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MAIN BACTERIAL DISEASES IN SUGARCANE (*Saccharum* spp.): A REVIEW

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Abstract

Sugarcane (*Saccharum* spp.) is among the most economically important crops worldwide, used for sugar and energy. However, its asexual propagation system makes it highly vulnerable to bacterial diseases. The most impactful include Ratoon Stunting (*Leifsonia xyli* subsp. *xyli*), Leaf Scald (*Xanthomonas albilineans*) and Red Stripe (*Acidovorax avenae* subsp. *avenae*). These diseases limit productivity, with control strategies relying mainly on developing resistant cultivars. This review synthesizes current scientific understanding of the main bacterial diseases affecting sugarcane, drawing on publications from 1995 to 2025, highlighting their biological characteristics, epidemiology, and management practices. Information was gathered through a comprehensive bibliographic review using Scopus, ScienceDirect, SciELO, Google Scholar and WoS databases. Bacterial diseases threaten sugarcane due to vegetative propagation, limited diagnostics, and scarce resistant cultivars. Integrated, multidisciplinary strategies, including molecular tools, breeding, and improved diagnostics, are key to sustainable management under changing climate conditions.

Keywords: Disease control; Genetic resistance; Phytopathogenic bacteria; Plant-pathogen interactions; *Saccharum spp.*

PRINCIPAIS DOENÇAS BACTERIANAS NA CANA-DE-AÇÚCAR (*Saccharum spp.*): UMA REVISÃO

Resumo

A cana-de-açúcar (*Saccharum spp.*) está entre as culturas de maior importância econômica mundial, sendo utilizada para produção de açúcar e energia. No entanto, seu sistema de propagação assexuada a torna altamente vulnerável a doenças bacterianas. As mais impactantes incluem a escaldadura das soqueiras (*Leifsonia xyli* subsp. *xyli*), a escaldadura-das-folhas (*Xanthomonas albilineans*) e a estria vermelha (*Acidovorax avenae* subsp. *avenae*). Essas doenças

limitam a produtividade, sendo que as estratégias de controle são embasadas principalmente no desenvolvimento de variedades resistentes. Esta revisão sintetiza o conhecimento científico atual sobre as principais doenças bacterianas que afetam a cana-de-açúcar, com base em publicações de 1995 a 2025, destacando suas características biológicas, epidemiologia e práticas de controle. As informações foram obtidas por meio de uma abrangente revisão bibliográfica utilizando as bases de dados Scopus, ScienceDirect, SciELO, Google Scholar e WoS. As doenças bacterianas ameaçam a cana-de-açúcar devido ao método de propagação, às limitações no diagnóstico e à escassez de variedades resistentes. Estratégias integradas e multidisciplinares, incluindo ferramentas moleculares, melhoramento genético e aprimoramento dos diagnósticos, são fundamentais para um manejo sustentável diante das oscilações constantes de condições climáticas.

Palavras-chave: Controle de doenças; Resistência genética; Bactérias fitopatogênicas; Interações planta-patógeno; *Saccharum spp.*

1. Introduction

Sugarcane (*Saccharum spp.*) is one of the most economically important crops in the world agricultural scenario, standing out as the main raw material used for the production of sugar and energy (Carneiro *et al.*, 2022; Srithawong *et al.*, 2026). The prevalence and severity of illnesses that lower productivity stand out among the factors that restrict sugarcane production. Due to the asexual propagation system, the crop is extremely susceptible to bacterial diseases, since even infected stalks may not show symptoms (Borém; Miranda, 2017).

Diseases are the result of a pathogen-host-environment interaction, in which the climate has a significant impact on frequency of occurrence and how they manifest geographically. Therefore, it is crucial to conduct studies to ascertain the importance of each disease and the pursuit of prevention and control strategies for each area of incidence (Borém; Miranda, 2017).

In this context, the goal is to use resistant cultivars to control almost all agricultural diseases, which emphasizes the significance and difficulty of breeding programs in choosing sugarcane genotypes that are resistant or tolerant to the major crop diseases (Carvalho *et al.*, 2016).

