

Sixth session
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PLANT PATHOGENS IMPORTANT FOR THE BWC

Working Paper by South Africa

The list of plant pathogens that was drawn up at the fourth session of the Ad Hoc Group was evaluated against the criteria drawn up at the same session. These criteria are :

1. Agents known to have been developed, produced or used as weapons.
2. Agents which have severe socio-economic and/or significant adverse human health impacts, due to their effect on staple crops, to be evaluated against a combination of the following criteria
 - a) Ease of dissemination (wind, insects, water, etc.);
 - b) Short incubation period and/or difficult to diagnose/identify at an early stage;
 - c) Ease of production;
 - d) Stability in the environment;
 - e) Lack of availability of cost-effective protection/treatment;
 - f) Low infective dose;
 - g) High infectivity;
 - h) Short life cycle.

3. The findings of this evaluation are summarised in the attached table. Also attached is a brief description of each of the plant pathogens on the list.
4. According to this evaluation, only the following plant pathogens should appear on the List :
 - Colletotrichum coffeanum var virulans.
 - Dothistroma pini.
 - Erwinia amylovora.
 - Pseudomonas solanacearum.
 - Pyricularia oryzae
 - Ustilago Maydis
 - Xanthomonas
 - Xanthomonas albilineans.
 - Xanthomonas campestris pv oryzae.
 - Telletia tritici.
 - Sclerotinia Sclerotium

EVALUATION TABLE OF PLANT PATHOGENS

Criteria

	PLANT PATHOGEN	1	2	2a	2b	2c	2d	2e	2f	2g	2h	BW potential
1	Citrus greening disease bacteria	-	-	-	+	-	-	+	-	-	+	Doubtful
2	<i>Colletotrichum coffeanum</i> var <i>virulans</i>	-	-	+	-	+	+	-	±	-	NA	Good
3	<i>Chochliobolus miyabeanus</i>	-	±	+	-	+	+	-	±	-	NA	Doubtful
4	<i>Dothistroma pini</i> (<i>Scirrhia pini</i>)	-	+	+	+	-	+	+	+	+	NA	Good
5	<i>Erwinia amylovora</i>	-	+	+	±	+	-	+	+	+	NA	Good
6	<i>Microcyclus ulei</i>	-	-	+	±	+	-	-	-	-	NA	Doubtful
7	<i>Phytophthora infestans</i>	-	+	+	+	+	+	-	+	+	NA	Doubtful
8	<i>Pseudomonas solanacearum</i>	-	+	+	+	+	+	+	+	+	NA	Good
9	<i>Puccinia erianthi</i>	-	-	+	-	-	-	+	-	+	NA	doubtful;
10	<i>Puccinia graminis</i>	+	+	+	-	-	+	+	+	+	NA	Medium
11	<i>Puccinia striiformis</i> (<i>Puccinia glumarum</i>)	-	+	+	-	-	-	-	-	+	NA	Limited
12	<i>Pyricularia oryzae</i>	+	+	+	-	+	+	-	+	+	NA	Good
13	Sugar cane Fiji disease virus	-	+	-	-	-	-	-	-	-	+	Limited
14	<i>Tilletia indica</i>	-	-	+	+	-	+	-	+	+	NA	Weak
15	<i>Ustilago Maydis</i>	-	+	+	+	+	+	+	+	+	NA	Good
16	<i>Xanthomonas albilineans</i>	-	+	+	+	+	+	+	-	+	NA	Good
17	<i>Xanthomonas campestris</i> pv <i>citri</i>	-	-	+	+	+	-	±	+	+	NA	Limited
18	<i>Xanthomonas campestris</i> pv <i>oryzae</i>	-	+	+	-	+	+	+	+	+	NA	Good

19	<i>Tilletia tritici</i>	+	+	+	+	-	+	-	+	+	NA	Good
20	<i>Sclerotinia sclerotiorum</i>	-	+	+	-	+	+	+	+	+	NA	Good

+ Conforms to criterium - Does not conform to criterium

SUMMARY OF CHARACTERISTICS OF PLANT PATHOGENS

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The following summarized information is where possible, mainly based on the internationally accepted CMI (Commonwealth Mycological Institute of the Commonwealth Agricultural Bureaux International) descriptions:

1. Citrus greening disease bacteria

The status of this pathogen is still uncertain; Bacterium, Mycoplasma Like Organism (MLO) or Phytoplasma. Can be reasonably destructive on citrus (non-staple food) causing deformed fruit, dwarfed plants, decreased yields etc.

Distribution: Southern Africa, South East Asia.

Transmission: Needs insect vector; African or Asian Psyllids, grafting.

Control: Vector control to limit distribution, tree injection with tetracyclines gives non-permanent relief but cumbersome and expensive.

