Pathogen Risks Associated with Bulk Maize Imports to Australia from the United States of America

A REPORT BY TECHNICAL WORKING GROUP 1: DISEASE RISK ANALYSIS, FOR THE IMPORT RISK ANALYSIS OF THE IMPORT OF MAIZE FROM THE USA FOR PROCESSING AND USE AS ANIMAL FEED

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Summary

At least ten pathogens can occur in the pathway, of bulk maize grain imports from the United States of America (USA), that pose high quarantine risks to Australian agriculture. These pathogens, in order of overall risk, are:

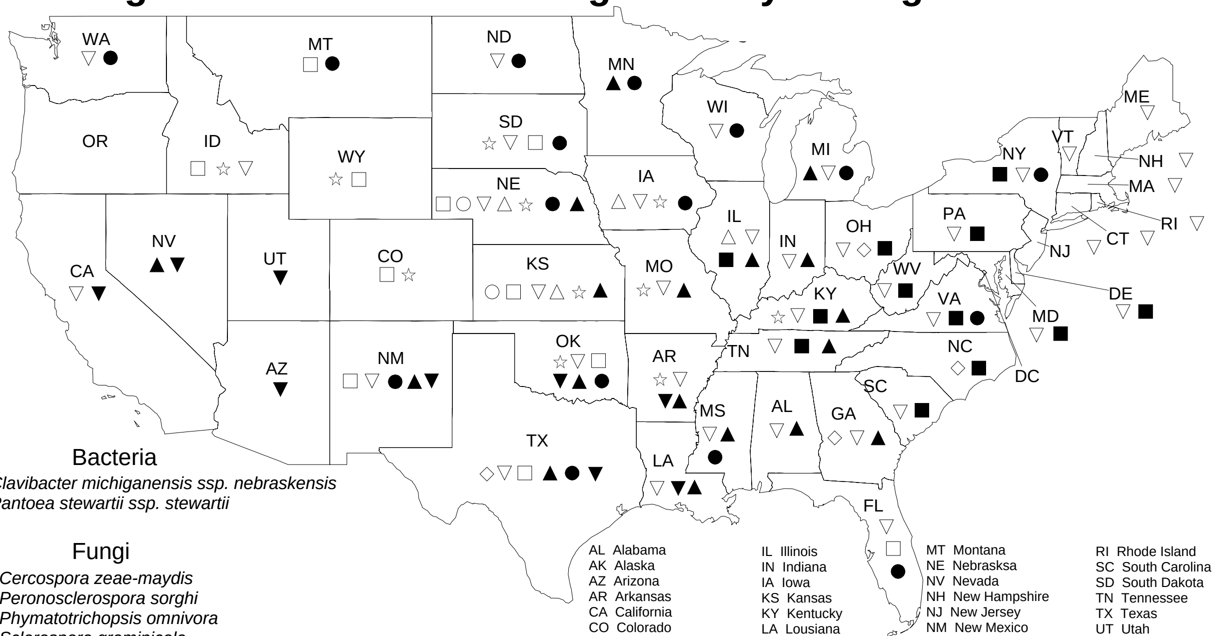
- *Peronosclerospora sorghi*, which attacks sorghum and maize causing downy mildew
- Maize dwarf mosaic potyvirus, which attacks maize
- High Plains virus, which attacks maize and wheat
- Wheat streak mosaic rymovirus, which attacks maize and wheat
- *Sclerospora graminicola*, which attacks maize, sorghum, pearl millet and many grasses
- *Phymatotrichopsis omnivora*, which causes Texas root rot of cotton and numerous other dicotyledonous plants
- Maize chlorotic mottle machlomovirus, which attacks maize
- Cercospora zeae-maydis, which attacks maize causing gray leaf spot
- *Pantoea stewartii*, which causes Stewart's wilt, a serious disease of sweet corn
- *Clavibacter michiganensis* subsp. *nebraskensis*, which causes Goss's bacterial wilt of maize

We regard the risk of an exotic pathogen escaping during transport and handling of untreated bulk maize grain from port of entry to final use at a feed lot to be very high.

A worst case scenario from allowing bulk imports into Australia of USA maize grain would be that a pathogen like *Peronosclerospora sorghi* could establish and spread in Australia, jeopardising the sorghum and maize industries that have current gross values of $225 million and $75 million per year, respectively. If *Tilletia indica*, the cause of Karnal bunt in wheat, were introduced through wheat admixtures in the bulk maize, the $5 billion Australian wheat industry could be severely damaged through loss of export markets.

