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BUREAU OF SUGAR EXPERIMENT STATIONS

QUEENSLAND, AUSTRALIA

PEST RISK ANALYSIS OF SUGARCANE FOR THE NORTHERN AUSTRALIA QUARANTINE STRATEGY - PART 2 QUARANTINE PATHOGENS

by

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CO97010

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1.0 INTRODUCTION

The purpose of this pest risk analysis (PRA) is firstly to identify quarantine pests and pathogens which pose a threat to sugarcane, which may enter Australia through its northern borders into the area covered by the AQIS Northern Australia Quarantine Strategy (NAQS); and secondly to, identify measures which could be taken by various agencies to reduce the risks of entry or to minimise the impact of such pests should they arrive.

The PRA was conducted as outlined in the FAO Standard "Guidelines for Pest Risk Analysis"[2], and is one of a series of PRAs commissioned by NAQS. The other host plants covered in this series are (insert names of host plants).

Sugarcane (*Saccharum* L. interspecific hybrids) is the second largest export crop in Australia with total earnings of AUS$1.7 - 2 billion. Sugarcane is grown along the coastal strip from Grafton in New South Wales to Mossman in Queensland, and a new industry has recently been established in the Ord River district in Western Australia. Within Queensland the sugar industry has been expanding at 3-5% per annum since 1990 and the total production in 1996 was 5.4 million tonnes of sugar produced from 400,000 ha.

Sugarcane is a traditional crop of the inhabitants of the Torres Strait islands and is grown in gardens throughout these islands. Islanders who have moved to the Australian mainland continue to cultivate sugarcane in their gardens. It is not uncommon to see sugarcane growing in home gardens in many of the coastal cities and towns north of Sydney. Sugarcane and its relatives are native to Papua New Guinea and there has been traditional trade between Papua New Guinea and the Torres Strait in sugarcane as well as other crops.

Until recently, trade in sugarcane products has been restricted to the highly processed crystalline sugar, molasses and to a much lesser extent by-products made from the sugarcane fibre. These products present negligible quarantine risk. In recent years there has been a growing interest in trade of cane pieces for traditional cooking, trade in second-hand sugarcane machinery and importation of clones of close relatives of sugarcane for ornamental use (eg *Miscanthus spp.*) or use as a vegetable (eg *S. edule*). Germplasm exchange for traditional plant breeding purposes is a high priority of the Australian sugar industry (Hogarth and Berding, 1996).

Diseases of sugarcane cause considerable losses in many countries (Hughes, 1978). The important diseases of sugarcane in Australia have recently been reviewed by Croft and Smith (1996). Apart from the losses from the complex sugarcane yield decline syndrome (Magarey and Croft, 1995), losses from diseases in sugarcane in Australia are below 1% of total production (McCleod, 1996). This is a low level of loss compared to the 10-15% loss which is reported from some countries (Alexander & Viswanathan, 1996) and is an important factor in the competitive advantage of the Australian sugar industry. Losses are generally low in the Australian sugar industry because of the absence of some major diseases and active control programs for those diseases which are present.

The International Society of Sugar Cane Technologists (ISSCT) Pathology Sectional Committee periodically publishes an updated list of the diseases and pathogens of sugarcane and their distribution in the Proceedings of the ISSCT Conference. In 1992, the list of diseases included 98 diseases caused by microbes (Autrey *et al*, 1992). The diseases of sugarcane and the pathogens of sugarcane have been reviewed in detail (Ricaud *et al*, 1989; Sivanesan and Waller, 1986; Hughes *et al*, 1964; Martin *et al*, 1961). An assessment of the relative economic importance of the then known diseases was compiled by Hughes (1978), and a list of diseases of quarantine significance was compiled by Frison and Putter (1993). This paper identifies pathogens of significant risk to Australia from natural spread and illegal movement of sugarcane plants, and by authorised movement of sugarcane germplasm, sugarcane products or contaminated equipment into northern Australia.

2.0 SUGARCANE DISEASES, THEIR PRESENCE IN AUSTRALIA AND THEIR IMPORTANCE

The most recent list of sugarcane diseases published by the ISSCT Pathology Sectional Committee (Autrey *et al*, 1992 and Autrey, 1995) is shown in Table 2. The quarantine status of each pathogen was assessed by first rating the economic importance of the disease that it causes, based on available literature. Where no recent or readily available literature was available for the disease, the importance was considered low. The occurrence of the disease in Australia was based on the ISSCT list except where more recent information was available. Of the 98 diseases listed in Table 2, 32 were rated as of intermediate to high economic importance or of uncertain importance. The uncertainty of the importance of seven diseases was due to lack of information on extent of yield loss, distribution and occurrence. The majority of these diseases have been identified in the last 10 years. Downy mildews caused by two *Peronosclerospora* species have been listed as of uncertain importance because of possible confusion with the downy mildew caused by *P. sacchari*, which is known to be a serious disease. Of these 32 diseases, 17 diseases caused by 21 pathogens could be considered of possible quarantine significance to Australia because they have not been reported in Australia, strains of the pathogen are not present in Australia or they are under active control. These 21 pathogens were reviewed and information on their geographical distribution, biology and economic importance is outlined in the attached dossiers. The relative risk of each disease entering through the northern borders of Australia is outlined in the dossiers, and suggested actions to reduce the risk, or prevent spread if an incursion occurs, are noted. Ten diseases were considered to be high quarantine risks for entry through the northern borders of Australia and these are listed in order of priority in Table 3.

Surveillance for diseases in the Australian sugar industry is conducted by local Cane Protection and Productivity Boards and the Bureau of Sugar Experiment Stations (BSES). Many thousands of hectares of on-farm plant sources are inspected each year as well as random surveys of commercial fields. The results of these surveys are compiled by BSES and reported in the Biennial Conference of the Cane Protection and Productivity Boards. The distribution of diseases in Australia was based on information from these reports and personal communications with Mr Brian Egan, consultant pathologist to the Western Australian sugar industry (phone 07 3355 0524).

The Ord River district of Western Australia has been growing experimental crops of sugarcane for 20 years and a commercial sugar industry commenced operation in 1996. This district is free of many sugarcane pathogens which are present in the eastern states. The diseases listed in Appendix 1, have been recorded in Australia and are of economic importance, but have not been reported in the Ord River district. Strict interstate quarantine is enforced on plants introduced into the Ord River district.

3.0 POTENTIAL QUARANTINE PATHOGENS

Table 2 Potential quarantine pathogens of sugarcane for the NAQS target list

	Disease	Causal Agent	Author	Status in Aust.	Importance
B[a]	Leaf scald	*Xanthomonas albilineans*	(Ashby) Dowson	Yes one serotype	High
B	Ratoon stunting disease	*Clavibacter xyli subsp. xyli*	Davis *et al*	Yes active control	High
F	Downy mildew	*Peronosclerospora sacchari*	(T Miyake) Shirai & K Hara	No	High
F	Downy mildew	*Peronosclerospora philippinensis*	(Weston) C G Shaw	No	Uncertain
F	Downy mildew	*Peronosclerospora spontanea*	(Weston) C G Shaw	No	Uncertain
F	Leaf scorch	*Stagonospora sacchari*	Lo & Ling	No	High
F	Pachymetra root rot	*Pachymetra chaunorhiza*	Croft & Dick	Yes	High
F	Pineapple disease	*Ceratocystis paradoxa*	(Dade)C Moreau	Yes	High
F	Red rot	*Glomerella tucumanensis*	(Speg.)v.Arx & E Muller	Yes	High
F	Rust (common)	*Puccinia melanocephala*	H & P Sydow	Yes	High
F	Sugarcane smut	*Ustilago scitaminea*	H Sydow	No	High
F	Wilt	*Gibberella subglutinans*	(Edwards)Nelson *et al*	Yes	High
F	Yellow spot	*Mycovellosiella koepkei*	(Krüger) Deighton	Yes	High
P	Grassy shoot	Phytoplasma		No	High
P	White leaf	Phytoplasma		No	High
U	Chlorotic streak	Unknown		Yes	High
V	Fiji disease	Fiji disease virus		Yes limited distrib.	High
V	Mosaic	Sorghum mosaic virus		No	High
V	Mosaic	Potyvirus from Pakistan		No	High
V	Mosaic	Sugarcane mosaic virus		Yes one strain	High
V or P	Ramu stunt	Suspect virus or phytoplasma		No	High
B	Gumming	*Xanthomonas campestris* pv *vasculorum*	(Cobb) Dye	No	Intermediate
B	Red stripe/top rot	*Burkholdia rubrilineans*	(Lee *et al)* Strapp	Yes	Intermediate
F	Brown spot	*Cercospora longipes*	E Butler	No	Intermediate
F	Eye spot	*Drechslera sacchari*	(E Butler) Subram. & Jain	Yes	Intermediate

