

The editors are all sugarcane pathologists and members of the ISSCT (International Society of Sugar Cane Technologists) pathology section committee: P. Rott at CIRAD (Centre de coopération internationale en recherche agronomique pour le développement, Montpellier, France), R.A. Bailey at SASEX (South African Sugar Association Experiment Station, Mount Edgecombe, South Africa), J.C. Comstock at USDA-ARS (United States Department of Agriculture, Agricultural Research Service, Canal Point, USA), B.J. Croft at BSES (Bureau of Sugar Experiment Stations, Woodford, Australia) and A.S. Saumtally at MSIRI (Mauritius Sugar Industry Research Institute, Réduit, Mauritius).

CIRAD

The Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) is a French centre for international co-operation in development-oriented agricultural research, with emphasis on tropical and subtropical zones. It carries out research, agricultural development, and training operations in about 50 countries.

ISSCT

The International Society of Sugar Cane Technologists (ISSCT) is an association of scientists, technologists, institutions and companies/corporations concerned with the technical advancement of the cane sugar industry and its co-products. Over the years, ISSCT has played a prominent role in promoting technical publications for the industry and, since 1961, has published three volumes on sugarcane diseases.

Cover photo
Eye spot disease, caused by Bipolaris sacchari, *Mexico (P. Rott)*

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Contents

67 Diseases caused by fungi

Preface

Since its IXth Congress in 1956, the International Society of Sugar Cane Technologists (ISSCT) has encouraged its Pathology Section to publish books on sugarcane diseases by specialists in this field. Two volumes were published through the Elsevier Publishing Company, Amsterdam, The Netherlands in 1961 and 1964, the first volume dealing with the most important and documented diseases and the second with diseases either of lesser importance or less common.

At the XVIth Congress of the ISSCT in 1977, it was felt that new editions of these volumes were needed. However, following investigations, it was decided to publish a new book dealing with major diseases of sugarcane in place of the previous volume 1. The volume which was subsequently published in 1989, included most of the diseases treated in the first volume 1, together with certain diseases which had been published previously in volume 2, but were now included because of their increased importance.

In 1992, ISSCT decided to proceed with a new edition of the previous volume 2, but at the XXIInd Congress in 1995, it was concluded that the publication of a practical field guide for all sugarcane diseases would be more useful.

The Pathology Section Committee entrusted the work to an editorial team comprising P. Rott, Chairman (CIRAD, France), R.A. Bailey (SASEX, South Africa), J.C. Comstock (USDA-ARS, USA), B.J. Croft (BSES, Australia) and A.S. Saumtally (MSIRI, Mauritius), all members of the committee.

CIRAD (the French Centre for International Co-operation in Development-oriented Agricultural Research) offered to publish the book within its series REPERES and to provide the financial investment needed. It was also decided to follow the same format adopted by CIRAD for its D-CAS software used as an interactive PC aid for the diagnosis of sugarcane diseases, and to produce at the same time as the hard copy of the book, a CD-ROM of an up-dated version of the software, both products being under the auspices of ISSCT and CIRAD.

I have no doubt that this volume and the CD-ROM will prove extremely useful to all those who have to deal with the management and control of sugarcane diseases world-wide. A good deal of the information included is derived from the previous three volumes, updated with new information where applicable, and with recent results on improved molecular diagnostic techniques.

On behalf of the ISSCT, I should like to express our thanks to CIRAD for its support and collaboration, to the editors and contributors of the various chapters for their efforts, and to all the organizations with which they are associated, for enabling them to undertake this work.

Claude Ricaud
Permanent Secretary
International Society of Sugar Cane Technologists
September 1999

Résumé

De nombreux changements ont eu lieu en pathologie de la canne à sucre au cours des dix dernières années. De nouvelles connaissances sont apparues sur des maladies connues, de nouvelles maladies ont été décrites et identifiées et, grâce aux progrès de la biologie moléculaire, de nouvelles techniques de diagnostic ont été mises au point. C'est pourquoi la section pathologie de la Société internationale des technologues de la canne à sucre (ISSCT) a décidé de publier un nouveau livre sur les maladies de la canne à sucre. Son objectif est de fournir une information actualisée relative aux connaissances scientifiques et aux aspects pratiques de la lutte, sans pour autant décrire de façon exhaustive les maladies. Chaque maladie fait l'objet d'un chapitre illustré de nombreuses photographies en couleurs, dans lequel sont rassemblées des données sur son agent causal, sa distribution géographique, ses symptômes, sa transmission, son spectre d'hôtes, son épidémiologie et son importance économique. Des informations concernant les souches de l'agent pathogène, le diagnostic et la lutte ainsi qu'une bibliographie complètent chacun de ces chapitres.