According to our assessment, it will not be possible to source maize grain from areas in the USA free of all high risk quarantine pathogens (Figure 1). We believe that the only feasible way of minimising risks is to heat treat the grain either off-shore or at port of entry. If heat treatment is applied before shipment, then further safeguards, including cleanliness of ship's holds and rail cars, as well as integrity of the shipment, will be required.

Figure 1. Distribution of High Priority Pathogens in the USA



Bacteria

△ *Clavibacter michiganensis ssp. nebraskensis*
▽ *Pantoea stewartii ssp. stewartii*

Fungi

■ *Cercospora zeae-maydis*
▲ *Peronosclerospora sorghi*
▼ *Phymatotrichopsis omnivora*
● *Sclerospora graminicola*

Viruses

□ High Plains virus
○ Maize chlorotic mottle machlomovirus
◇ Maize dwarf mosaic potyvirus
☆ Wheat streak mosaic rymovirus

AL Alabama
AK Alaska
AZ Arizona
AR Arkansas
CA California
CO Colorado
CT Connecticut
DE Delaware
DC District of Columbia
FL Florida
GA Georgia
HI Hawaii
ID Idaho

IL Illinois
IN Indiana
IA Iowa
KS Kansas
KY Kentucky
LA Lousiana
ME Maine
MD Maryland
MA Massachusetts
MI Michigan
MN Minnesota
MS Mississippi
MO Missouri

MT Montana
NE Nebrasksa
NV Nevada
NH New Hampshire
NJ New Jersey
NM New Mexico
NY New York
NC North Carolina
ND North Dakota
OH Ohio
OK Oklahoma
OR Oregon
PA Pennsylvania

RI Rhode Island
SC South Carolina
SD South Dakota
TN Tennessee
TX Texas
UT Utah
VT Vermont
VA Virginia
WA Washington
WV West Virginia
WI Wisconsin
WY Wyoming

Map prepared by AQIS, based on pathogen distribution information contained in the datasheets at Appendix 3.
1/3/99

Report of Technical Working Group 1

Disease Risk Analysis for Bulk Grain Imports from the USA

The disease risk analysis was conducted according to the FAO's "International Standards for Phytosanitary Measures, Guidelines for Pest Risk Analyses" (Annex 2, Part 2, pp. 44-59 of Anon., 1998). Membership to the Disease Risk Analysis Technical Working Group and Terms of Reference are:

Membership

Professor John Irwin (Chair)	Professor of Botany University of Queensland, Brisbane
Dr Sharan Singh	Manager, Grains and Seeds Market Access Team Plant Quarantine Policy Branch Policy and International Division Australian Quarantine and Inspection Service Canberra
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Terms of reference

- *Identify quarantine pathogens associated with imports of maize grain from the USA consistent with the International Standard for Phytosanitary Measures (ISPM), Guidelines for Pest Risk Analysis, developed by the Food and Agriculture Organisation of the United Nations (FAO), and in particular assess the potential of these pathogens to*
  - *enter, establish and spread in Australia and,*
  - *cause economic damage, including crop losses and loss of export markets.*
- *Consider various risk management options consistent with the Australian government policy, the World Trade Organisation (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement) and relevant international standards, including the FAO International Standards for Phytosanitary Measures (ISPMs).*
- *Liaise on relevant issues with other Technical Working Groups (TWGs) established under the Risk Analysis Panel (RAP) on the import of maize grain from the USA, and other national and international technical experts, as necessary.*
- *Assess the key disease risks associated with contamination of bulk shipments of maize with seeds of other agricultural plant species such as barley, oat, millet, sorghum, soybean and wheat.*
- *Report the findings of the working group to the RAP.*

Earlier Pest Risk Analyses

Three pest risk analyses have recently been done on maize grain from the USA (Phillips, 1994a, b; Evans *et al*., 1996). The terms of reference for Phillips' (1994a, b) studies were similar to those for this study. However, Dr Phillips was given only one month to complete the reports, which necessitated a very rapid appraisal of the information available. The Evans *et al*. (1996) report dealt with risks associated with the transport of imported bulk grain within Australia.

In the current study, Technical Working Group 1 has made a more comprehensive study of the disease risks associated with the import of bulk maize grain from the USA than was possible for Phillips (1994a, b). The conclusions reached by TWG 1 will enable the RAP to reconsider the conclusions reached by Evans *et al*. (1996).

Stage 1: Initiating the Pest Risk Analysis

The pathway was identified as bulk maize grain imports from the USA. The area of origin of the maize grain was considered to be the entire USA.