	Disease	Causal Agent	Author	Status in Aust	Importance
F	Pokkah boeng	*Gibberella fujikuroi*	(Sawada) Wollenw	Yes	Intermediate
F	Pokkah boeng	*Gibberella subglutinans*	(Edwards) Nelson *et al*	Yes	Intermediate
F	Root rots	*Pythium spp.*		Yes	Intermediate
U	Ramu leaf scorch	Unknown		No	Intermediate
V	Red leaf mottle	Peanut clump virus		No	Intermediate
V	Striate mosaic	Sugarcane striate mosaic virus		Yes	Intermediate
U	Ramu streak	Unknown		No	Uncertain
U	Sereh	Unknown		No	Uncertain
V	Bacilliform virus	Sugarcane bacilliform virus		Yes	Uncertain
V	Mild mosaic	Sugarcane mild mosaic virus		Yes	Uncertain
V & P	Yellow leaf syndrome	Sugarcane yellow leaf virus and Phytoplasma		Yes	Uncertain
B	Bacterial sun spot	*Burkholdia spp.*		No	Low
B	Bacteriosis	*Undetermined*		No	Low
B	Mottled stripe	*Burkholdia rubrisubalbicans*	(Christopher & Edgerton) Krasil'nikov	Yes	Low
B	Stinking rot	*Burkholdia desaiana*	(Burkholder) Savulescu	No	Low
B	Bacterial mottle	*Erwinia chrysanthemi*	Burkholder *et al*	Yes	Low
F	Alternaria leaf spot	*Alternaria alternata*	(Fr.) Keisler	No	Low
F	Arrow rot	*Fusarium sp.*		Yes	Low
F	Baker's leaf spot	*Bakerophoma sacchari*	Died	No	Low
F	Banded sclerotial disease	*Thanatephorus sasakii*	(Shirai) Tu & Kimborough	Yes	Low
F	Banded sclerotial disease	*Thanatephorus cucumeris*	(Frank) Donk	Yes	Low
F	Basal stem, root & sheath rot	various *Basidiomycete* fungi		Yes	Low
F	Black leaf spot	*Phyllachora sacchari*	P Henn.	No	Low
F	Black rot	*Ceratocystis adiposa*	(E Butler) C Moreau	Yes	Low
F	Black spot	*Cerocospora acerosum*	Dickhoff & Hein.	No	Low
F	Black stem rot	*Selenophoma sp.*		No	Low
F	Black stripe	*Pseudocercospora atrofiliformis*	(Yen *et al*) Yen	No	Low
F	Brown rot	*Corticium sp.*		Yes	Low
F	Brown stripe	*Drechslera stenospila*	(Drechsler) Subram.& Jain	Yes	Low
F	Collar rot	*Hendersonina sacchari*	E Butler	No	Low

	Disease	Causal Agent	Author	Status in Aust	Importance
F	Covered smut	*Sphacelotheca macrospora*	Yen & Wang	No	Low
F	Culm and midrib rot	*Papularia vinosa*	(Berk. & Curt.) Mason	No	Low
F	Diplodia rot	*Diplodia sp.*		No	Low
F	Dry rot	*Botryosphaeria quercuum*	(Schwein.) Sacc.	No	Low
F	Dry top rot	*Ligniera vascularum*	(Matz) M T Cook	No	Low
F	Ergot	*Claviceps purpurea*	(Fr.) Tul.	Yes	Low
F	Ergot	*Claviceps pusilla*	Ces.	Yes	Low
F	False floral smut	*Claviceps sp.*		Yes	Low
F	Floral smut	*Sphacelotheca schweinfurthiana*	(Thüm) Sacc.	No	Low
F	Floral smut	*Sphacelotheca cruenta*	(Kühn) Potter	No	Low
F	Floral smut	*Sphacelotheca erianthi*	(H&P Sydow) Mundkur	No	Low
F	Fusarium sett or stem rot	*Fusarium fujikuroi*	(Sawda) Wollenweber	Yes	Low
F	Fusarium sett or stem rot	*Fusarium tricinctum*	(Cda.) Sacc.	No	Low
F	Helminthosporium leaf	*Helminthosporium spp.*		No	Low
F	Iliau	*Clypeoporthe iliau*	(Lyon) Barr	Yes	Low
F	Inflorescence binding	*Ephelis pallida*	Pat.	No	Low
F	Leaf blast	*Paraphaeospaeria michotii*	(Westend.) O Erikss.	No	Low
F	Leaf spots	*various fungi*		No	Low
F	Leaf-splitting disease	*Mycosphaerella striatiformans*	(Cobb) Sacc.&Trott.	No	Low
F	Leaf-splitting disease	*Peronosclerospora northii*	(Weston) C G Shaw	No	Low
F	Leaf-splitting disease	*Peronosclerospora miscanthi*	(T Miyake) C G Shaw	No	Low
F	Myriogenospora leaf binding	*Myriogenospora aciculispora*	Vizioli	No	Low
F	Periconia leaf spot	*Periconia sacchari*	Johnston	No	Low
F	Pestalotia leaf spot	*Pestalotia fuscescens var. sacchari*	(Sor.) Wakker	Yes	Low
F	Phyllosticta leaf spot	*Phyllosticta sorghina*	Sacc.	No	Low
F	Phytophthora rot of cuttings	*Phytophthora megasperma*	Drechsler	No	Low
F	Phytophthora rot of cuttings	*Phytophthora erythroseptica*	Pethybridge	No	Low
F	Powdery mildew	*Erysiphe graminis*	DC.	No	Low
F	Ramu orange leaf	*Basidiomycete* fungus		No	Low
F	Red leaf spot (purple spot)	*Dimeriella sacchari*	(v.Breda de Haan) Hansf. Ex Abbott	Yes	Low

	Disease	Causal Agent	Author	Status in Aust	Importance
F	Red line disease	*Fusarium sp.*		No	Low
F	Red rot of leaf sheath	*Corticium rolfsii*	Curzi	Yes	Low
F	Red spot of leaf sheath	*Mycovellosiella vaginae*	(Krüger) Deighton	Yes	Low
F	Rind disease	*Phaeocytostroma sacchari*	(Ell.&Ev.) B Sutton	Yes	Low
F	Ring spot	*Leptosphaeria sacchari*	v Breda de Haan	Yes	Low
F	Rust (orange)	*Puccinia kuehnii*	E Butler	Yes	Low
F	Schizophyllum rot	*Schizophyllum commune*	Fr.	Yes	Low
F	Sclerophthora	*Sclerophthora macrospora*	(Sacc.) Thirum. *et al*	Yes	Low
F	Sclerotium disease	*Sclerotium sp.*		No	Low
F	Seedling blights	*various fungi*		No	Low
F	Sheath rot	*Cytospora sacchari*	E Butler	Yes	Low
F	Sooty mould	*Capnodium spp.*		Yes	Low
F	Sooty mould	*Fumago sacchari*	Speg.	Yes	Low
F	Target blotch	*Helminthosporium spp.*		No	Low
F	Veneer blotch	*Deightoniella papuana*	D Shaw	No	Low
F	White speck (rash)	*Elsinoe sacchari*	Lo	No	Low
F	Zonate foot rot	*Fomes sp.*		No	Low
F	Zonate leaf spot	*Gloeocercospora sorghi*	D Bain & Edgerton ex Deighton	No	Low
U	Dwarf	*Unknown*		Yes	Low
U	Ring mosaic	*Unknown*		No	Low
U	Sembur	*Unknown*		No	Low
U	Spike	*Unknown*		No	Low
U	White stripe	*Unknown*		No	Low
V	Reovirus (South Africa)	*Reovirus*		No	Low
V	Sobemovirus (PNG)	Sobemovirus		No	Low
V	Streak	*Sugarcane streak virus*		No	Low

a B = bacterium F = fungus P = phytoplasma U = unknown V = virus

4.0 PROPOSED QUARANTINE PATHOGENS

Table 3 Proposed quarantine pathogens of sugarcane for the NAQS target list in order of priority

Pathogen type	*Species name*	Author	Common name	Relative Priority
Fungus	*Ustilago scitaminea*	H Sydow	Sugarcane smut	1
Fungus	*Peronosclerospora sacchari*	(T Miyake) Shirai & K Hara	Downy mildew	2
Fungus	*Peronosclerospora philippinensis*	(Weston) C G Shaw	Downy mildew	2
Fungus	*Peronosclerospora spontanea*	(Weston) C G Shaw	Downy mildew	2
Virus	Fiji disease virus		Fiji disease	3
Virus or phytoplasma	Suspect virus or phytoplasma		Ramu stunt	4
Virus	Sorghum mosaic virus		Mosaic	5
Virus	Potyvirus - Pakistan		Mosaic	5
Virus	Sugarcane mosaic virus		Mosaic	5
Bacterium	*Xanthomonas albilineans*	(Ashby) Dowson	Leaf scald	6
Phytoplasma	Sugarcane white leaf phytoplasma		White leaf	7
Phytoplasma	Sugarcane grassy shoot phytoplasma		Grassy shoot	8
Fungus	*Stagonospora sacchari*	Lo & Ling	Leaf scorch	9
Fungus	*Cercospora longipes*	E Butler	Brown spot	10

5.0 DOSSIERS ON SUGARCANE PATHOGENS

5.1 Sugarcane smut

Species: *Ustilago scitaminea*

Author: H Sydow

Order:

Family:

Common name(s): Sugarcane smut, Culmicolous smut

Synonyms and changes in combination:

Hosts: *Saccharum* complex species (*Saccharum* interspecific hybrids, *S. officinarum, S. spontaneum, S. robustum* , *S. edule* , *S. barberi* , *S. sinense), Erianthus saccharoides, Imperata arundinacea, Rottboellia cochinchinensis*

Note:
Sorghum bicolor and *Zea mays* can produce symptoms when artificially inoculated but are not considered natural hosts.