Sugarcane morphology, anatomy and physiology

G. Claude Soopramanien

Sugarcane is a member of the family Gramineae and it belongs to the genus *Saccharum* (S.) (Tribe: Andropogoneae). The six known species are perennial grasses which originated in the Old World. *Saccharum spontaneum* and *S. robustum* occur in the wild, while the four other species are considered as cultigens.

Saccharum spontaneum L. (2n = 40–128) has profuse tillering, aggressive rhizomes, stalks 0.3 to 8 m in height, hard and pithy internodes with little juice and sucrose. Breeders use it for vigour, hardiness and resistance to major diseases.

Saccharum robustum Brandes & Jeswiet ex Grassl (2n = 60–194) is indigenous to New Guinea and has erect or recumbent stalks which may reach 10 m in height. It is used to a limited extent in breeding programmes because of its susceptibility to leaf scald and *Sugarcane mosaic virus*.

Saccharum officinarum L. (2n = 80) is known as the 'Noble' cane due to its thick and sweet stems. It probably originated in New Guinea and is grown in the south-western Pacific for chewing. *Saccharum officinarum* reached Hawaii about AD 800 and was first used in India to make sugar. The species is adapted to tropical conditions and the stalks have a comparatively high sucrose and low fibre content. The noble canes are often susceptible to major diseases.

Saccharum barberi Jeswiet (2n = 82–142), *S. sinense* Roxb. (2n = 118) and *S. edule* Hassk. (2n = 74) also have a lower fibre and higher sucrose content than the two wild species. They are also susceptible to diseases.