The key issue is that commercial quantities of tens of thousands of tonnes of grain would be involved. Other factors in the pathway that require consideration include: soil, trash, and admixtures of other grains (eg. barley, oats, millet, sorghum, soybean, wheat, rice, beans, sunflower, peanut, linseed and chickpea). If soil is present at 0.1%, then a 1,000 tonne shipment of bulk grain would contain 1 tonne of soil. This is a significant quantity when considering the numbers of propagules of microorganisms likely to be present. Similarly, substantial quantities of trash (maize or other species: leaf, stem and root material) could be present in bulk import lots.

Potential quarantine pathogens likely to enter Australia via the defined pathway were identified by compiling disease lists for Australia, and for the World (Appendix 1, compiled by Nasir *et al*., 1998). At least 428 microorganisms have been associated with maize. These microorganisms were assessed for their presence in the USA and Australia, ability to be transported with bulk maize grain, and ability to cause significant losses (Appendix 2). From these ratings, each maize pathogen was categorised as to its potential quarantine status with respect to Australia, using the following system:

- A Present in USA, in pathway, not present in Australia or officially controlled in Australia, and capable of significant economic damage
- B As for A except lower economic damage
- C Present in USA, in pathway, present in Australia but with equivocal evidence for exotic pathogenic strains capable of economic damage
- D Present in Australia and not officially controlled, or not in pathway, or not in USA
- E Insufficient information for judgement

Pathogens with an A rating are regarded as potential quarantine pests, as may also be the pathogens with B and C ratings, when considered in relation to the defined pathway (Appendix 2), and to the accepted international definition of a quarantine pest. However, pathogens that we have given an A rating, on the preliminary assessment, are believed to pose the greatest risk, because of their established capacity to cause economic damage. There were 16 category A, 49 category B, no category C, 257 category D and 106 category E pathogens. Data sheets for 10 of the A category pathogens are given at Appendix 3.

Several pathogens in category E exhibit pathogenic variability. However, there are insufficient data available on the strains present in Australia to make a further judgement as to the quarantine status of that particular pathogen. Further studies may show that some of these are category C pathogens.

A list of potential quarantine pathogens on likely admixtures of bulk grain imports is shown in Appendix 4. There are very high risk quarantine pathogens on this list including *Tilletia indica*, the cause of Karnal bunt of wheat. If introduced, *T. indica* could cause potential losses of up to $491,000,000 per year to the Australian wheat industry (Murray and Brennan, 1998).

Stage 2: Pest Risk Assessment

The 16 maize pathogens that scored an "A" on the preliminary risk assessment were subjected to a more detailed relative risk analysis, to rank them in order of importance (Table 1). Each pathogen was ranked on a 1–9 scale relative to the remaining 15 pathogens (1 = extremely low risk, 9 = extremely high risk) for various parameters, based on the collective judgement of the TWG members. This is a reduced version of an approach developed by the Central Science Laboratory, York, UK and the European and Mediterranean Plant Protection Organisation (EPPO).

The mean of the first three parameters (their capacity for entry, establishment, and spread) represents a Disease Introduction Risk value. The capacity for entry is an assessment that the pathogen could be transported with bulk maize grain, and is highest for pathogens that are seed-borne. Establishment is the likelihood that the pathogen could develop on a suitable host on arrival. Spread is a measure of the suitability of Australian conditions for the movement away from the point of establishment and continued survival and development.

Similarly, their Economic Damage Risk potential was presented as a mean of their capacity to reduce yield and trade. The effect on yield was judged from the reported effects on yield in the USA. Exotic pathogens, if introduced, could affect the ability of Australian farmers to sell maize and other commodities within Australia and overseas.

The mean of the last two parameters (capacity for pathogenic variability and their relative cost of management) gives a Disease Management Risk. High pathogenic variability makes it difficult to breed for disease resistance, while other management procedures (tillage, rotation, fungicide applications) may be required for control. The Disease Management Risk provides an indication of cost of management should an incursion occur (the higher the value, the higher the cost).

The mean of each of the seven listed criteria provides an Overall Risk rating. The following ten pathogens, presented in rank order, have an overall risk of ≥5 out of 9:

- *Peronosclerospora sorghi*
- Maize dwarf mosaic potyvirus
- High Plains virus
- Wheat streak mosaic rymovirus
- *Sclerospora graminicola*
- *Phymatotrichopsis omnivora*
- Maize chlorotic mottle machlomovirus
- *Cercosopora zeae-maydis*
- *Pantoea stewartii* subsp. *stewartii*
- *Clavibacter michiganensis* subsp. *nebraskensis*

Pathogens listed in Table 1 but ranking <5 on the overall rating generally fell into distinct groups. The nematodes present a generally low risk of introduction, as entry could only be as eggs or cysts in soil or plant trash. Once introduced, spread would be slow in contrast to seed-transmitted airborne pathogens such as *Peronosclerospora sorghi* and Maize dwarf mosaic potyvirus.