Distribution: Worldwide in association with sugarcane except Papua New Guinea, South Pacific islands and Australia.

Nearest known location to Australia: Indonesian islands of Sumatra, Java and Sulawesi and the Philippines.

Economic damage: Sugarcane smut has caused serious economic losses in nearly all countries where it occurs. The economic importance of the disease is through direct yield losses (15-30% in susceptible varieties), cost of control programs and through restrictions on the use of germplasm.

Losses in excess of $100M could occur if the disease became widely distributed.

Entry potential: There is a high risk that smut may naturally spread to Australia from Indonesia or the Philippines. The risk would greatly increase if smut spreads to Irian Jaya or East Timor where Indonesia is actively planning to establish sugarcane plantations. Long distance aerial dispersal of smut has occurred in the past and smut could possibly enter Australia from any country in Africa or Asia. Illegal import of infected sugarcane or import of contaminated farm machinery could introduce the disease. Spores of the fungus could be carried on the clothing of travellers who have been in smut infested sugarcane fields.

Colonisation potential: Smut is a major disease in tropical and sub-tropical climates and has the potential to establish and severely affect all districts of the Australian sugar industry.

Spread potential: Teliospores are well adapted to wind dispersal and the disease can be

Biology: Smut infection of sugarcane is characterised by the production of a whip-like structure from the meristems of the cane stalk. This whip is the sorus of the fungus and is black with a silver-grey membrane. Infected plants are severely stunted, have profuse tillering and stalks are thin, giving the plant a grassy appearance. Teliospores only infect through lateral buds on standing cane stalks or buds on cuttings planted into infested soil. The fungus will remain dormant within the bud until the bud germinates. The fungus grows in association with the developing plant meristem and each developing lateral bud primordium is infected. The planting of systemically infected cane stalks gives rise to infected plants. *U. scitaminea* can infect other *Saccharum* species and a few grasses (*Rottboellia cochinchinensis* and *Imperata arundinacea*). Teliospores survive for up to 2-3 months in moist soil but for longer periods in dry conditions.

Physical damage: Produces whip-like structures from the meristems, stunting and profuse tillering.

Plant part affected: Flower ■ Fruit □ Seed □ Leaf ■ Stem ■ Root □ Other □

Detection/diagnosis: Observation of characteristic whip-like structures and microscopical examination of fungal spores. DNA probes are available to confirm diagnosis (S Schenck, Hawaiian Agricultural Research Centre, Email sschenck@harc-hspa.com).

Options for response to detection:

Offshore: If detected in Papua New Guinea, Irian Jaya or East Timor, attempts could be made to reduce inoculum potential by assisting these countries to control the disease. Rating Australian germplasm for resistance in Indonesia is planned.

Onshore: Eradication is unlikely to be possible if found in a commercial crop but a major containment program would be initiated. If found in a non-commercial crop area, a major eradication program is likely to be undertaken. Resistant varieties and strict movement controls would be used to assist in eradication.

Estimated risk: High. History of spread worldwide. A very serious pathogen.

Quarantine status: Quarantinable

References: Ferreira, S A and Comstock, J C 1989. Smut. In: Ricaud, C, Egan, B T, Gillaspie, A G and Hughes, C G eds. 1989. *Diseases of Sugarcane - Major Diseases*. Elsevier, Amsterdam. 211-229.

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5.2 Downy mildew

Species: *Peronosclerospora sacchari*

Author: (T Miyake) Shirai & K Hara

Species: *Peronosclerospora philippinensis*

Author: (Weston) C G Shaw

Species: *Peronosclerospora spontanea*

Author: (Weston) C G Shaw

Order:

Family:

Common name(s): Downy Mildew

Synonyms and changes in combination: Previously these three species were in the genus *Sclerospora*

Hosts:
Peronosclerospora sacchari
Saccharum complex species (*Saccharum* interspecific hybrids, *S. officinarum, S. spontaneum, S. robustum* , *S. edule* , *S. barberi* , *S. sinense),* maize (*Zea mays*) is highly susceptible

Peronosclerospora philippinensis
Maize (*Zea mays*), *Saccharum* interspecific hybrids, *S. officinarum*

Peronosclerospora spontanea
Saccharum interspecific hybrids, *S. officinarum, S. spontaneum*

Distribution:

Peronosclerospora sacchari
Fiji, India, Indonesia, Japan, Papua New Guinea, Philippines, Taiwan, Thailand

Peronosclerospora philippinensis
India, Philippines

Peronosclerospora spontanea
Philippines, Thailand

Nearest known location to Australia:

Peronosclerospora sacchari

This pathogen was present in Australia until 1972. No disease has been found in commercial fields since 1959 and the last experimental plot of infected plants was destroyed in 1972. This disease can be considered eradicated from Australia. The disease is present in Fiji, Indonesia, Papua New Guinea, and the Philippines.

Peronosclerospora philippinensis

Philippines

Peronosclerospora spontanea

Philippines

Economic damage: Downy mildew is reported to be a very severe disease with extensive yield losses in susceptible varieties (Leu and Egan, 1989; Suma and Pais, 1996; Tamanikaiyaroi and Johnson, 1996). In Papua New Guinea, losses were estimated at up to 15% in susceptible varieties (Suma and Pais, 1996). Up to 36% of clones imported to Papua New Guinea are too susceptible for commercial production and 50% of Australian clones are susceptible (Suma and Pais, 1996). Restrictions on the use of susceptible varieties would affect the yield potential in areas where the disease is present.

Entry potential: Spread of downy mildew to Australia by wind-blown spores is not considered possible because of the delicate nature of the conidia. Downy mildew could be introduced into Australia in illegally imported plants or cuttings from Papua New Guinea, Irian Jaya or Fiji. This is a relatively high risk as there have been a number of cases of sugarcane cuttings being illegally imported to Australia from Papua New Guinea in recent years. The importance of spread of oospores on contaminated equipment is difficult to assess because of the uncertain role of these spores in the epidemiology of the disease.

Colonisation potential: When downy mildew occurred in Australia it was present and caused significant yield losses in all districts of the Australian sugar industry. The disease therefore has potential to establish and significantly affect all districts if an incursion occurs.

Spread potential: Spores only 400 m. Spread in infected cuttings.

Biology: The disease is characterised by pale to light yellow leaf streaks which turn reddish-brown to dark red on ageing. Affected plants are stunted. In late autumn-early winter oospores are produced in leaves causing the leaves to shred. Some stalks can abnormally elongate in early winter, standing out well above the rest of the crop.

Downy mildew is fully systemic within plants and cuttings from infected plants will reproduce the disease. Conidia are produced on leaves during warm nights with high humidity. Conidia generally do not travel more than 400 m and do not survive for any significant period after sunrise of the morning on which they were formed. Infection is through very young developing leaf tissue and through lateral buds. The role of oospores in disease transmission is unclear.

P. philippinensis and *P. spontanea*

Both these pathogens have been reported on sugarcane causing similar symptoms to *P. sacchari*. Few definitive studies have been conducted to determine the exact proportion of disease caused by each species. *P. philippinensis* is a serious pathogen of maize in the Philippines (Husmillo and Reyes, 1980).

Physical damage: The disease is characterised by pale to light yellow leaf streaks which turn reddish-brown to dark red on ageing. Affected plants are stunted. Some stalks can abnormally elongate in early winter, standing out well above the rest of the crop.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ■ Root ☐ Other ☐

Detection/diagnosis: Observation of leaf symptoms and microscopical examination of fungal spores.