Environmental stability: stable in living host. Stability outside host unknown. Climatic requirements of vector determines importance of disease.

Ease of production: Conflicting reports on ability of pathogen to be cultured. Must accept as extremely difficult to mass produce. Vector easily mass reared.

BW potential: Doubtful

2. *Colletotrichum coffeanum* var. *virulans*

Fungal pathogen now known as *Colletotrichum kahawae* and causes anthracnose of coffee berries (Coffee berry disease). Can be very destructive in terms of yield loss and seedling death of this non-staple food crop but does not kill mature plants. Different races have not yet been recorded.

Distribution: Central and southern Africa.

Transmission: Seed borne, rain splash, passive vectors such as man, birds and machinery.

Control: Fungicide sprays are not effective. Chemical seed treatment not yet successfully developed. Resistant varieties are available.

Environmental stability: Can survive as latent infection. Conidiospores have a short life but conidia can survive more than a year on plant debris.

Ease of production: Can be mass produced on artificial substrates but is notoriously unstable under these conditions and loses its pathogenicity rapidly.

BW potential: Not a staple food and thus not regarded as important but may cause serious world wide economic problems.

3. *Cochliobolus miyabeanus* (CMI 302)

Brown spot of rice can be highly destructive when causing seedling death and less destructive as a leafspot. Infection process needs specific micro climatic conditions and plant development stage(s)

Distribution: Occurs in all rice producing regions.

Transmission: Seed borne, Wind

Control: Use of resistant cultivars (all major rice producers have resistant germplasm available),

chemical seed treatment, fungicide sprays can be effective. Disease can be successfully controlled.

Pathogen overwinters and is stable on plant debris.

Fungus can be easily mass produced

BW potential: doubtful.

4. *Dothistroma pini* (*Scirrhia pini*) (CMI 368)

Dothistroma blight of pines can be highly destructive depending on the frequency of infection. The fungus needs specific narrow climatic conditions for infection.

Distribution: Europe, Asia, Africa, North and South America. Different races have not been recorded.

Transmission: Seed borne, wind, clouds may carry spore inoculum.

Control: Resistant pine species are available. Non-systemic fungicide sprays show some activity but are not practical and economically viable

Environmental stability: Inoculum viability debris limited to 2-6 months.

Mass production of the pathogen is easily done on artificial substrates.

BW potential is good although pine is not a staple food it is of strategic

5. *Erwinia amylovora* (CMI 44)

Fire blight of apple, pear, quince and related species is very destructive. Not yet recorded in South Africa.

Distribution: North America, Central America, New Zealand, Japan, China, Europe, North Africa.

Transmission: Water, vegetative material, insects.

Control: Eradicate infected material. Chemical and antibiotic sprays not very successful.

The bacteria is not stable in the environment outside its host material.

This pathogen can easily be produced in commercial fermenters.

BW potential: good.

6. *Microcyclus ulei* (CMI 225)

South American leaf blight of Para rubber is highly destructive and has prevented the development of a natural rubber industry in America. A number of different races occur making breeding for resistance therefor more complicated.

Distribution: Restricted to tropical South and Central America The fungus needs specific temperature and humidity conditions for infection limiting its possible BW potential.

Transmission: Airborne spores.

Control: Sprays of dithane in early stages are effective. Use of resistant varieties is limited as these deliver inferior yields.

The fungus has a short life cycle and is not stable without its host.

Slow growth rate on artificial media may lead to difficulty in production (contaminants etc) but not impossible

BW potential is doubtful.

7. *Phytophthora infestans* (CMI 238)

Late blight of potato and tomato is extremely destructive on this staple food caused by a fungus with a wide host range of members of the Solanaceae. Two distinct compatibility groups with a number of races each exist and new races develop continuously. Infection is dependent on specific climatic conditions.

Distribution: World wide.

Transmission: Wind and rain splash.

Control: Systemic and contact fungicides give good control but is expensive. Resistant cultivars are attacked by new races.

Stability in tubers, plant debris, haulms is good and fungus lasts a long time in contaminated soil.

The pathogen can easily be produced in large quantities on artificial substrates.

BW potential: doubtful.

8. *Pseudomonas solanacearum* (CMI 15)

Potato, tomato and tobacco wilt; slime disease, Granville wilt; bacterial ring disease, Moko disease of banana are some of the most devastating diseases caused by this bacterium which attacks numerous hosts of Solanaceae, Musaceae, Compositae, Fabacea etc. Different races of the bacterium occurs which combined with its broad host range make breeding for resistance difficult.

Distribution: Tropical, subtropical and warm temperate parts of: Asia, Africa, Australasia, Europe, West Indies, North and Central America.