Reduced pre-harvest burning, maintaining straw in raw cane areas, minimal cultivation, no-till planting, and other conservationist-driven practices all contribute to an increase in the frequency of phytosanitary issues in sugarcane growing regions. These practices tend to lessen the

degradation of the cultivation area but have an impact on plant health throughout the harvests (Dinardo-Miranda; Fracasso, 2013).

There are currently 216 diseases known to affect sugarcane, 58 of which have been discovered in Brazil, the world's leading producer of sugarcane, and at least ten of these are thought to be of significant economic importance for the crop. These illnesses are brought on by a variety of pathogens, including bacteria, viruses, nematodes, and fungi. *Leifsonia xyli* subsp. *xyli*, *Xanthomonas albilineans*, and *Acidovorax avenae* subsp. *avenae* are the agents of the three most important bacterial diseases of sugarcane: Ratoon stunting, Leaf scald and Red stripe, respectively (Tokeshi, 1997; Davis *et al.*, 1984).

Effective disease surveillance in sugarcane production relies heavily on accurate and timely detection of latent pathogens, such as *Leifsonia xyli* subsp. *xyli*. Visual inspection only is insufficient, as ratoon stunt does not produce distinctive external symptoms. Consequently, sensitive laboratory methods are required to detect infections in propagative materials, especially in regions dependent on vegetative propagation. Enhancing detection capacity at early stages is fundamental for reducing disease spread and ensuring the success of clean seed initiatives (Grisham; Hoy, 2019).

Bacterial diseases in sugarcane pose significant phytopathological and economic challenges to the global sugar-energy sector. Ratoon Stunting Disease (RSD), for example, can reduce yield by up to 30% under field conditions, severely affecting cane weight and juice quality. In Australia, annual losses due to RSD have been estimated at AUD 25 million (Magarey; Mchardie; Hession, 2021). In Brazil, surveys of over 13,000 ha and 1,154 fields in the Center-South region revealed that about 10% of commercial fields were infected, leading to annual economic losses exceeding USD 1 million (Urashima *et al.*, 2017).

In recent years, molecular diagnostic techniques have contributed to sugarcane disease management. Viswanathan and Rao (2011) highlighted the use of serological and molecular methods, including ELISA and PCR-based assays, for the detection of sugarcane pathogens. These diagnostic tools can contribute to early disease detection and support breeding and phytosanitary programs.

Although some of these diseases have been known for decades, there are still important knowledge gaps regarding their epidemiology, diagnosis, and effective control strategies. Therefore, reviewing and systematizing current scientific knowledge is essential for improving sugarcane breeding programs and disease management approaches.

This review aims to describe the main bacterial diseases affecting sugarcane worldwide, highlighting the biological features of their causal agents, their modes of transmission, associated symptoms, and existing control strategies.

2. Materials And Methods

This literature review was conducted by consulting four major scientific databases: Scopus, ScienceDirect, SciELO, Google Scholar and WoS. The bibliographic search was conducted using keywords related to the major bacterial diseases of sugarcane, such as "*Leifsonia xyli* subsp. *xyli*", "*Xanthomonas albilineans*", and "*Acidovorax avenae* subsp. *avenae*". The inclusion criteria encompassed peer-reviewed articles published in English and Portuguese, which presented original data or consolidated knowledge on pathogen characteristics, diagnostic methods, and control strategies. Data were analyzed to identify common features of the diseases, recommended control methods, and existing gaps in current research.

Sugarcane; Disease; *Saccharum* spp; Bacteria; *Leifsonia xyli* subsp. *xyli* (Lxx); *S. albilineans* (Ashby) Dowson; *Acidovorax avenae* subsp. *avenae*; Ratoon stunting; Leaf scald; Red stripe were among the keywords used in various combinations. Articles without clear methodological foundations or those not directly related to sugarcane were excluded. The collected data were analyzed to identify commonalities and differences in disease behavior, regional patterns of occurrence, and gaps in existing knowledge, particularly regarding integrated disease management and cultivar resistance.