Options for response to detection:

Offshore: Already present. BSES conducts screening of Australian germplasm in Papua New Guinea.

Onshore: If found in a commercial crop or a non-commercial crop area, a major eradication program is likely to be undertaken. Replacement of susceptible varieties with resistant varieties would be an important part of an eradication program. Treatment of infected cuttings with metalaxyl (Ridomil) is very effective at eliminating the fungus and protecting plants from reinfection. This fungicide may be used to assist control programs.

Estimated risk: *P. sacchari* and *P. philippinensis* must be considered high quarantine risks to Australia, not only for sugarcane but also for maize. The close proximity of sources of infection in Papua New Guinea, the Philippines and Fiji and the extensive travel between Australia and these countries, increases the risk. The importance of *P. spontanea* is uncertain.

Quarantine status: Quarantinable

References: Leu, L S and Egan, B T Downy Mildew. In: Ricaud, C, Egan, B T, Gillaspie, A G and Hughes, C G eds. 1989. *Diseases of Sugarcane - Major Diseases*. Elsevier, Amsterdam. 107-121

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5.3 Fiji disease

Species: Fiji disease virus

Author:

Order:

Family:

Common name(s): Fiji disease

Synonyms and changes in combination:

Hosts: *Saccharum* complex species (*Saccharum* interspecific hybrids, *S. officinarum, S. spontaneum, S. robustum , S. edule , S. barberi , S. sinense), Erianthus maximus*

Distribution: Fiji disease occurs in Australian sugarcane producing districts from Proserpine south (approximately half of the industry). It has never been recorded north of Proserpine and strict quarantine procedures are in place to prevent the risk of further spread. Within the major canegrowing districts of Mackay and Bundaberg, extensive control programs have been implemented for many years and the disease has not been reported in the past five years. Districts south of, and including, Maryborough continue to report the disease on a regular basis.

Fiji disease is also present in Fiji, Indonesia (limited to native gardens and wild canes on eastern islands and not in commercial crops which are currently restricted to Sumatra, Java, Sulawesi and Kalimantan), Malagasy Republic (now thought to be eradicated), Malaysia, New Caledonia, Papua New Guinea, Philippines, Samoa, Solomon Islands, Thailand, Vanuatu.

Nearest known location to Australia: South Pacific islands and Papua New Guinea

Economic damage: Fiji disease has caused devastating losses and has threatened the existence of the sugar industry in areas of Fiji and southern Queensland (Egan *et al*, 1989). In individual fields, losses of 100% can occur. Fiji disease is potentially one of the most serious diseases of sugarcane when susceptible varieties are present and conditions are suitable for the insect vectors.

Entry potential: It is possible that Fiji disease could spread to Australian territory in the Torres Strait from Papua New Guinea by natural spread of the insect vector. *Saccharum officinarum* is grown widely in native gardens in the Torres Strait and in some communities on Cape York.

The illegal movement of sugarcane cuttings (and related *Saccharum* species) from Papua New Guinea, Irian Jaya, Fiji or other South Pacific islands presents a major risk of the disease entering northern Queensland. Quarantine boundaries under Queensland State legislation are used to prevent movement of cane from Proserpine south to northern districts except when it has been held in quarantine for at least one year.

Colonisation potential: It is highly probable that Fiji disease would be an important disease throughout the regions where it is not currently present in Australia. The vector is already present in these regions.

Spread potential: The insect vector can travel at least 30-50 km and possibly greater than 100 km. The disease can be carried in infected cuttings.

Biology: Fiji disease causes severe stunting, dark green leaves, often with a ragged, bitten-off appearance and diagnostic galls on the underside of leaves (Egan *et al*, 1989). The virus is transmitted by planthoppers of the genus *Perkinsiella* (*P. saccharicida, P. vastatrix, P. vitiensis*). *P.saccharicida* Kirk. is the only vector present in Australia.

Early instars of the insect vectors acquire the virus and can transmit the virus for the rest of their lives. Swarms of the vector can occur under ideal conditions, and it is thought that the disease was spread by insects over distances much greater than 100 kms during the epidemic in southern Queensland.

The incubation period in plants is from 15 days to 6 months. Early symptoms are difficult to detect with only a few small leaf galls occurring in some clones. Cuttings from infected plants produce a high percentage of infected plants.

Physical damage: Severe stunting, dark green leaves, often with a ragged, bitten-off appearance and diagnostic galls on the underside of leaves

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ■ Root ☐ Other ☐

Detection/diagnosis: Galls on the underside of the leaf are the diagnostic symptom of Fiji disease. Microscopic examination of a transverse cross section of the leaf galls can be used to distinguish Fiji galls from other leaf abnormalities. Fiji galls are formed from a proliferation of phloem cells. In some clones the symptoms are difficult to distinguish and the disease has a long latency period. A PCR assay can be used to diagnose the disease (contact Peter Whittle, see below).

Options for response to detection:

Offshore: Already present, no action.

Onshore: A major eradication program would be initiated if the disease was found in commercial fields or non-crop areas in northern Australia. Resistant varieties, destruction of infected plants, control of the vector and strict movement controls on sugarcane plants would be part of the program.

Estimated risk: Fiji disease virus is a high quarantine risk to northern canegrowing districts of Queensland and to the Ord River district. It is a serious disease and occurs in close proximity to these districts.

Quarantine status: Quarantinable

References: Egan, B T, Ryan, C C and Francki, R I B 1989. Fiji disease. In: Ricaud, C, Egan, B T, Gillaspie, A G and Hughes, C G eds. 1989. *Diseases of sugarcane - Major Diseases*. Elsevier, Amsterdam. 263-287.

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5.4 Ramu stunt

Species: Suspect virus or phytoplasma

Author:

Order:

Family:

Common name(s): Ramu stunt

Synonyms and changes in combination:

Hosts: *Saccharum* interspecific hybrids, *S. officinarum*

Distribution: Ramu stunt has only been reported from the Ramu Valley in Papua New Guinea but no extensive survey has been conducted in other parts of Papua New Guinea or surrounding islands (Magarey *et al*, 1995). (Insect vector see pest section)

Nearest known location to Australia: Papua New Guinea

Economic damage: Ramu stunt caused a severe epidemic in the small Ramu Sugar Plantation in Papua New Guinea in 1985/86 with 40% reduction in yield over the whole plantation (Suma and Pias, 1996). Drastic measures had to be taken to limit the damage or yield losses would have increased in subsequent years.

Up to 30% of all clones imported to Ramu Sugar Plantation from overseas are susceptible to Ramu stunt.

Entry potential: Natural spread of the planthopper vector of Ramu stunt to commercial sugarcane fields is considered to be a high risk because of its current common occurrence in the Torres Strait and Cape York. Because the distribution of the pathogen outside the Ramu Valley is unknown, the risk of the pathogen being present in the vector cannot be determined. Ramu stunt could be introduced into Australia in illegally imported plants or cuttings. This is a relatively high risk as there have been a number of cases of sugarcane cuttings being illegally imported to Australia from Papua New Guinea in recent years.

Colonisation potential: Unknown

Spread potential: Unknown

Biology: Ramu stunt causes severe stunting, and chlorotic striping on the leaf blade, general yellowing of the leaves and stool death (Magarey *et al*, 1995). Initial studies have identified a planthopper, *Eumetopina flavipes* Muir as the vector. This insect does not occur in commercial sugarcane in Australia but is common in the Torres Strait islands and has been reported from Cape York (Allsopp, 1991). Nothing is known about the persistence of the pathogen in the vector. The disease can be transmitted by infected cuttings. Similar symptoms to Ramu stunt have been observed in a few grasses but, because no definitive diagnostic procedure has been developed, the presence of the disease cannot be confirmed.

Physical damage: Severe stunting, chlorotic striping on the leaf blade, general yellowing of the leaves and plant death.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ■ Root ☐ Other ☐

Detection/diagnosis: Observation of leaf symptoms. No reliable diagnostic assay is available.

Options for response to detection:

Offshore: BSES currently screens Australian germplasm for resistance in Papua New Guinea.

Onshore: Eradication should be attempted. Destruction of infected plants, resistant varieties and strict movement control of sugarcane plants. Control of the vector would also need to be considered.

Estimated risk: The causal agent of Ramu stunt and its vector *E. flavipes* are high risk quarantine pests for Australia. Because the vector is already in Torres Strait and Cape York and the disease is in PNG, the risk is high.

Quarantine status: Quarantinable

References: Magarey, R C, Suma, S and Egan, BT 1995. New sugarcane diseases in commercial cane at GUSAP, PNG. Proceedings of the International Society of Sugar Cane Technologists. 22:472-476.