Phymatotrichopsis omnivora, a minor pathogen of maize but serious on cotton and many other dicotyledons, was regarded as having a lower potential for establishment (soil or trash borne only). If an incursion did occur and it became established, it would be extremely difficult to manage.

Cercospora zeae-maydis is a serious disease on maize in humid areas. However, it is regarded as less of an overall risk than some of the other fungal, bacterial and viral pathogens. This is because it is likely to be only trash-borne and to be pathogenic only on maize (Appendix 1).

Six of the above ten pathogens are listed by Phillips (1994a) as quarantine diseases of concern. Phillips (1994a) did not include High Plains virus, *Sclerospora graminicola* and *Phymatotrichopsis omnivora*. Since Phillips' study, High Plains virus has been shown to be seed-borne, which justifies its present inclusion. Phillips' Terms of Reference meant that he did not consider pathogens that were not seed-borne. *S. graminicola* and *P. omnivora* are trash and soil-borne, and so are in the pathway we considered.

Phillips (1994a) included *Ustilago zeae*, *Sporisorium holci-sorghi* and *Claviceps gigantea*. We believe that there is insufficient data to justify the inclusion of the first two on the basis of possible differences in strains between the USA and Australia. However, further work may show that strains in Australia differ from those in the USA. This would change the classification of *U. zeae* and *S. holci-sorghi* from E to C, and justify Phillips' (1994a) conclusion. The last pathogen, *C. gigantea*, has not been recorded in the USA, so is not a pathogen of concern in this case. However, *C. gigantea* is present in parts of Mexico, so care would be required to ascertain the origin of "USA" maize.

There are many quarantine pathogens of other crops potentially present on admixtures likely to be present in bulk maize grain. We have not done risk analyses on these but believe that their risks would be managed by the treatments recommended to control the maize pathogens. However, if untreated bulk maize of USA origin were transported within agricultural areas of Australia, there would be a high risk that these other pathogens could be introduced.

The TWG has no reservations that each of the pathogens listed in Table 1 is a quarantine pest. A summary of the important features of three of the high risk pathogens (*Peronosclerospora sorghi*, High Plains virus and Wheat streak mosaic rymovirus) is presented below. These pathogens illustrate the range of issues that arise from such quarantine pests.

1. Peronosclerospora sorghi

Peronosclerospora sorghi, the cause of sorghum downy mildew, presents one of the greatest quarantine risks to the Australian grains industry from the importation of bulk maize from the USA. The disease was first reported in the USA in Texas in 1961 (Keyes *et al*., 1964). By the early 1970's it had reached the corn belt in the Ohio River Valley in Indiana and Illinois (Frederiksen, 1980).

There is recent evidence that *P. sorghi* consists of more than one species. Some strains that occur on maize are now recognised as a separate species, *P. zeae*. Further work is needed to determine the distribution of this species (Jeger *et al*., 1998). We will consider them one species until the situation in the USA is better defined.

Symptomatology and host range

There are two types of symptom produced by *P. sorghi* in both sorghum and maize. First, systemic infection occurs by oospores or conidia during the first 4 weeks of germination of the seed. Second, local lesions resulting from conidial infection of older plants may also give rise to systemic infection (Schuh *et al*., 1986). The fungus can cause serious losses in both sorghum and maize, although it is generally regarded as a more serious pathogen on sorghum (Doggett, 1970). As well as infecting sorghum and corn, other hosts include Sudan grass (*Sorghum sudanense)*, shatter cane (*Sorghum bicolor)* and Johnson grass (*Sorghum halepense*).

In corn, most systemically infected plants are sterile, but occasionally some will set seed.

Life history

P. sorghi survives by producing oospores in infected host tissue. Oospores are produced less numerously in corn than sorghum (Bigeriwa *et al*., 1998). Pratt *et al*. (1978) reported oospore populations in soil following sorghum, of 8–95 per gram. Oospores are thought to survive for at least 3 years under a variety of conditions (Frederiksen, 1980), and can be wind dispersed. In arid areas, oospores initiate infection of seedlings, whereas in areas where a perennial host such as Johnson grass is present, infection can be initiated from conidia (Bigeriwa *et al*., 1998).