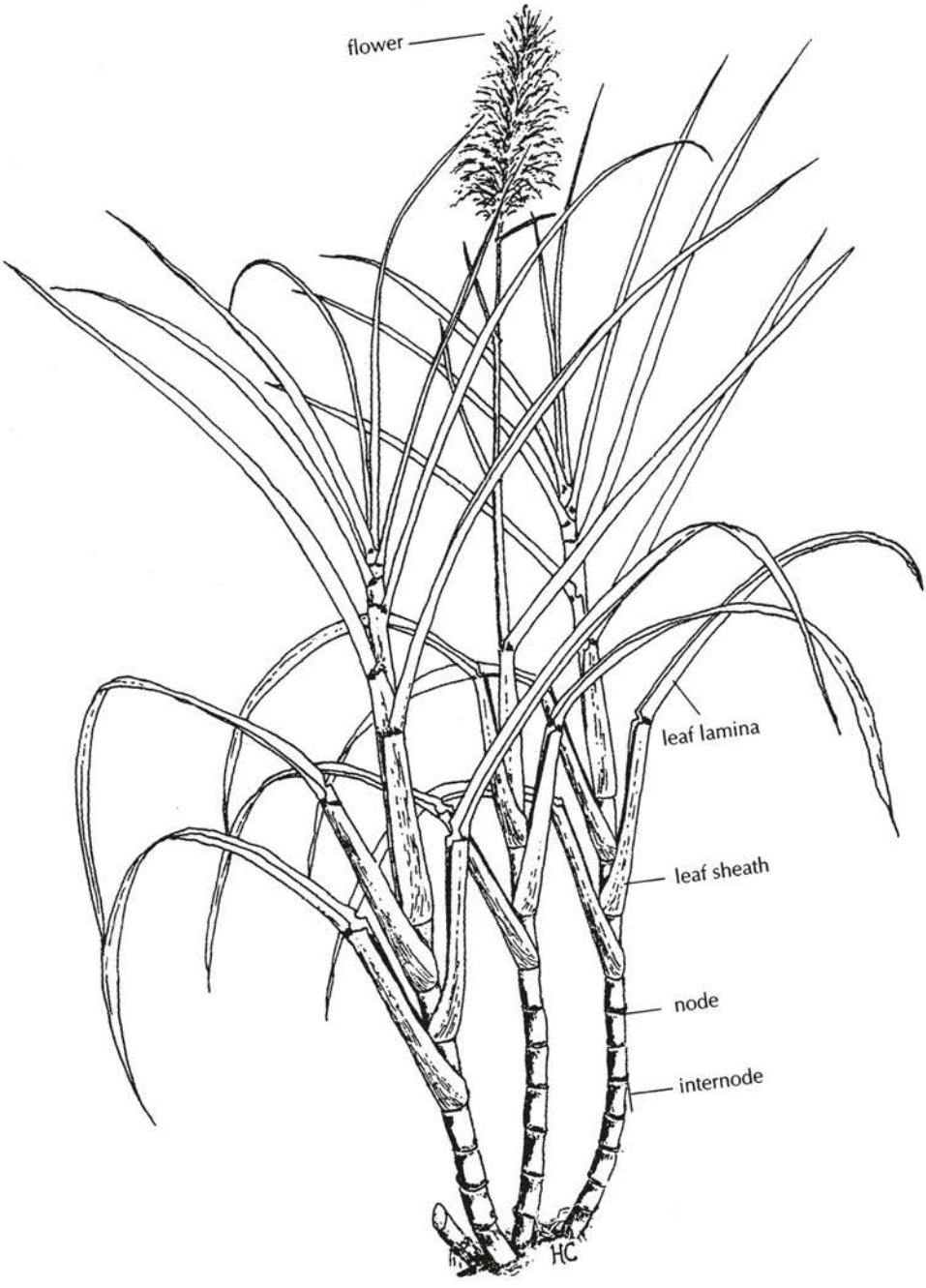

Figure 1. Sugarcane plant (H. Chaillet).

The sugarcane, as all tufted grasses, consists of a clump of stems (Figure 1), also referred to as shoots, stalks or tillers, with a fibrous root system. The stalk is made up of a number of phytomers (a phytomer is made up of one node, an internode and its subtending leaf lamina and leaf sheath) with the oldest ones at the base. A brief description of the morphology and anatomy of the sugarcane is given below together with an outline of the physiology of its growth and development. For more details the reader should refer to: ALEXANDER, 1973; BLACKBURN, 1984; FAUCONNIER and BASSEREAU, 1970; HUMBERT, 1963; JULIEN *et al.*, 1989; LYON, 1920; MARTIN, 1961; and VAN DILLEWIJN, 1952.

Morphology and anatomy

The root system

When a piece of cane stalk, referred to as a cutting or stem cutting or cane sett, is planted under favourable conditions, roots (known as sett roots) develop from primordia in the region of the root band (Figure 2). These roots are thin and branched and their main function is to provide water and nutrients to the young shoot developing from the lateral bud. The life span of these roots is relatively short (2 to 3 months) and their function is subsequently taken over by shoot-roots. The shoot-roots develop from primordia within the root bands on the lower portion of the developing shoots. They are thick and whitish with few branches at first. In an established clump (stool) three types of roots may be

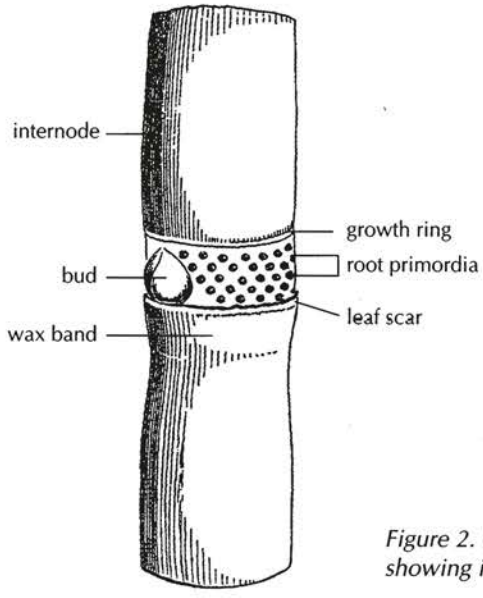

Figure 2. Portion of a sugarcane stalk showing its different parts (J. Guého).