Suma, S and Pais, E Major diseases affecting sugarcane production on the Ramu Sugar Estate, Papua New Guinea, In: Croft, B J, Piggin, C M, Wallis, E S and Hogarth, D M, eds. *Sugarcane Germplasm Conservation and Exchange. ACIAR Proceedings*. No. 67, Canberra, 107-121.

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5.5 Mosaic

Species: Sorghum mosaic virus
Sugarcane mosaic virus
Potyvirus- Pakistan

Author:

Order:

Family:

Common name(s): Sugarcane mosaic

Synonyms and changes in combination:

Sorghum mosaic virus = Sugarcane mosaic strains H, I, M
Sugarcane mosaic virus = Sugarcane mosaic strains A, B, C, D, E
Potyvirus- Pakistan = Sugarcane mosaic virus strain F

Hosts: The mosaic viruses can infect a wide range of cultivated and wild grasses from at least 23 genera.

Distribution: Sixty-nine countries including Australia.

In Australia, only strain A of SCMV and the closely related Johnson grass mosaic virus (previously SCMV strain J) (Buchen-Osmond *et al*, 1988) have been reported. The detailed location of strains of SCMV and SrMV (previously SCMV strains, H, I and M) are reported in Koike and Gillaspie (1989). Strain F of SCMV is now thought to be a separate potyvirus (Jensen and Hall, 1993) and has been found in cane imported to the USA from Pakistan.

Nearest known location to Australia: Sorghum mosaic virus has been reported from the USA, India, Japan and the Philippines.

Economic damage: Mosaic has caused serious losses in many countries particularly in sub-tropical areas. Losses have been measured at up to 50% in susceptible varieties (Koike and Gillaspie, 1989). Greatest losses appear to be associated with SrMV (SCMV strains H & I). In Pakistan, mosaic, possibly strain F, is extremely common and is causing significant losses (James, personal communication).

Entry potential: Natural spread of other strains of SCMV or SrMV to Australia is unlikely. Entry of mosaic on illegally imported cuttings of sugarcane or a wide range of other grasses is a high risk.

Colonisation potential: Sugarcane mosaic generally only causes significant disease losses in the sub-tropical regions of the world. In Australia, SCMV has only rarely been reported north of Mackay in the past 50 years. It is likely that any new strains could establish and be important in the districts from Mackay south.

Spread potential: Both SCMV and SrMV are transmitted by at least seven species of aphid in a non-persistent manner (Koike and Gillaspie, 1989). *Rhopalosiphum maidis* (Fitch) and *Dactynotus ambrosiae* Thos. are efficient vectors. Mosaic can also be spread by planting infected cuttings.

Biology: Mosaic produces contrasting shades of green on the leaf lamina and a mosaic pattern on the stem, particularly in sugarcane clones with a reddish stalk colour. Leaf symptoms appear as normal green on a background of paler green or yellow chlorotic areas. Affected plants are generally unthrifty.

Physical damage: Contrasting shades of green on the leaf lamina and a mosaic pattern on the stem, particularly in sugarcane clones with a reddish stalk colour.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ■ Root ☐ Other ☐

Detection/diagnosis: Observation of leaf symptoms, mechanical inoculation to indicator plants, serological and PCR diagnostic assays (contact Grant Smith, see below).

Options for response to detection:

Offshore: No action.

Onshore: Eradication would be difficult because of the wide host range of these viruses. Eradication may be possible if the incursion occurs in an isolated region.

Estimated risk: Sorghum mosaic virus, strains of SCMV other than strain A and the potyvirus from Pakistan (SCMV strain F) are high risk quarantinable pathogens for Australia. Strains not present in Australia are present in Indonesia and the Philippines and therefore present a risk for entry through northern borders.

Quarantine status: Quarantinable

References: Koike, H and Gillaspie, A G 1989. Mosaic. In: Ricaud, C, Egan, B T, Gillaspie, A G and Hughes, C G eds. 1989. *Diseases of Sugarcane - Major Diseases.* Elsevier, Amsterdam. 301-332.

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5.6 Leaf scald

Species: *Xanthomonas albilineans*

Author: (Ashby) Dowson

Order:

Family:

Common name(s): Leaf scald

Synonyms and changes in combination: *Bacterium albilineans, Pseudomonas albilineans, Agrobacterium albilineans, Phytomonas albilineans, Xanthomonas albilineans var. paspali*

Hosts: *Saccharum* complex species (*Saccharum* interspecific hybrids, *S. officinarum, S. spontaneum, S. robustum , S. edule , S. barberi , S. sinense)*, maize (*Zea mays*), *Paspalum dilatatum, Paspalum conjugatum, Brachiaria piligera, Imperata cylindrica, Panicum maximum, Pennisetum purpureum and Rottboellia cochinchinensis.*

Distribution: Fifty-seven countries including Australia. Leaf scald has been recorded in all canegrowing districts in Australia except the Ord River district. Only one serotype of the bacterium has been reported from Australia.

Nearest known location to Australia: Variants of the bacterium not present in Australia occur in Papua New Guinea.

Economic damage: Leaf scald is a serious disease which can cause significant yield losses and loss of highly susceptible varieties.

Entry potential: Not by natural spread. Illegal importation of infected cuttings is the highest risk.

Colonisation potential: Leaf scald can establish and cause serious disease in all sugarcane growing regions.

Spread potential: Infected cuttings produce a high percentage of infected plants. The bacterium can be spread by wind-blown rain, particularly during severe weather events such as cyclones. The disease is also readily spread by cutting implements such as knives and mechanical harvesting and planting equipment. Spread in latently infected cuttings is a high risk.

Biology: The disease can remain latent in plants for months or longer. The bacteria cannot survive for long in the soil but a number of common weed species can act as alternative hosts.

Physical damage: Leaf scald has a wide range of symptoms but the diagnostic symptom is the white, well defined, pencil-line streaks on the leaf blade (Ricaud and Ryan, 1989). The disease also causes burning of the leaf tips giving the plant a scalded appearance, shooting of lateral buds, general chlorosis of the leaves and complete death of stalks.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ■ Root ☐ Other ☐

Detection/diagnosis: Observation of leaf and stalk symptoms, isolation of the bacterium and serological and DNA assays (PCR assays have been developed in the USA but are not yet available in Australia). Serological assays can be performed at BSES Tully and Indooroopilly.

Options for response to detection:

Offshore: Already off shore. No action.

Onshore: Eradication would be attempted if an exotic variant was found in a non-commercial crop area. Resistant varieties and supply of disease-free planting material would be used. Alternative hosts may limit the likely success of an eradication program.

Estimated risk: High risk. Serious pathogen with many variants. One variant not present in Australia is in PNG and could enter through northern borders.

Quarantine status: Quarantinable. Leaf scald is under active control in Australia, with extensive disease-free seed schemes and plant breeding for disease resistance. Only one variant is present in Australia.

References:
Ricaud, C and Ryan, C C 1989. Leaf scald. In: Ricaud, C, Egan, B T, Gillaspie, A G and Hughes, C G eds. 1989. *Diseases of Sugarcane - Major Diseases*. Elsevier, Amsterdam.39-58.

Davis, M J, Rott, P, Warmuth, C J, Chatenet, M and Baudin, P. 1997. Interspecific genomic variation within *Xanthomonas albilineans*, the sugarcane leaf scald pathogen. Phytopathology 87:316-324.

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5.7 White leaf

Species: Sugarcane white leaf phytoplasma

Author:

Order:

Family:

Common name(s): Sugarcane white leaf

Synonyms and changes in combination:

Hosts: *Saccharum* interspecific hybrids, *S. officinarum, S. spontaneum, S. robustum, S. edule* , possibly other grasses but this has not been confirmed by definitive studies.

Distribution: Taiwan, Thailand

Nearest known location to Australia: Thailand (A phytoplasma disease similar to sugarcane white leaf disease was found in grasses in northern Western Australia and Darwin in 1997 but this disease has not been found in sugarcane).

Economic damage: White leaf is a serious disease in Thailand and Taiwan (Rishi and Chen, 1989). Yield losses in severely affected fields can be so great that it is no longer viable to harvest the fields. White leaf is considered the most serious disease of sugarcane in Thailand (Koike, 1986). In Taiwan, the disease was important in the past but extensive control programs have reduced its importance.

Entry potential: Natural spread of white leaf disease by spread of infectious planthoppers is possible, but the limited reports of spread outside the countries in which it occurs suggests that this is a low risk. Spread by illegal import of cuttings is possible. The widespread occurrence in Thailand would suggest this is the most likely source of the disease.

Colonisation potential: The suitability of environments in Australian canegrowing districts for the white leaf phytoplasma and its vector, *M.hiroglyphicus* is unknown.

Spread potential: White leaf disease can be spread by planting infected cuttings and by the planthopper, *Matsumuratettix hiroglyphicus* Matsumura. The vector carries the phytoplasma in a persistent manner, becoming infectious 14-40 days after feeding on an infected plant.