Conidia produced from systemically infected plants are short lived (a few hours under ideal conditions) and probably only play a role in short distance (ca. 100 m) spread. Infection by conidia can occur after a 2-hour wetness period at 20–25^0C (Cohen and Skerman, 1977).

The fungus can infect corn seed, being confined in mature seeds to the pericarp and pedicel. The embryo and endosperm appear to be protected by the aleurone layer (Jones *et al*., 1972). Seed-transmission of the disease occurs from planting infected seeds in the soft dough stage. Jones *et al*. (1972) reported transmission in corn could be prevented by reducing the moisture content to 9% and by storage for 40 days prior to planting. This conclusion was based on a total of 75 seeds per treatment. Although drying of seed kills the mycelium, oospores survive, and seed-transmission can occur (Jeger *et al*., 1998).

Pathogenic specialisation

Frederiksen (1980) reported evidence for pathogenic specialisation within isolates of *P. sorghi* attacking sorghum in Texas. There have also been reports of strains with different host species specificities. A sorghum-maize strain is present in the US and a maize strain occurs in north-western India and Thailand (Bonde, 1982). The latter strain is possibly a separate species, *P. zeae* (Jeger *et al*., 1998).

Management

Crop rotation is of limited value, due to the longevity of oospores and the capacity to infect Johnson grass and other *Sorghum* spp. and *Panicum* spp. Roguing and metalaxyl seed treatments also can be used to some effect, but by far the most effective management strategy is host resistance (Frederiksen, 1980). It is impossible to find maize genotypes that do not support systemic growth of the pathogen. Planting in soils at less than 20^0C has also been advocated as a successful means of reducing primary infection of maize by oospores (Frederiksen, 1980).

Likelihood of downy mildew developing in Australia

Conditions of temperature and relative humidity during the growing season of maize are favourable for development of downy mildew at many locations within maize growing areas of Australia (Appendix 5). Favourable conditions are particularly common in many maize and sorghum growing areas of Queensland, while conditions become less favourable in New South Wales.

Summary of the risks of introducing Peronosclerospora sorghi into Australia in bulk maize grain imports

- *P. sorghi* is unequivocally in the pathway (maize seed, sorghum admixtures, trash or soil), and not present in Australia. It is likely to cause serious economic losses if introduced into Australia, particularly in grain sorghum, other *Sorghum* spp., sweet corn, maize, *Panicum* spp. and *Pennisetum* spp. The gross value of Australian sorghum in 1996/97 was $225 million, and maize, $75 million.
- *P. sorghi* is seed-borne and can also be carried in trash and soil.
- *P. sorghi* is distributed in the USA from southern Texas to central Illinois, where it was reported on sweet corn in 1990 (Pataky and Pataky, 1990). It can infect wild sorghums and it would be expected to produce oospores in systemically infected maize (Bigeriwa *et al*., 1998). Thus it would be difficult to source from maize-producing areas in the USA that could be absolutely certain to be free of *P. sorghi*.
- Many feed lots in Australia are in agricultural areas where maize and sorghum are grown. If untreated imported grain is transported to such feed lots, there is a likelihood that *P. sorghi* will be introduced through spillage of grain, soil or trash present in the bulk import. If spillage occurred, oospores of *P. sorghi* could be dispersed by wind. The wide distribution of Johnson grass in northern Australia would provide a perennial source of susceptible host material.
- The systemic nature of *P. sorghi* could mean that it would remain undetected for a considerable period of time, particularly in an uneconomic host such as Johnson grass. Thus the pathogen could spread widely before being detected. This would reduce the likelihood that successful eradication could be achieved.

2. High Plains virus (HPV)

HPV was first recognised in 1993 in the western plains of the USA in maize. The virus is transmitted by the eriophyid mite *Aceria tosichella*, and can be lethal to maize, wheat, barley and other grasses. The disease is known to be seed-transmitted, and can be recognised by the presence of a 32 kDA protein that is specific to HPV infection.

Aetiology

A characteristic of HPV is the presence of large double membrane bodies found in infected cells. There are other members of this not yet fully characterised virus group that includes wheat spot mosaic virus. The HPV genome has been largely sequenced, and consists of at least 4 ds RNA species. RNA #3 directs formation of the diagnostic 32 kDA protein. There is still much work that needs to be done to fully characterise HPV.