distinguished, their relative lengths or abundance being dependent upon genotype and soil conditions. The three types are known as: superficial roots, buttress roots and the 'rope system'. The superficial roots are thin and branched with numerous root hairs. They occupy the upper layers of the soil and provide water and nutrients for the stalk. The buttress roots are slightly thicker and are deeper in the soil. Their main function is to anchor the plant although they may also absorb water. The 'rope system', which is made up of two or more intertwined roots, grows more or less vertically down the soil profile, sometimes up to 2 or 3 m. These roots may provide the plant with water under dry conditions.

The root of the sugarcane plant is similar to those of other monocotyledons, i.e. with a root cap or calyptra, a growing point and an elongation zone with unicellular root hairs.

In cross-section (Figure 3), the sugarcane root is seen to be made up of three rings of tissue with a central core. The outer ring is made up of an epidermal layer adjacent to the exodermis and the schlerenchyma (thickened cells). The larger ring (the cortex) is made of thin parenchyma cells. The third ring is the endodermis which encloses the vascular tissues, i.e. the xylem and the phloem.

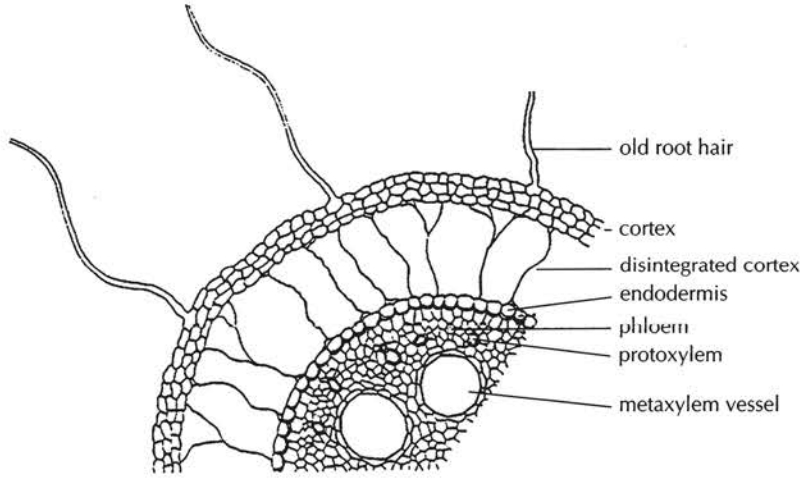

Figure 3. Transverse section through young sett root of sugarcane (J. Guého).

The stem

The stem is made up of a series of nodes and internodes with the youngest ones at the top of the stalk enclosed in the young developing leaves. As in most monocotyledons, the vegetative apical meristem gives rise to phytomers after differentiation.

The mature cane internode is cylindrical in shape, and its length, diameter and colour vary with genotype as well as environmental conditions. The internode may have corky cracks and/or corky patches which differ from the growth cracks that occur when the stalks split lengthwise under certain conditions, e.g. alternating wet and dry conditions.

Between the internode and the node, a light coloured ring called the growth ring may be observed. It resumes its activity, e.g. when the stalk is lodged. At the node there is a root band consisting of root primordia, a lateral bud and the leaf scar. The lateral bud varies in shape according to the genotype. The leaf scar marks the place where the leaf sheath was attached to the node.

The stem is made up of a large mass of storage tissue (mainly for sucrose) consisting of parenchyma cells within which are interspersed the vascular bundles (Figure 4). The outer layer of the stem is made up of an epidermal outermost ring and an adjacent layer called the cortex or rind. These cells may contain some pigment and are lignified.