Biology: White leaf disease is characterised by white stripes on the leaves, mottling or total chlorosis (Rishi and Chen, 1989). The symptoms are masked in older plants by low temperatures. Stalks of affected plants are thin. The disease symptoms in plants develop 3-6 months after transmission by the vector. The disease can be eliminated from cuttings by hot water treatment (50° C for 2-3 hr).

Physical damage: Chlorosis of leaves and severe stunting.

Detection/diagnosis: Observation of symptoms and DNA phytoplasma specific probes followed by DNA sequence analysis (contact K. Gibb see below).

Options for response to detection:

Offshore: No action

Onshore: Eradication should be attempted. Destruction of diseased plants and control of the insect vector if present would be required. Strict movement controls on cane plants.

Estimated risk: White leaf disease should be considered a moderate quarantine risk for Australia. If the disease and the vector became established in Australia, the disease could cause significant losses. The risk of introduction to Australia is currently low because of the distance to the nearest known source.

Quarantine status: Quarantinable

References: Rishi, N and Chen, C T 1989. Grassy shoot and white leaf diseases. In: Ricaud, C, Egan, B T, Gillaspie, A G and Hughes, C G eds. 1989. *Diseases of Sugarcane - Major Diseases*. Elsevier, Amsterdam. 289-300.

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5.8 Grassy shoot

Species: Sugarcane grassy shoot phytoplasma

Author:

Order:

Family:

Common name(s): Sugarcane grassy shoot

Synonyms and changes in combination:

Hosts: *Saccharum* interspecific hybrids, *S. officinarum*

Distribution: Bangladesh, Malaysia, Nepal, India, Myanmar, Sri Lanka, Thailand

Nearest known location to Australia: Thailand and Malaysia.

Economic damage: Grassy shoot disease can cause losses of up to 70% in some fields. Affected plants produce little or no millable cane (Rishi and Chen, 1989). Alexander and Viswanathan (1996) rated grassy shoot the third most important disease of sugarcane in India.

Entry potential: Because of the confusion about the vector(s) responsible for transmission of grassy shoot disease, it is difficult to assess the risk of natural spread. Illegal import of cuttings represents a significant risk.

Colonisation potential: Unknown

Spread potential: Unknown

Biology: Grassy shoot produces severe stunting, profuse tillering and chlorotic stripes on the leaf blade (Rishi and Chen, 1989). In some cases the chlorotic stripes coalesce to produce complete chlorosis of shoots.

Grassy shoot is transmitted by planting infected cuttings. The method of secondary transmission has not been conclusively determined. Sorghum, *Sorghum bicolor* (L) Moench, and elephant grass, *Pennisetum purpureum* Schum., are possible alternative hosts but this has not been confirmed by definitive tests.

Physical damage: Chlorosis and severe stunting.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ■ Root ☐ Other ☐

Detection/diagnosis: Observation of symptoms and DNA phytoplasma specific probes followed by DNA sequence analysis (contact K. Gibb, see below).

Options for response to detection:

Offshore: No action

Onshore: Eradication should be attempted. Destruction of diseased plants and strict movement controls on cane plants.

Estimated risk: Grassy shoot phytoplasma is a moderate quarantine risk for Australia. The distance of known sources of infection and the limited history of movement of the disease reduce the risk. The assumed requirement for a vector (all known phytoplasmas have insect vectors) may limit spread in Australia unless the vector is already present or is introduced with the disease.

Quarantine status: Quarantinable

References: Rishi, N and Chen, C T 1989. Grassy shoot and white leaf diseases. In: Ricaud, C, Egan, B T, Gillaspie, A G and Hughes, C G eds. 1989. *Diseases of Sugarcane - Major Diseases.* Elsevier, Amsterdam. 289-300.

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5.9 Leaf scorch

Species: *Stagonospora sacchari*

Author: Lo & Ling

Order:

Family:

Common name(s): Leaf scorch

Synonyms and changes in combination:

Hosts: *Saccharum* complex species (*Saccharum* interspecific hybrids, *S. officinarum, S. spontaneum, S. robustum* , *S. edule* , *S. barberi* , *S. sinense), Micanthus sinensis, M. floridulus.*

Distribution:

Argentina	Indonesia	Philippines
Bangladesh	Japan	South Africa
Cuba	Nigeria	Taiwan
India	Panama	Thailand
Indochina	Papua New Guinea (doubtful)	

Nearest known location to Australia: Indonesian island of Sumatra and the Philippines. The record of leaf scorch in Papua New Guinea is believed to be incorrect.

Economic damage: Leaf scorch is an important disease in Taiwan, Philippines (Lo and Leu, 1989) and more recently Indonesia (Sumatra) (Mirzawan *et al*, 1996). Yield losses of up to 30% have been reported.

Entry potential: The natural spread of leaf scorch to Australia is unlikely. Further spread in Indonesia or from the Philippines to Papua New Guinea would increase this risk. Spread on illegally imported cuttings or leaf pieces is possible. The spread of the disease to Sumatra in the early 1980s is thought to have been associated with an unauthorised import of cane from Taiwan. Transmission by leaf residues on machinery is a definite risk for entry of this pathogen.

Colonisation potential: The epidemiology of leaf scorch disease would suggest that the disease would establish and be more severe in the wet tropical regions, but it could also cause some losses in other regions when environmental conditions are favourable.

Spread potential: Spores are dispersed by wind blown rain and on contaminated leaves or cuttings.

Biology: Spores of *S. sacchari* are formed during periods of free moisture on the affected leaf and are dispersed by rain splash or wind-blown rain. Spores do not spread significantly during dry, windy weather. Exposed spores can survive for two weeks but spores enclosed in pycnidia can survive for several months. The disease is not systemic but spores can adhere to cuttings on pieces of leaf material. The only control measure for leaf scorch is

Physical damage: Leaf scorch causes large reddish-brown to straw coloured spindle shaped streaks on the leaf blade with a definite yellowish halo (Lo and Leu, 1989). The streaks often coalesce giving the leaf a scorched appearance.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ☐ Root ☐ Other ☐

Detection/diagnosis: Observation of leaf symptoms and microscopic identification of fungal spores.

Options for response to detection:

Offshore: No Action.

Onshore: Eradication in a commercial crop is unlikely to be successful but eradication in non- crop areas should be attempted. Containment of an incursion to a region within Australia may be possible. Resistant varieties would be important in eradication programs.

Estimated risk: Moderate quarantine risk. Further movement of the disease in Indonesia would increase the risk.

Quarantine status: Quarantinable

References: Lo, T T and Leu, L S 1989. Leaf scorch. In: Ricaud, C, Egan, B T, Gillaspie, A G and Hughes, C G eds. 1989. *Diseases of Sugarcane - Major Diseases*. Elsevier, Amsterdam.135-143

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5.10 Brown spot

Species: *Cercospora longipes*

Author: E Butler

Order:

Family:

Common name(s): Brown spot

Synonyms and changes in combination:

Hosts: *Saccharum* complex species (*Saccharum* interspecific hybrids, *S. officinarum, S. spontaneum, S. robustum* , *S. edule* , *S. barberi* , *S. sinense)*

Distribution: Thirty-four countries in Africa, Asia and the Americas

Nearest known location to Australia: Papua New Guinea and Indonesia

Economic damage: Brown spot is generally considered to be of minor economic importance (Abbott, 1964) but one report from Louisiana measured yield losses of up to 12% (Abbott, 1951). On a recent study tour of South Africa by BSES pathologists, many fields were observed with severe leaf scorching caused by a heavy infestation of brown spot.

Entry potential: Natural spread is unlikely. Illegal movement of sugarcane is the most likely means of entry into Australia. Brown spot is not a risk in germplasm exchange. High risk areas for entry are the Torres Strait, Cape York and northern cities.

Colonisation potential: Brown spot has been reported to cause significant loss of leaf area in tropical and sub-tropical climates, and it is likely that the disease could establish in many districts of the Australian sugar industry.

Spread potential: Spores of the fungus are produced on both sides of the leaf and are spread by wind blown rain. Spores can be carried on leaf material adhering to cuttings.

Biology:

Physical damage: Brown spot causes red-brown oval shaped lesions on the leaf blade. The spots are surrounded by a narrow yellow halo. Severely affected leaves die prematurely giving fields a scorched appearance.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ☐ Root ☐ Other ☐

Detection/diagnosis: Observation of leaf symptoms and microscopical examination of fungal spores.

Options for response to detection:

Offshore: Already known off shore.

Onshore: Eradication is unlikely to be feasible or justified in commercial crop areas; increased quarantine restrictions if found in northern non-crop areas (Torres Strait, Cape York, Darwin).