Additionally, emphasis was placed on retrieving studies that provided regional comparisons, quantitative data, or field trial results to enhance the depth of analysis. Priority was also given to review articles and experimental research conducted in major sugarcane-producing countries, particularly Brazil, India, and Australia, due to their significant contributions to global sugarcane research. The search strategy aimed to ensure diversity in sources and approaches, allowing a broader understanding of bacterial disease dynamics under different climatic, genetic, and management conditions.

3. Results and Discussion

Across sugarcane production systems, the epidemiologically relevant window for bacterial diseases spans the vegetative phase, from tillering through the grand growth period, when potential yield loss is maximized. This pattern aligns with the ordinal evidence synthesis across phenological stages, indicating stronger and more consistent reports of susceptibility/symptom

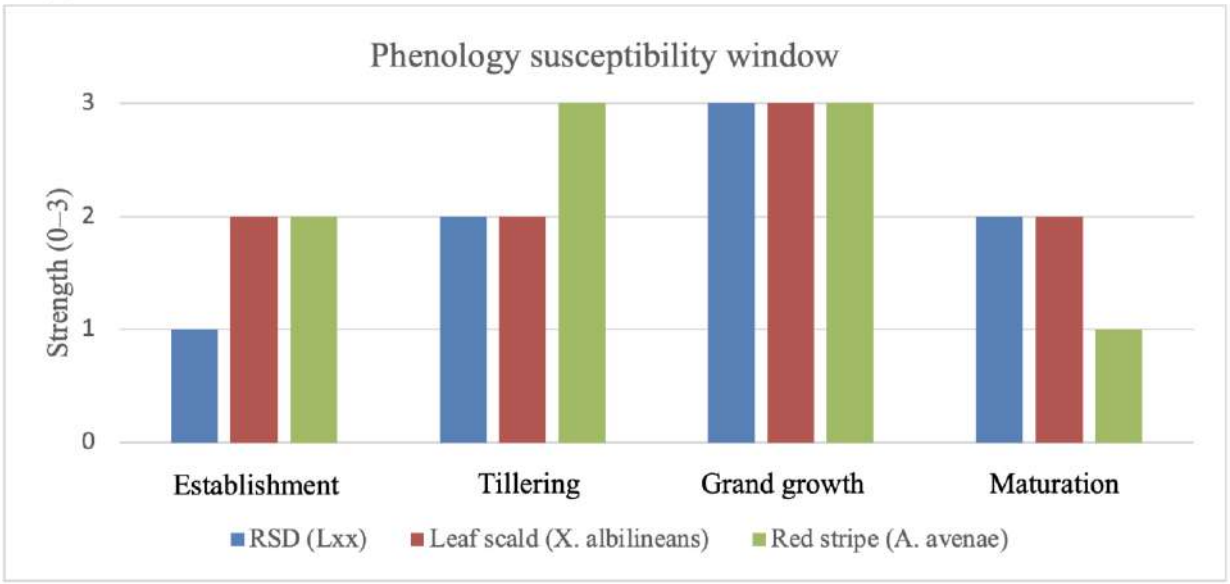
expression during grand growth for the major bacterial diseases considered (Figure 1). In terms of crop stage, infections occur in both plant cane and ratoons, but incidence and impact are consistently higher in ratoon crops (particularly from the second ratoon onwards), because seed-borne latent infections persist after harvest and mechanical transmission during cutting accumulates over successive cycles.

Figure 1. Phenological susceptibility window for major sugarcane bacterial diseases. **(A)** Heatmap table presenting the ordinal evidence synthesis (0–3) across phenological stages and diseases; **(B)** corresponding bar chart. Scores reflect the strength and consistency of literature reports (0 = none/weak; 3 = strong/consistent) and do not represent measured incidence curves.

(A)

Phenological stage	RSD (Lxx)	Leaf scald (X. albilineans)	Red stripe (A. avenae)
Establishment	1	2	2
Tillering	2	2	3
Grand growth	3	3	3
Maturation	2	2	1

(B)



Ordinal scale (evidence synthesis): 0 = none/weak; 1 = low; 2 = moderate; 3 = strong/consistent.