Distribution

HPV has been positively identified in 10 states of the USA, from eastern Nebraska to western Idaho, and from Montana and South Dakota to the Texas panhandle. It has also been identified from sweet corn samples from Florida, Chile and Brazil. Genetic variability exists in maize reactions to HPV but it has not yet been characterised (Marcon *et al*., 1997).

Significance to Australian grains industry

Because HPV is only a relatively recently discovered virus (1993), there is still much to learn about its aetiology, distribution and management. Importantly, diagnostic tools have now been generated which will allow determination of its distribution and further clarification of its economic significance. We regard this pathogen as very high risk to the Australian grains industry because:

- HPV is seed-borne and seed-transmitted in maize.
- It can cause yield losses of up to 75%.
- The disease also affects wheat and barley, thus it must be regarded as a major threat to the $5 billion Australian wheat industry.

Devitalisation of the seed by grinding should be an effective management strategy for this pathogen, since there is no evidence it is mechanically transmitted. Work should be initiated to determine whether HPV is present in Australia.

3. Wheat streak mosaic virus (WSMV)

WSMV causes a serious disease of wheat, particularly in the Great Plains region, where annual losses up to 2% occur (Christian, 1993) and local losses can be 100% (McNeil *et al.*, 1996). WSMV is both seed-borne and seed-transmitted, and is transmitted by the wheat curl mite *Aceria tosichella*. High Plains virus is often found in association with WSMV, not surprising since they share a common vector. WSMV has also been found along with MDMV in the same maize plant (Hill *et al*., 1974), and is seed-transmitted in maize.

Host range

WSMV has a relatively broad host range, encompassing many plants in the grass family. It infects wheat, barley, oats, maize and millets (*Panicum*, *Setaria* and *Echinochloa* spp.). It is the type member of the rymovirus group, whose members are all mite transmitted.

Variability

WSMV was first recorded in 1932 (McKinney, 1937). There is considerable molecular diversity in the virus (McNeil, 1996), and it is thought molecular groups may correlate with host adaptation.

Significance to Australian grains industry

WSMV causes unequivocally a serious disease in large areas of the USA and is seed-transmitted in maize. Its entry and establishment in Australia would pose a greater national economic risk to the $5 billion wheat industry than to maize. In maize, it could also be expected to cause substantial losses but with a less significant national impact. Devitalisation of all seed by grinding should be an effective management strategy for this virus.

Summary of Stage 2

Ten medium to high risk quarantine pathogens have been identified and ranked on the basis of their likelihood to enter and cause loss in Australia (Table 1). Some of them have the capacity to cause serious losses on commodities of substantially higher value than maize. For example, *Peronosclerospora sorghi* can attack sorghum while High Plains virus and wheat streak mosaic virus can damage wheat. It is also highly likely that additional quarantine pathogens exist among those categorised as B or E in Appendix 2. We have concentrated our efforts on those listed in Table 1 that are clearly identifiable as quarantine pests.

Stage 3: Pest Risk Management

In stages 1 and 2 we have established that there are high risk pathogens likely to be present in bulk maize imports from the USA. Some have relatively wide host ranges, extending to sorghum, wheat and naturalised grasses such as Johnson grass. In Australia there are many situations where feed lots and crops of maize, sorghum and wheat are in close proximity to each other. These issues need to be considered when developing possible management options.

Devitalization of maize seed by grinding would be an effective strategy to prevent entry and establishment of the four viral diseases. This strategy alone would not be fully effective for management of quarantine bacteria and fungi associated with maize grain.

Setting maximum levels for trash, soil and admixtures would not manage the risk for trash- and soil-borne pathogens, since substantial quantities of these materials are likely to be present in bulk imports. Oospores of *Peronosclerospora sorghi* would be present in contaminated soil at levels of <1–95 propagules per gram. Thus, there is a clear risk that soil or trash could provide a viable avenue for entry and establishment of pathogens such as *Peronosclerospora sorghi*, *Cercospora zeae-maydis*, *Sclerospora graminicola*, *Phymatotrichopsis omnivora* and the other pathogens listed in Table 1 except the viruses.

Options for managing the risk of entry of these pathogens are sourcing grain from pest-free areas, removal of soil and trash, devitalizing seed by grinding, and pasteurizing by heat (Table 2).