Estimated risk: Brown spot should be considered a moderate quarantine risk to Australia. It is present in PNG and therefore could enter through northern borders.

Quarantine status: Quarantinable

References: Abbott, E V 1964. Brown spot. In: Hughes, C G, Abbott, E V and Wismer, C A eds. *Sugar Cane Diseases of the World.* Vol. II, Elsevier, Amsterdam, 24-28

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6.0 DOSSIERS OF OTHER PROPOSED QUARANTINABLE DISEASES OF SUGARCANE THAT ARE NOT CONSIDERED OF HIGH RISK FOR NAQS

6.1 Ratoon stunting disease

Species: *Clavibacter xyli* subsp. *xyli*

Author: Davis *et al*

Order:

Family:

Common name(s): Ratoon Stunting Disease

Synonyms and changes in combination:

Hosts: No recorded natural hosts other than *Saccharum* complex species.

Distribution: It occurs in almost all countries but has not been reported from Papua New Guinea.

Nearest known location to Australia: RSD is widespread in established canegrowing districts of Australia but has not been reported from the Ord River district.

Economic damage: Ratoon stunting disease (RSD) is the most economically important disease of sugarcane because of its widespread occurrence and the difficulty of control (Gillaspie and Teakle, 1989). Yield losses average 20%. In excess of $2 million is spent in Australia each year on control of this disease.

Entry potential: Infected cuttings are the greatest risk of entry.

Colonisation potential: All canegrowing areas.

Spread potential: The disease is highly infectious on cutting implements and spreads easily in diseased cuttings.

Biology: The disease causes no external symptoms which makes diagnosis difficult. No strains of the bacterium have been reported but there has been limited research in this area. Hot water treatment at 50°C for 3 hours which is a standard procedure for quarantine of sugarcane gives a high percentage of disease-free plants. The bacterium does not survive for more than 4-7 days outside host tissue.

Physical damage: No external symptoms other than stunting, red dots in vascular bundles can be seen when stalks are sliced open but the symptoms are not always reliable.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ☐ Stem ■ Root ☐ Other ☐

Detection/diagnosis: Phase contrast microscopic examination, ELISA assay and PCR detection from vascular extracts(contact Barry Croft, see below).

Options for response to detection:

Offshore: Already present, no action.

Onshore: Prevent entry to the Ord River by strict controls on entry of planting material and contaminated equipment, especially cane harvesters and planters.

Estimated risk: High risk to the Ord River district. Low risk to other areas because already present and extensive control program in place.

Quarantine status: Quarantinable for Ord River.

References: Gillaspie, A J and Teakle, D S 1989 Ratoon stunting disease. In: Ricaud, C, Egan, B T, Gillaspie, A G and Hughes, C G eds. 1989. *Diseases of Sugarcane - Major Diseases.* Elsevier, Amsterdam. 59-80.

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6.2 Gumming

Species: *Xanthomonas campestris pv vasculorum*

Author: (Cobb) Dye

Order:

Family:

Common name(s): Gumming

Synonyms and changes in combination: *Bacillus vascularum, Bacterium vascularum, Pseudomonas vascularum, Phytomonas vasculara, Xanthomonas vasculorum*

Hosts: *Saccharum* complex species (*Saccharum* interspecific hybrids, *S. officinarum, S. spontaneum, S. robustum , S. edule , S. barberi , S. sinense)*, maize (*Zea mays* L.), three palms (*Dictyosperma album, Roystonea regia* and *Areca cathecu)*, broom bamboo (*Thysanolaena maxima)* and Gautemala grass (*Tripsacum fasciculatum)*.

Distribution: Thirty countries. Gumming disease was present in Australia until 1950 but there have been no reports since this time and the disease can therefore be considered eradicated. Gumming does not occur in Papua New Guinea or Indonesia and has been eradicated from Fiji.

Nearest known location to Australia: Mauritius, Reunion, Malagasy Republic and Africa.

Economic damage: Gumming was a major disease in Australia until the early 1930s. With the replacement of the noble canes (*S. officinarum*) with interspecific hybrids, the disease decreased in significance. A recent epidemic occurred in Mauritius in the 1980s which caused significant yield losses.

Entry potential: Not by natural spread. Spread by illegal import of cuttings is possible.

Colonisation potential: Gumming disease was widespread in all canegrowing districts of Australia when it was present earlier in this century.

Spread potential: The bacterium is spread by wind-blown rain. The disease can be spread by cutting implements and by planting infected cuttings.

Biology: The bacterium does not survive for long in soil.

Physical damage: Gumming causes yellow to orange leaf streaks on the leaf blade, general chlorosis of the leaves, stalk death and reddening and gum pockets internally within stalks (Ricaud and Autrey, 1989).

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ■ Root ☐ Other ☐

6.3 Leaf blight

Species: *Leptosphaeria taiwanensis*

Author: Yen and Chi

Order:

Family:

Common name(s): Leaf blight

Synonyms and changes in combination:

Hosts: *Saccharum* interspecific hybrids, *S. officinarum*

Distribution: India, Philippines, Japan and Taiwan.

Nearest known location to Australia: Philippines

Economic damage: Leaf blight causes significant loss of green leaf area but no study of the effect of the disease on yield has been reported (Yen, 1964). The disease is only a serious problem in high rainfall areas.

Entry potential: The disease is not carried systemically within cuttings of sugarcane. The risk of natural spread of the disease or spread in authorised imports of germplasm would be negligible. Spread on illegal import of cuttings could occur.

Colonisation potential: Only high rainfall areas.

Spread potential: Spread by wind blown rain over limited distances.

Biology: The disease develops during wet weather.

Physical damage: Leaf blight causes yellow spindle shaped spots on leaves which turn into reddish brown streaks, and these can coalesce to give the leaf a scorched appearance (Yen, 1964).

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ☐ Root ☐ Other ☐

Detection/diagnosis: Observation of symptoms and microscopic examination of spores.

Options for response to detection:

Offshore: No action

Onshore: Eradication is unlikely to be feasible or justified in commercial crop areas; increased quarantine restrictions if found in northern non-crop areas (Torres Strait, Cape York, Darwin).

Detection/diagnosis: Observation of symptoms on leaves and internally in stalks and isolation of bacterium. Serological and DNA diagnostic assays have been developed in Mauritius but are not currently available in Australia.

Options for response to detection:

Offshore: No action.

Onshore: Eradication would be attempted by destruction of diseased plants. Eradication was successful from commercial fields in the 1930-40 period. Introduction of resistant varieties to affected area would assist eradication.

Estimated risk: *Xanthomonas campestris* pv *vasculorum* should be considered an intermediate quarantine risk. Its absence from PNG and Indonesia reduces the risk for entry through northern borders.

Quarantine status: Quarantinable

References: Ricaud, C and Autrey, L J C 1989. Gumming disease. In: Ricaud, C, Egan, B T, Gillaspie, A G and Hughes, C G eds. 1989. *Diseases of Sugarcane - Major Diseases.* Elsevier, Amsterdam. 21-38.

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Estimated risk: Leaf blight is present in the Philippines and could be carried on contaminated cuttings. Limited occurrence and limited history of spread suggest the risk is low.

Quarantine status: Quarantinable

References: Yen, W Y 1964. Leaf blight. In: Hughes, C G, Abbott, E V and Wismer, C A eds. *Sugar Cane Diseases of the World.* Vol. II, Elsevier, Amsterdam, 33-36.

Australian Experts:

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6.4 Ramu leaf scorch

Species: Unknown

Author:

Order:

Family:

Common name(s): Ramu Leaf Scorch

It is currently considered of minor importance at the Ramu Sugar Plantation (Suma and Pais, 1996). Ramu leaf scorch is only a minor quarantine risk for Australia.

Synonyms and changes in combination:

Hosts: *Saccharum* interspecific hybrids, *S. officinarum*

Distribution: Papua New Guinea

Nearest known location to Australia: Papua New Guinea

Economic damage: Significant leaf scorching in some seasons. Some yield loss may occur.

Entry potential: Unknown

Colonisation potential: Unknown

Spread potential: Unknown

Biology: The cause of Ramu leaf scorch (Papua New Guinea) has not been determined but recent research suggests an insect of the genus *Lophops* may be involved.

Physical damage: Straw coloured spots with red-brown margins and a yellowish halo on leaves, scorching of the leaf tip as lesions coalesce.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ☐ Root ☐ Other ☐

Detection/diagnosis: Observation of symptoms, no causal agent determined.

Options for response to detection:

Offshore: Already present, no action.

Onshore: Increased quarantine restrictions if found in northern non-crop areas (Torres Strait, Cape York, Darwin).

Estimated risk: Present in PNG and could enter through the Torres Strait. Risk is difficult to assess until a causal agent is identified.