Figure 1 further indicates that susceptibility/symptom expression is most consistently reported during the vegetative window, peaking at grand growth (score = 3 for all diseases). Ratoon stunting (*Lxx*) increases from establishment to grand growth (1→2→3) and remains moderate at maturation (2), consistent with systemic/latent infection and cumulative spread in ratoons (Gillaspie; Teakle, 1989; Matsuoka, 2013). Leaf scald (X. *albilineans*) follows a similar

profile (2–2–3–2), reflecting frequent latent infections with more consistent expression during rapid growth (Rott *et al.*, 1997). In contrast, red stripe (A. *avenae*) is highest from tillering to grand growth (3–3) and declines at maturation (1), matching its episodic expression under humid/rainy conditions (Fontana *et al.*, 2013; Matsuoka, 2013). Overall, this synthesis supports prioritizing monitoring and sanitation from tillering through grand growth.

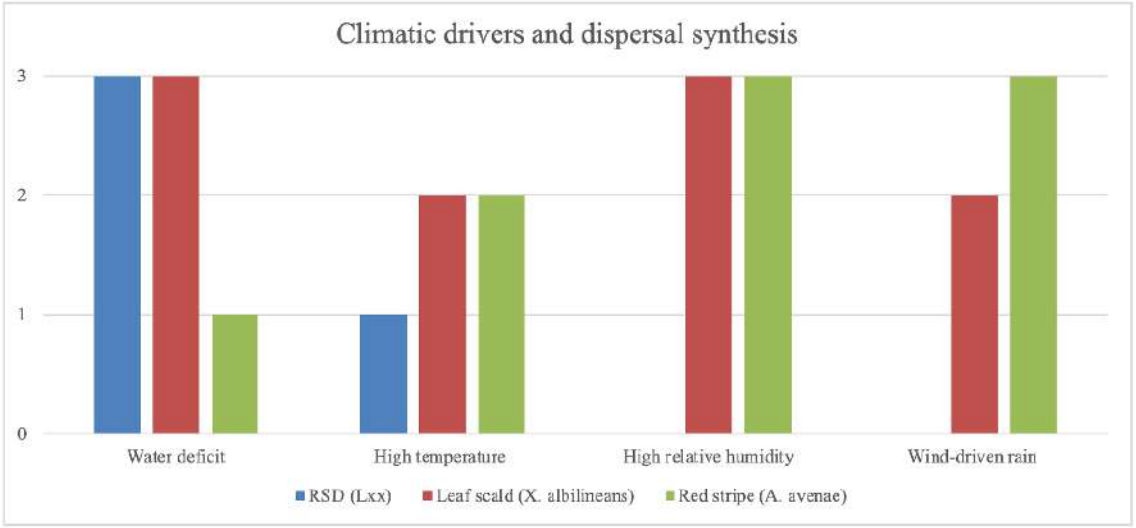
Among the diseases considered, ratoon stunting disease (*Leifsonia xyli* subsp. *xyli*) is typically the most widespread and economically important due to its largely symptomless, systemic nature and efficient spread by contaminated implements; leaf scald (*Xanthomonas albilineans*) can also be severe, especially when plant cane is established from infected seedcane and drought/heat triggers acute symptoms; red stripe (*Acidovorax avenae* subsp. *avenae*) is more episodic, often flaring after periods of high rainfall and high nitrogen, and may be first noticed in young plant cane but can persist into ratoons. The following subsections summarize each pathogen's biology, key symptoms, dissemination pathways, and management.

Figure 2. Climatic drivers and dispersal synthesis for major sugarcane bacterial diseases. **(A)** Heatmap table presenting the ordinal evidence synthesis (0–3) across climatic drivers/mechanisms and diseases; **(B)** corresponding bar chart. Scores reflect the strength and consistency of literature reports (0 = none; 3 = strong/consistent) and do not represent measured incidence curves.

(A)

Climatic driver / mechanism	RSD (*Lxx*)	Leaf scald (*X. albilineans*)	Red stripe (*A. avenae*)
Water deficit	3	3	1
High temperature	1	2	2
High relative humidity	0	3	3
Wind-driven rain	0	2	3

(B)



Ordinal scale (evidence synthesis): 0 = none; 1 = low; 2 = moderate; 3 = strong/consistent.