From assessment of the published literature, it may be possible to source seed from pathogen-free areas for each of the pathogens listed in Table 1. However, there is a wide distribution across the USA for these pathogens when considered as a group, eg. humid areas in the south-eastern USA for *Cercospora zeae-maydis* and arid regions in the south-western USA for *Phymatotrichopsis omnivora*. The distribution of *Peronosclerospora sorghi* overlaps with *Phymatotrichopsis omnivora*, but would appear to extend further north to central Illinois. The bacterial pathogens *Pantoea stewartii* and *Clavibacter michiganensis* have a wider distribution, entering into the northern USA. It is unlikely that maize grain could be sourced from areas free of all of the quarantine pathogens listed in Table 2.

Thus, treatment of grain to kill possible quarantine pathogens on maize seed, soil, trash and other seed admixtures offers the only viable strategy for managing the risk (Table 2). Heat treatment would appear to be the most effective mechanism. Work is needed to optimise the heat treatment to ensure that all quarantine pathogens are eliminated. Maximum tolerances for other seed admixtures, trash and soil need to be considered, but become less important if requirements for heat treatment are imposed.

Other components in the pathway that need to be considered other than maize seed, seeds of admixtures, maize trash and soil are:

- Cleanliness of rail cars used to freight the sourced bulk maize in the USA. Spores of the Karnal bunt fungus (*Tilletia indica*) and other pathogens could be present in freight cars used to transport the bulk maize.
- Cleanliness of ship holds used to transport the bulk maize.

Evans *et al.* (1996) concluded that there was minimal chance of spillage of material during transport within Australia and that any spillages could be readily contained. We disagree. Spillage of grain and associated admixtures, soil and trash, and the discharge of dust into the air during loading, transport, unloading and processing of grain are extremely difficult to control and are common. Such spillage and discharge will provide opportunities for the establishment of pathogens.

Three recent incursions of quarantine pests show that it is difficult if not impossible to eradicate a pathogen once it has established:

- A major campaign in Western Australia failed to eradicate *Colletotrichum gloeosporioides*, the cause of anthracnose of lupins, once it established in 1996.
- Efforts to prevent the spread of *Ascochyta rabiei* within chickpea-growing areas of eastern Australia have failed and a widespread epidemic of blight developed in 1998.
- *Sphacelia sorghi*, causing ergot of sorghum, spread rapidly throughout sorghum growing areas in 1996, making eradication impossible.

Summary of Stage 3

Heat treatment is the only viable option for minimising risk of entry of quarantine pathogens. This treatment should be done either at the port of entry to Australia or off shore. If it is delayed until the seed reaches the feed-lot, the possibility of grain spillage or dust discharge during handling and transport of grain presents a high risk to Australian industry. If an incursion occurs, containment and eradication would be difficult if not impossible.

Conclusions

1. The pathway of bulk maize grain from the USA includes maize grain, admixtures of other crop and weed seeds, soil and trash.
2. At least 15 pathogens can occur in the pathway that are capable of causing significant economic damage.
3. Ten of these pathogens present a higher risk. In order of importance, these are:

- *Peronosclerospora sorghi*
- Maize dwarf mosaic potyvirus
- High Plains virus
- Wheat streak mosaic rymovirus
- *Sclerospora graminicola*
- *Phymatotrichopsis omnivora*
- Maize chlorotic mottle machlomovirus

- *Cercospora zeae-maydis*
- *Pantoea stewartii* subsp. *stewartii*
- *Clavibacter michiganensis* subsp. *nebraskensis*

4. Heat treatment is the only viable option for minimising risk of entry of quarantine pathogens.

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Table 1. A qualitative analysis of the relative risk* to Australia of quarantine pathogens on maize grain from the USA