Quarantine status: Quarantinable

References: Suma, S and Pais, E Major diseases affecting sugarcane production on the Ramu Sugar Estate, Papua New Guinea, In: Croft, B J, Piggin, C M, Wallis, E S and Hogarth, D M, eds. *Sugarcane Germplasm Conservation and Exchange. ACIAR Proceedings.* No. 67, Canberra, 107-121.

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6.5 Red leaf mottle

Species: Peanut clump virus

Author:

Order:

Family:

Common name(s): Red Leaf Mottle

Synonyms and changes in combination:

Hosts: Sugarcane, sorghum and peanuts

Distribution: Burkina Faso, Senegal and Sudan

Nearest known location to Australia: Africa

Economic damage: Red leaf mottle can cause significant yield losses of up to 6% in the plant crop but losses are less in ratoon crops (Baudin *et al*, 1994).

Entry potential: Could be carried in infected cuttings.

Colonisation potential: The vector of peanut clump virus is a common fungal soil inhabitant and therefore there is a potential for the disease to spread in many sugarcane districts. However, not enough is known about the disease in sugarcane to determine the likely extent of the disease.

Spread potential: The disease is transmitted in soil by the fungus, *Polymyxa graminis,* and by planting infected cuttings

Biology:

Physical damage: Red leaf mottle causes a range of symptoms in different clones (Rott, 1996). The symptoms include chlorotic stripes with red-brown mottling, wine red leaf spots or white streaks or patches.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ■ Root ☐ Other ☐

Detection/diagnosis: ELISA assays are available (contact Philippe Rott, CIRAD, Montpellier, France, Email rott@cirad.fr)

Options for response to detection:

Offshore: No action.

Onshore: Destroy infected plants, restrict movement of sugarcane cuttings.

Estimated risk: The risk is low because of the limited occurrence. Risk may be higher in peanuts.

Quarantine status: Quarantinable

References: Baudin, P, Sene, A and Marion, D 1994. Effect of peanut clump virus on the yields of two sugarcane varieties. In: Rao, G P, Gillaspie, A G, Upadhyaya, P P, Bergamin Filho, A, Agnihotri, V P and Chen, C T eds. *Current Trends in Sugarcane Pathology.* International Books and Periodicals Supply Service, Pitampura, Delhi, 141-150.

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6.6 Ramu streak

Species: Unknown

Author:

Order:

Family:

Common name(s): Ramu Streak

Synonyms and changes in combination:

Hosts: Unknown

Distribution: Ramu Valley, Papua New Guinea

Nearest known location to Australia: Papua New Guinea

Economic damage: Unknown

Entry potential: Unknown

Colonisation potential: Unknown

Spread potential: Unknown

Biology: A chlorotic streak symptom distinguishable from other known sugarcane diseases has been observed at a relatively high incidence in some fields on the Ramu Sugar Plantation in Papua New Guinea (Magarey *et al*, 1995). Nothing is known about the cause, transmission, distribution or economic importance of the disease.

Physical damage: Yellowish-green streaks on the leaf blade.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ☐ Root ☐ Other ☐

Detection/diagnosis: Observation of symptoms, no assay is available.

Options for response to detection:

Offshore: Already present, no action.

Onshore: Increased quarantine restrictions if found in northern non-crop areas (Torres Strait, Cape York, Darwin).

Estimated risk: Present in PNG and could enter through the Torres Strait. Difficult to assess until a causal agent is identified.

Quarantine status: Quarantinable

References: Magarey, R C, Suma, S and Egan, B T 1995. New sugarcane diseases in commercial cane at GUSAP, PNG. Proceedings of the International Society of Sugar Cane Technologists. 22:472-476.

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6.7 Sereh

Species: Unknown

Author:

Order:

Family:

Common name(s): Sereh

Synonyms and changes in combination:

Hosts: *Saccharum officinarum*

Distribution: Indonesia, possibly China. A recent report of a sereh-like disease in a cane imported to Taiwan from China is the first report of similar symptoms for many years (personal communication reported by Croft, 1996).

Nearest known location to Australia: Indonesia

Economic damage: Sereh was a devastating disease in Indonesia in the early part of this century but disappeared when hybrid varieties were introduced.

Entry potential: Carried in cuttings. Unknown

Colonisation potential: Unknown

Spread potential: Unknown

Biology: Unknown

Physical damage: Profuse tillering, grassy appearance, severe stunting, adventitious hairy roots on many or all nodes of a stalk, reddening of the vascular bundles within stalks and sometimes on leaves.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ■ Root ☐ Other ☐

Detection/diagnosis: Observation of symptoms.

Options for response to detection:

Offshore:

Onshore:

Estimated risk: This disease has not been reported for many years except for a recent report from Taiwan in canes imported from China. However there is no way to confirm that this was in fact sereh disease. The disease was present in Indonesia. The risk must be low.

Quarantine status: Quarantinable

References: Rands, R D and Abbott, E V 1964 Sereh. In: Hughes, C G, Abbott, E V and Wismer, C A eds. *Sugar Cane Diseases of the World.* Vol. II, Elsevier, Amsterdam, 182-189.

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6.8 Yellow leaf syndrome

Species: Sugarcane yellow leaf virus and an undescribed phytoplasma

Author:

Order:

Family:

Common name(s): Yellow leaf syndrome (YLS)

Synonyms and changes in combination:

Hosts: *Saccharum* interspecific hybrids, *S. officinarum*

Distribution: Australia, Brazil, South Africa, USA (including Hawaii), Venezuela, and probably widespread.

Nearest known location to Australia: Both the sugarcane yellow leaf virus and the undescribed phytoplasma have been recorded in Australia, but the distribution and the diversity of the pathogens in Australia is still under investigation.

Economic damage: Yellow leaf syndrome has caused significant losses in Hawaii and Brazil (Burnquist and Vega, 1996). Major varieties have been withdrawn from production because of their susceptibility to this syndrome.

Entry potential: The introduction of YLS to Australia in illegal imports of cuttings is possible. YLS symptoms were detected in clones legally imported from Florida to Australia in 1994 (Croft and Smith, 1996). These clones were destroyed.

Colonisation potential: Unknown

Spread potential: Unknown

Biology: Yellow leaf syndrome is characterised by yellowing of the mid-rib of the first few fully expanded leaves (Lockhart *et al*, 1996), with yellowing and reddening sometimes extending out onto the leaf blade. Sugarcane yellow leaf virus has been transmitted by aphids. The vector of the phytoplasma is unknown. Both the virus and the phytoplasma are carried in infected cuttings.

Physical damage: Yellowing of the leaf mid-rib and unthrifty growth.

Plant part affected: Flower ☐ Fruit ☐ Seed ☐ Leaf ■ Stem ☐ Root ☐ Other ☐

Detection/diagnosis: Observation of symptoms. PCR assays are being developed for the virus and phytoplasma associated with YLS (contact Grant Smith, see below).

Options for response to detection:

Offshore: No action.

Onshore: Eradication should be attempted until more information is available about the status of this disease in Australia. The northern borders are not seen as a high risk for entry of YLS because the status of the disease in PNG and Indonesia is unclear.

Estimated risk: The causal agents of yellow leaf syndrome must be considered high risk pests for Australia until further information is available about the causal agents and the distribution of the agents in Australia.

Quarantine status: Quarantinable

References: Lockhart, B E L, Irey, M J and Comstock, J C 1996. Sugarcane bacilliform virus, sugarcane mild mosaic virus and sugarcane yellow leaf syndrome. In: Croft, B J, Piggin, C M, Wallis, E S and Hogarth, D M, eds. *Sugarcane Germplasm Conservation and Exchange. ACIAR Proceedings*. No. 67, Canberra, 108-112.

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APPENDIX 1

Quarantine pathogens of sugarcane for the Ord River region which occur in the eastern states of Australia.

Pathogen type	Species name	Author	Common name
Bacterium	*Xanthomonas albilineans*	(Ashby) Dowson	Leaf scald
Bacterium	*Clavibacter xyli subsp. xyli*	Davis *et al*	Ratoon stunting disease
Fungus	*Pachymetra chaunorhiza*	Croft & Dick	Pachymetra root rot
Fungus	*Glomerella tucumanensis*	(Speg.) v. Arx & E. Müller	Red rot
Fungus	*Puccinia melanocephala*	H. & P. Sydow	Rust (common)
Fungus	*Mycovellosiella koepkei*	(Krüger) Deighton	Yellow spot
Fungus	*Drechslera sacchari*	E. Butler	Eye spot
Virus	Fiji disease virus		Fiji disease
Virus	Sugarcane mosaic virus		Mosaic
Virus	Sugarcane striate mosaic virus		Striate mosaic
Unknown	Unknown		Chlorotic streak