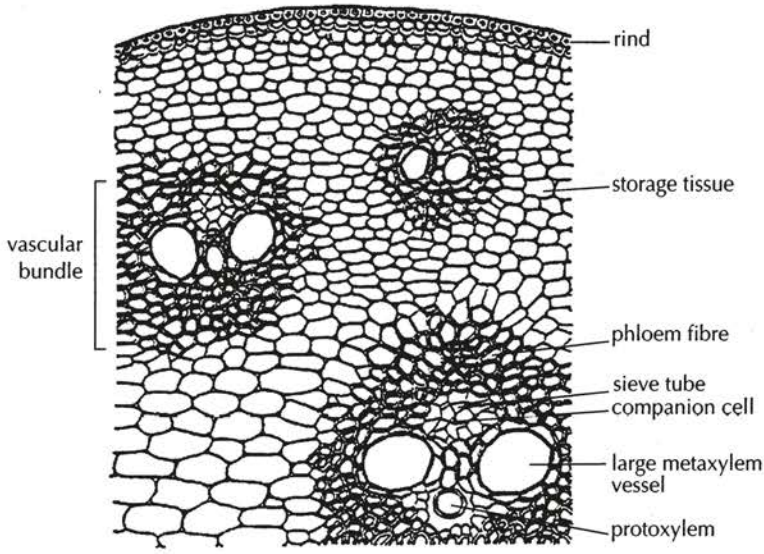

Figure 4. Cross-section of stem of sugarcane showing main features (J. Guého).

The leaf

The leaf of the sugarcane is made up of two parts, the leaf sheath and the leaf lamina. The leaf sheath is the lower portion of the leaf; it is tubular, wraps around the internode and its margins overlap at the base. The outer surface of the leaf sheath may bear variable numbers of hairs.

The leaf lamina is strap-shaped and tapers towards the leaf tip. The margins are sharp and may be coarsely toothed. The midrib is quite conspicuous and is usually white on the upper surface. The blade joint is the point where the leaf lamina meets the upper limit of the leaf sheath. The inner surface is known as the throat, whilst the outer region is known as the collar or leaf triangle (sometimes referred to as the dewlap). The colour of the leaf lamina varies from light to dark green.

The leaf of the sugarcane may be various shades of green but the sheaths, when still enclosed, are light green or whitish. A cross-section of the leaf blade (Figure 5) reveals an upper and a lower epidermis in between which are found small and large vascular bundles, fibre cells, parenchyma or mesophyll (similar to palisade) cells (Kranz type anatomy). The bundle sheath is a ring consisting of a layer of parenchyma cells containing chloroplasts. The mesophyll cells also contain chloroplasts and, together with the vascular bundle sheath cells, participate in photosynthesis.

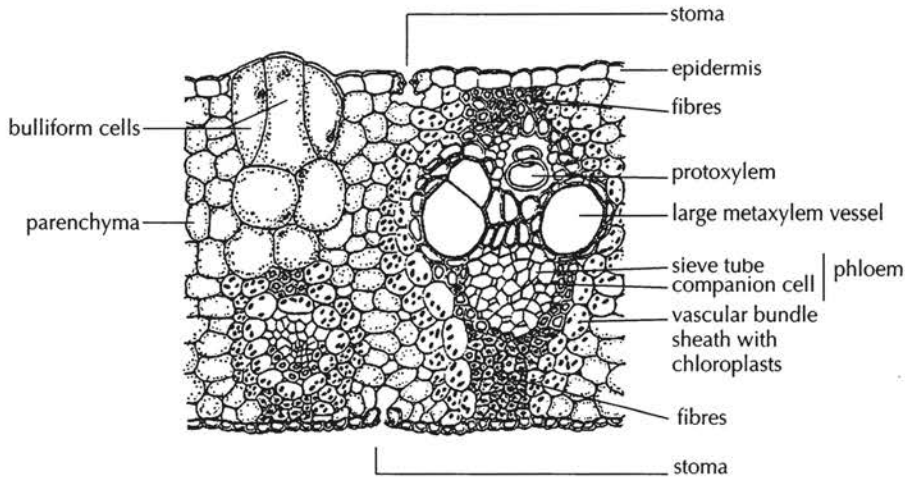

Figure 5. Vertical section through leaf blade of sugarcane showing two vascular bundles and associated tissues (J. Guého).

The flower

The sugarcane flower consists of a main axis which bears primary and secondary branches. On the latter are found pairs of spikelets. Each spikelet has a lemma, a palea, an inner and outer glume as well as a bifid stigma (purplish in colour), as well as three anthers. On the branches are also found numerous hairs which give a silvery appearance to a field with profusely flowering plants.