To complement the phenological susceptibility window, we synthesized climatic drivers and dispersal mechanisms reported for the three major bacterial diseases (Figure 2). Leaf scald outbreaks are frequently linked to stress conditions and warmer weather, which can intensify symptom expression at field scale (Birch, 2001; Rott *et al.*, 1997). Red stripe shows a stronger association with humid/rainy periods and rain-driven dissemination, consistent with reports from different producing regions (Fontana *et al.*, 2013; Li *et al.*, 2018). RSD, in turn, is mainly disseminated through planting material and contaminated tools, although stress can modulate disease expression and yield losses under commercial production (Chakraborty *et al.*, 2024; Urashima *et al.*, 2017).

Importantly, the phenological susceptibility window (Figure 1) is aligned with the climatic factors and dispersal mechanisms synthesized in Figure 2, suggesting epidemiological coherence between the crop stage and environmental conditions. The peak susceptibility consistently observed during the grand growth period (score = 3 for all diseases) coincides with phases of intense vegetative growth, characterized by greater canopy density and increased leaf area, which may favor the formation of more humid microclimates within the crop. High relative humidity and the occurrence of splash-driven rainfall are widely recognized as factors that favor the infection and dissemination of *Xanthomonas albilineans* and *Acidovorax avenae*, the causal agents of leaf scald and red stripe, respectively (Ricaud *et al.*, 1989; Rott *et al.*, 2000; Li *et al.*, 2018). Thus, the elevated scores observed in Figure 1 for the grand growth stage are consistent with the main environmental factors synthesized in Figure 2. In contrast, ratoon stunting disease (*Leifsonia xyli* subsp. *xyli*) presents an epidemiological dynamic predominantly associated with mechanical transmission and the use of infected planting material, with lower dependence on external climatic conditions for its dissemination (Ricaud *et al.*, 1989). Taken together, these patterns indicate that the risk of bacterial diseases in sugarcane results from the interaction between the phenological stage of the crop and the prevailing environmental factors in each period of the crop cycle.

3.1 Ratoon stunting – causal agent: *Leifsonia xyli* subsp. *xyli* (Lxx)

The causal agent of Ratoon Stunting Disease (RSD), *Leifsonia xyli* subsp. *xyli*, was first consistently isolated and identified from sugarcane tissues exhibiting characteristic stunting symptoms by Davis *et al.* (1980). Their groundbreaking work demonstrated that this xylem-limited bacterium was capable of inducing stunting and growth reduction in sugarcane, confirming its role

as the primary pathogen. This foundational discovery not only provided the basis for diagnostic assay development but also marked a turning point in understanding latent infections in vegetatively propagated crops.

Ratoon stunting is a major disease of sugarcane, caused by *Leifsonia xyli* subsp. *xyli* (Lxx), a Gram-positive, fastidious, non-spore-forming, obligate aerobic bacterium. The pathogen, formerly classified as *Clavibacter xyli* subsp. *xyli* (Cxx), colonizes the xylem vessels of sugarcane and has since been reclassified based on molecular and rRNA gene analyses (Carvalho *et al.*, 2016).

The Lxx bacterium is Gram-positive, fastidious, does not form endospores, is an obligate aerobe, lacks flagella (atrichous), and has cells that are straight or slightly curved rods (pleomorphic), measuring approximately 0.2 × 5.0 µm. In culture, it produces tiny and translucent colonies at temperatures between 26 and 30°C, with a diameter ranging from 0.1 to 0.3 mm (Matsuoka, 2013).

Due to the absence of typical external symptoms and ambiguous internal symptoms, diagnosing this disease based solely on visual inspection is challenging (Gillaspie; Teakle, 1989). Therefore, the presence of Lxx bacteria must be confirmed in xylem sap samples using serological techniques or PCR analysis (Rossetto; Santiago, 2022). Ratoon stunting can lead to yield losses ranging from 12% to 37% under normal conditions and up to 60% under additional water stress conditions (Gillaspie; Teakle, 1989).