Transmission: Infected material, contaminated soil, water, implements.

Control: No effective chemical treatments available. Resistant cultivars or varieties but new races develop continuously.

The bacterium is stable in soil and host tissue. Spores are not produced and vegetative unprotected cells have limited life span.

Easily produced in relatively simple fermenters.

BW potential: Excellent.

9. *Puccinia erianthi* (CMI 9)

Leaf Rust of sugarcane can be destructive on certain standard varieties. Two races of the rust fungus have been reported. The pathogen has a very narrow host range.

Distribution: China, India.

Transmission: Wind

Control: Certain fungicides have been found effective. Although resistance exists, no large scale breeding programs have been reported.

Environmental stability: Although the spores remain viable up to 5 weeks between 18-28C, temperatures of over 35C inactivates them rapidly. Urediospores remain viable for only a few hours. Pathogen remains stable on volunteer plants.

This obligate parasite can only be produced on live hosts. Its narrow host range complicates matters..

BW potential: doubtful.

10. *Puccinia graminis* (f.sp.*tritici* and *secalis*) (CMI ?)

Stem rust or black rust of wheat and barley has in the past been very destructive. Use of resistant cultivars is probably limiting its destructiveness. However a number of different races exists making breeding for resistance complicated. Although the host range can be regarded as narrow, this rust fungus needs a alternative host (*Berberis* and certain *Mahonia* spp.) to complete its complex life cycle. The full cycle is not a prerequisite for continued pathogenicity on cereals but is necessary for overwintering and early infection of wheat as well as the development of new races.

Distribution: World wide

Transmission: Wind, as surface contaminant of seed.

Control: Resistant cultivars although resistance is not permanent as new races of the pathogen continuously develop. Incomplete life cycle impedes this development. Fungicidal sprays have not been very successful.

Stability in environment is good on hosts and plant debris while free urediospores and teliospores have limited lifespan.

Ease of production: This obligate parasite needs living hosts and is further complicated by its need for alternative hosts for completion of its life cycle.

BW potential: Average because of its production problems. Most countries have active breeding programmes and consequently a short reaction time. The potential may be improved by genetic manipulation.

11. *Puccinia striiformis* (CMI 291)

Yellow rust (Europe), stripe or glume rust (N America) of cereals and 40 genera of grasses can be highly destructive in temperate regions. More than 50 races and several forma specialis of the rust fungus have been identified. Breeding for resistance is therefore complicated.

Distribution: Europe, Asia, N America, S America, C America, C Africa. Not recorded in Australasia.

Transmission: Over long distances by wind.

Control: Resistant cultivars/varieties. Fungicide sprays can be successful but not economically viable.]

Stability in environment: needs volunteer plants, grasses or debris to overwinter. Massive spread of inoculum indicates hardy spores.

Difficult to produce in large quantities as pathogen is obligate parasite and Live hosts are needed.

BW potential: limited because of production problems and temperate climatic requirements.

12. *Pyricularia oryzae* (CMI 169)

Blast disease of rice can be very destructive (90%) on this staple food. With its many races (219) and broad host spectrum, breeding for resistance is complex. The fungus needs high temperature and humidity for infection.

Distribution: Widespread; Africa, Asia, Australasia, Europe, N America, S America, C America, W Indies.

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Transmission: Wind.

Control: Resistant cultivars, Sprays of environmentally harmful fungicides can be effective.

Environmental stability: Stable, overwinters on straw and debris from reinfection takes place

Can easily be mass produced.

BW potential is good.

13. Sugarcane Fiji disease

Fiji disease is caused by a Phytoreo virus which is very destructive only on sugarcane.

Distribution: Fiji, Australia, Indonesia, Malaysia, Madagascar, Papua New Guinea, Phillippines, Samoa, Solomon Islands, Thailand, Vanuatu.

Transmission: The virus can only be transmitted by cuttings or plant hoppers as vector. Occurrence is coupled to conditions favourable to the insect vector.

Control: Control of vector and use of disease free propagation material.

Environmental stability: Virus particles occur

only in vector and infected plant material and never as free particles.

Ease of production: Difficult as live host is needed. Large scale rearing of plant hoppers is relatively simple.

BW potential: Limited. Dissemination of the virus will have to be through large mass releases of infected vector insects.

14. *Tilletia indica* (CMI 748)

This obligate parasite occurs only on and causes Karnal bunt of wheat and Triticale. Different races have not been found. The fungus needs high humidity/dew and low temperatures to infect plants during flowering phase. Infection is not systemic and disease is not highly destructive but affects quality.

Distribution: India, Pakistan, Iraq, Afghanistan, Mexico, Brazil.

Transmission: Wind, Contaminated soil, Infected seed.