Under drought conditions, affected plants display symptoms such as reduced growth, shortened internodes, and thinner stalks. Internal signs include vascular discoloration, often orange to reddish, primarily observed in the nodal regions of older culms. However, symptom expression is variable and influenced by environmental factors and water availability. Importantly, severe infections may occur without visible symptoms (Matsuoka, 2013).

Susceptible varieties may show internal vessel discoloration ranging from light orange to dark red in the oldest parts of mature stems. Symptoms such as "commas" and lines or dots, primarily located in the deeper parts of the culm, vary depending on vessel location and cut direction. These symptoms are generally present in most mature culm nodes. The absence of internal symptoms does not necessarily indicate healthy material, as some varieties can be severely infected without external symptoms. This variability is influenced by environmental factors and water availability (Gillaspie; Teakle, 1989; Matsuoka, 2013).

The host range of Lxx is likely restricted to *Saccharum* spp. (Zavaglia *et al*., 2016). The pathogen spreads in the field through infected plant material and by using contaminated cutting tools, such as harvesters and sugarcane planters (Gillaspie; Teakle, 1989). Currently, the only

control method employed is the thermal treatment of stalks, which involves immersing the stalks in hot water (52°C) for 30 minutes. However, this treatment does not eradicate the pathogen but only reduces its bacterial load (Matsuoka, 2013).

Genomic analyses of *Leifsonia xyli* subsp. *xyli* have provided important insights into its pathogenicity and adaptation to sugarcane. The complete genome sequence revealed several genes potentially associated with pathogenicity and a high number of predicted pseudogenes, findings consistent with ongoing adaptation to the restricted ecological niche of sugarcane xylem vessels (Monteiro-Vitorello *et al*., 2004).

Recent research has shown that *Leifsonia xyli* subsp. *xyli* is highly host-specific to *Saccharum* spp., with no evidence of its presence in insect vectors. A study by Panta *et al.* (2022) analyzed sugarcane-associated insects across multiple plant tissues using a specific PCR assay and found no detection of Lxx DNA, supporting the understanding that mechanical transmission via contaminated tools is the primary pathway (Panta *et al.*, 2022).

3.2 Leaf scald – causal agent: *Xanthomonas albilineans* (Ashby) Dowson

Leaf scald is a vascular disease of sugarcane caused by *Xanthomonas albilineans* (Ashby) Dowson, a Gram-negative, aerobic bacterium. The pathogen colonizes xylem tissues and is considered one of the most economically significant bacterial diseases in sugarcane production (Matsuoka, 2013).

The bacterium is bacilliform, motile via a single polar flagellum, and measures approximately 0.25–0.30 × 0.6–1.0 µm. In culture, it forms yellow, viscous, convex colonies with smooth edges, typically growing at 25 to 28 °C (Birch, 2001; Rott *et al.*, 1997). Its broad distribution includes nearly all sugarcane-producing regions worldwide, where leaf scald can cause significant damage (Birch, 2001).

Wilbrink and North were the first to demonstrate that the bacterium *Xanthomonas albilineans* (Ashby) Dowson invades the xylem causing leaf scald (Matsuoka, 2013).

One of the problems with the disease is that sugarcane cultivars can tolerate the pathogen without showing symptoms or the symptoms escape detection (Matsuoka, 2013). The difficulty in identifying it comes from the fact that it presents three types of symptoms: latent, chronic, and acute (Rott *et al.*, 1997).

The latent symptom prevails in most commercial varieties, which are tolerant and therefore live with the pathogen for years, without manifesting external symptoms. Internally, it is seen that mature culms have vascular discoloration in the nodal region, which is similar to the

symptoms of plants with the bacteria that cause stump rickets (Rott *et al.*, 1997). Due to the prevalence of latent infection with small populations of X. *albilineans* in plants, visual diagnosis is inadequate and sensitive pathogen detection techniques, such as the use of serological methods like microagglutination, ELISA, and the PCR technique, are required (Rott et al., 1997; Birch, 2001; Garces *et al*., 2014).

White streaks cover large areas of the leaf blade and may even extend to the sheath in the chronic symptom. With frequent sprouting of the basal stem buds, the striae can progress to different degrees of leaf chlorosis, from undeliberated edges to necrosis (Rott *et al.*, 1997).

The acute symptom only occurs in susceptible, intolerant, or intermediately resistant varieties, under extremely favorable conditions for the pathogen. In this case, there is burning of the leaves as if the plant had been scalded, sometimes without manifesting symptoms of lateral sprouting of the stem. Complete drying of the leaves makes identification difficult. Only after a few days do the culms sprout laterally, showing the chronic symptoms of the disease (Rott *et al.*, 1997).

Sugarcane is the main host of *X. albilineans*, but the bacteria can affect other species of the Poaceae family (Birch, 2001). The disease can spread by using machetes or other agricultural tools that have been contaminated with diseased plant exudates during harvesting or when planting infected stalks (Birch, 2001; Matsuoka, 2013).

There are no chemical or biological products that control the disease satisfactorily. The main disease control strategies are restricted to planting healthy seedlings and replacing susceptible varieties with resistant varieties (Birch, 2001). Thus, varieties with desirable agronomic characteristics and high production potential, but which are susceptible to the disease, are discarded during the selection process of new commercial varieties (Birch, 2001).

Recent advances have demonstrated that quantitative PCR (qPCR) provides a sensitive and accurate method for detecting and quantifying *Xanthomonas albilineans*, including in plants with latent infections. This improved detection capacity can contribute to pathogen identification and to breeding programs aimed at resistance to leaf scald (Garces et al., 2014).

3.3 Red stripe – causal agent: *Acidovorax avenae* subsp. *avenae*

Red stripe is a bacterial disease of sugarcane caused by *Acidovorax avenae* subsp. *avenae*, formerly misidentified as *Pseudomonas rubrilineans*. Its pathogenic role in sugarcane was confirmed by Fontana *et al.* (2013). This bacterium infects members of the Poaceae family, including maize, rice, sorghum, millet, oats, barley, rye, and sugarcane (Fontana *et al.*, 2013).

In susceptible sugarcane varieties, the disease causes a loss of stalks for crushing, decreases productivity, and consequently reduces the quality of the sugarcane juice (Fontana *et al.*, 2013). However, there are few studies conducted to characterize its causal agent.

Red stripe manifests as thin, long streaks from 5 to 60 cm long and rot from the top of the plant. The first symptoms appear on the leaves as soaked streaks that gradually turn reddish. In new lesions, exudation of the bacteria is commonly visible. Later, the symptoms extend to the apical meristem of the plant, which becomes wet as a result of tissue death, causing top rot. If conditions are favorable, top rot spreads down the culm, causing a crack where fetid liquid oozes out (Gillaspie; Teakle, 1989; Fontana *et al.*, 2013).

The expression of red stripe symptoms is favored by high relative humidity, high temperature, rainfall, and low soil water holding capacity (Fontana *et al.*, 2013). The incidence of red stripes was also positively correlated with several soil properties, such as nitrogen, phosphorus, potassium, zinc, and calcium levels (Fontana *et al.*, 2013; Johnson *et al.*, 2016). Long-distance dissemination is carried out by rain blown by the wind, which releases and transports small platelets of bacterial exudates adhered to the leaves (Gillaspie; Teakle, 1989; Fontana *et al.*, 2013).

The best strategy to avoid productivity losses due to red stripe is the use of resistant varieties (Fontana *et al.*, 2013). The planting of varieties prone to the disease should be avoided in heavy soils, very fertile, and in very humid places, such as lowlands and riverbanks (Matsuoka, 2013).

In India, where red stripe disease is frequently reported across major sugarcane-growing states, integrated management approaches have proven effective in minimizing crop damage. These include rigorous sanitation of seedcane, use of disease-free planting material, and field monitoring during humid months when outbreaks are more common. According to Viswanathan and Rao (2011), the combination of resistant cultivars with timely roguing of symptomatic plants has significantly reduced disease incidence in several demonstration trials. These findings reinforce the importance of context-specific strategies that incorporate both genetic resistance and cultural practices for sustainable control.