Control: Chemical seed treatment is effective and economical

Environmental stability: Teliospores survive well in soil

Ease of production: Problems associated with obligate parasites - needs live hosts.

BW potential: Poor, pathogen is to 'mild' to warrant attention.

15. *Ustilago maydis* (CMI 79)

Maize smut, Common smut, Blister smut can cause appreciable losses (10-17%) In addition, the spores can induce allergic reaction in man and may be toxic to animals and man. More than 500 races have been noted complicating the search for resistance.

Distribution: Worldwide where maize (corn) is grown) except New Zealand.

Transmission: Wind, seed surface borne, contaminated soil.

Control: Heat or chemical seed treatment but this is useless where soil is contaminated. Possibly resistant cultivars.

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Environmental stability is excellent. Spores remained viably after 8 years in dry soil.

Can be mass produced on artificial substrates.

BW potential: Good.

16. *Xanthomonas albilineans* (CMI 18)

This bacterium causes leaf scald on sugarcane where can become highly destructive. It has a wide

host range and can occur on maize and a number of grass species. The large number of races complicates breeding for resistance.

Distribution: Africa, Central & South America, Asia, Australasia.

Transmission: Infected sets,
Aerial dispersal, Insects, Rodents.

Control: Heat treatment of sets, resistant varieties. No chemical treatment available.

Environmental stability: The bacterium does not produce resistant spores. Disease may remain dormant as systemic infection until environmental conditions favours symptom expression.

The bacterium can easily be mass produced in simple commercial fermenters.

BW potential: Good.

17. *Xanthomonas campestris* pv. *citri* (CMI 11)

The bacterium causes citrus canker which can be very destructive on grapefruit. It is divided in 3 strains and attacks a broad spectrum of *Citrineae*.

Distribution: Africa, Asia, Australasia, S America

Transmission: Wind, Rain, Insects, Animals.

Control: Eradication of infected material, Resistant varieties. Chemical sprays are only partially successful. Disease was successfully eradicated in South Africa and USA.

Environmental stability: Limited. Does not produce resistant spores. Can survive 6 months on debris and 6 days in natural soils.

Can easily be mass produced in simple commercial fermenters.

BW potential: Limited because of stability. Grapefruit cannot be regarded as staple food.

18. *Xanthomonas campestris* pv. *oryzae* (CMI 239)

The broad host range bacterium causes bacterial blight of rice and Kresek disease of rice. Kresek is caused by the systemic infection in the tropics and is extremely destructive. Differences in pathogenicity between isolates have been reported but there are no differential varietal reactions to complicate breeding for resistance.

Distribution: Asia, Africa, S America, Mexico, Korea, Taiwan, Indonesia.

Transmission: Wind, Rain, Flood, vegetate material, Seed borne.

Control: Chemical seed treatment, Resistant cultivars, Elimination of volunteers. Chemical sprays not successful.

Environmental stability: Does not produce resistant or hardy spores. Overwinters on volunteers or in weed rhizosphere. Survival on debris seem limited.

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Can be easily mass produced in simple commercial fermenters.

BW potential: Medium to good. Candidate for genetic manipulation.

19. *Tilletia tritici* (CMI ?)

Cover smut, Stinking smut, Common bunt of wheat is caused by this broad host range fungus pathogen which has a single host life cycle. The fungus attacks the inflorescence replacing the kernels with bunt balls of black teliospores. The disease is regarded as very important, it suppresses yields and lowers the quality and smelly trimethylamine is produced while the spores may ignite and cause an explosion during

harvesting.

Distribution: Worldwide.

Transmission: Seed surface borne, Wind, contaminated soil.

Control: Resistant cultivars - they are short lived because new races continuously develop. Chemical seed treatment.

Environmental stability: Teliospores can survive up to 2 years in soil.

Production of this obligate parasite needs live hosts but as vast numbers of spores can be harvested, mass production is not impossible.

BW potential: Good. Could possibly be enhanced by genetic manipulation.

20. *Sclerotinia sclerotiorum* (CMI 513)

This plurivorous fungus causes cottony soft rot, white mold, and watery soft rot on a broad host spectrum such as vegetables, beans, sunflower, groundnuts soya bean and many others except cereals and woody plants. The fungus can attack any above ground parts at any development stage and is extremely destructive under cooler moist conditions as found under irrigation.

Distribution: Worldwide

Transmission: Airborne ascospores, Seed infected with mycelium or contaminated with sclerotia (survival structure)

Control: Disease free and uncontaminated seed, Fungicide sprays effective only during narrow time window 24-72 hours). No resistance to this disease has yet been found.

10 February 1997. This fungus can easily be mass produced on artificial substrate.

BW potential: High. Good candidate for genetic manipulation to broaden its temperature spectrum.