Red stripe affects sugarcane practically all over the world, but little molecular information is available about this disease. An outbreak occurred in Argentina, causing a 30% loss in yield (Fontana *et al.*, 2013). Since the 1970s, the disease has been reported in several Chinese provinces, with molecular surveys confirming its widespread occurrence in major sugarcane-growing regions (Li *et al*., 2018). A more complete understanding of the pathogen's genetic

diversity is needed to select resistant genotypes in breeding programs, design disease management strategies, and develop effective molecular diagnostic tests (Fontana *et al.*, 2013).

Molecular insights into *Acidovorax avenae* subsp. *avenae* have advanced through genomic and phenotypic investigations of strains isolated from infected sugarcane plants. Zhao *et al.* (2023) conducted detailed molecular and pathogenicity analyses and found that at least two distinct colony morphotypes (white cream and yellow) were associated with severe red stripe symptoms in *Saccharum* spp. cultivars LC07 150 and ZZ8 in China. These findings underscore the pathogen's genetic variability and suggest that virulence traits may differ across regional isolates, highlighting the importance of localized monitoring and tailored resistance strategies in breeding programs (Zhao *et al.*, 2023).

4. Final Considerations

Bacterial diseases remain a major constraint to sugarcane productivity, especially due to the crop's vegetative propagation system and the lack of effective chemical control methods. Among the most significant pathogens are *Leifsonia xyli* subsp. *xyli*, *Xanthomonas albilineans*, and *Acidovorax avenae* subsp. *avenae*, each responsible for important and widespread diseases with distinct epidemiological characteristics and management challenges. Current control strategies rely primarily on preventive approaches, such as the use of disease-free planting material, thermal treatment, and especially the development of resistant cultivars. Accurate and early diagnosis remains essential, yet often underutilized due to the asymptomatic or latent nature of infections in many cultivars.

In addition to technical barriers, the implementation of disease control strategies often faces logistical and socioeconomic limitations, especially in regions where access to certified planting material and diagnostic laboratories is scarce. Many sugarcane-producing areas rely heavily on informal propagation systems, increasing the risk of spreading latent infections. As such, improving access to clean seed programs and strengthening local diagnostic capabilities are fundamental steps toward reducing inoculum pressure and ensuring long-term field health.

Despite decades of research, key knowledge gaps persist, particularly regarding pathogen variability, host-pathogen interactions, and the development of rapid molecular diagnostic tools. In addition, the limited availability of resistant germplasm and the lack of widespread implementation of diagnostic screening protocols hinder broader disease mitigation.

In this context, expanding genetic studies, adopting precision agriculture techniques, and integrating molecular diagnostics into phytosanitary programs may provide long-term solutions.

Strategic collaboration between research institutions and the sugar-energy sector will be vital to convert scientific advancements into accessible and cost-effective tools for producers.

Integrating agronomic, molecular, and phytosanitary strategies will be essential to ensure sustainable sugarcane production in the face of evolving phytopathological challenges. A multidisciplinary approach will not only improve crop resilience but also support productivity, economic viability, and environmental sustainability in tropical agriculture.

Emerging molecular tools, such as CRISPR-Cas genome editing and transcriptomic profiling, are opening new avenues for sugarcane improvement. These technologies enable targeted manipulation of resistance genes and a deeper understanding of plant-pathogen interactions, which could accelerate the development of cultivars with broad-spectrum resistance. Their integration into breeding pipelines, alongside conventional selection and marker-assisted screening, may represent a turning point in bacterial disease management for the crop.

Furthermore, climate change is expected to exacerbate phytosanitary risks by altering pathogen distribution patterns and increasing the frequency of extreme weather events that favor disease outbreaks. Higher temperatures, irregular rainfall, and humidity fluctuations may not only accelerate bacterial spread but also affect host susceptibility and vector behavior. Anticipating these changes requires the integration of climate-resilient breeding objectives and adaptive management strategies into current research agendas.

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