Pathogen	*Disease Introduction Risks*				*Economic Damage Risks*			*Disease Management Risks*			**Overall Risk**
	Entry	Estab	Spread	*Mean Risk*	Yield	Trade	*Mean Risk*	Path. Variab.	Man. Costs	*Control Risk*	
Peronosclerospora sorghi	9	7	8	*8.0*	7	8	*7.5*	7	7	*7.0*	**7.6**
Maize dwarf mosaic potyvirus	9	9	9	*9.0*	7	3	*5.0*	6	6	*6.0*	**7.0**
High Plains virus	9	7	7	*7.7*	7	7	*7.0*	2	6	*4.0*	**6.4**
Wheat streak mosaic rymovirus (WSMV)	9	7	7	*7.7*	7	7	*7.0*	2	6	*4.0*	**6.4**
Sclerospora graminicola	2	7	8	*5.7*	6	8	*7.0*	5	6	*5.5*	**6.0**
Phymatotrichopsis omnivora	4	5	5	*4.7*	6	8	*7.0*	1	9	*5.0*	**5.4**
Maize chlorotic mottle machlomovirus	9	7	7	*7.7*	5	3	*4.0*	2	5	*3.5*	**5.4**
Cercospora zeae-maydis	6	7	7	*6.7*	6	3	*4.5*	3	5	*4.0*	**5.3**
Pantoea stewartii subsp. *stewartii*	9	5	3	*5.7*	5	6	*5.5*	3	5	*4.0*	**5.1**
Clavibacter michiganensis subsp. *nebraskensis*	9	5	7	*7.0*	3	3	*3.0*	3	5	*4.0*	**5.0**
Heterodera zeae	3	3	3	*3.0*	3	4	*3.5*	3	3	*3.0*	**3.1**
Ustilaginoidea virens	2	4	5	*3.7*	3	3	*3.0*	1	1	*1.0*	**2.7**
Dolichodorus heterocephalus	2	2	3	*2.3*	3	1	*2.0*	1	3	*2.0*	**2.1**
Hoplolaimus columbus	2	2	3	*2.3*	3	1	*2.0*	1	3	*2.0*	**2.1**
Longidorus breviannulatus	2	2	3	*2.3*	3	1	*2.0*	1	3	*2.0*	**2.1**
Pratylenchus scribneri	2	2	3	*2.3*	3	1	*2.0*	1	3	*2.0*	**2.1**

* Risk rating scale:

1 = extremely low risk	4 = low to medium risk	7 = high risk
2 = very low risk	5 = medium risk	8 = very high risk
3 = low risk	6 = medium to high risk	9 = extremely high risk

Table 2. Management options for high risk pathogens potentially present in maize grain from the USA

Pathogen	Pest Free Area	Free from Soil	Free from Trash	Devitalize Grind	Pasteurize Heat
Peronosclerospora sorghi	+	-	-	-	+
Maize dwarf mosaic potyvirus	+	-	-	+	+
High Plains virus	+	-	-	+	+
Wheat streak mosaic rymovirus	+	-	-	+	+
Sclerospora graminicola	+	-	-	-	+
Phymatotrichopsis omnivora	+	+	-	-	+
Maize chlorotic mottle machlomovirus	+	-	-	+	+
Cercospora zeae-maydis	+	-	+	-	+
Pantoea stewartii subsp. *stewartii*	+	-	-	-	+
Clavibacter michiganensis subsp. *nebraskensis*	+	-	-	-	+

MAIZE DISEASES
OF AUSTRALIA AND THE WORLD

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November 1998

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CONTENTS

INTRODUCTION

Maize Industry

Maize (*Zea mays* L.) is the second most important crop in the world in terms of total food production. It is the most widely distributed cereal in the tropics and is important in the Americas, Africa and Asia. Most of the maize produced in temperate areas is used for livestock feed and industrial products. Maize produced in tropical countries is primarily for direct human consumption.

Maize production in Australia is concentrated in New South Wales and Queensland, with smaller amounts produced in Western Australia and Victoria. Most of the maize produced in Australia is consumed domestically. In some years, production does not meet consumption. Details of production and consumption are given below:

Maize Production and Consumption (000 tones) in Australia*						
Year	NSW	QLD	WA	VIC	Total Production	Domestic Consumption
1987-88	72.07	124.21	4.82	5.50	207.01	197.46
1988-89	78.27	132.11	4.04	1.45	215.86	77.49
1989-90	97.63	114.60	4.82	1.04	218.09	209.63
1990-91	90.64	94.93	5.39	2.02	192.98	175.25
1991-92	119.09	141.24	4.94	2.95	268.22	248.55
1992-93	107.87	74.57	12.95	2.76	198.15	175.47
1993-94	100.00	87.00	15.00	2.00	204.00	221.06
1994-95	145.34	79.89	11.38	5.14	241.74	297.05
1995-96	180.00	120.00	12.00	5.00	317.00	300.16
1996-97	244.00	110.00	12.00	5.00	371.00	324.90

* Australian Commodity Statistics, 1997. Australian Bureau of Agricultural and Resource Economics, Canberra. 346 pp.

The shortfalls in Australian maize production have led to industry pressure for bulk maize imports. AQIS is currently conducting a pest risk analysis for bulk maize grain imports from the USA for processing and animal consumption. AQIS has also received a proposal to import maize from the European Union.

Maize Diseases

Two lists of maize (*Zea mays* L) diseases have been prepared: an Australian list and a world list. It should be noted that whilst all of the microorganisms contained in these lists are associated with maize, some may not be pathogenic.

These lists have been developed for use in pest risk analyses on possible imports into Australia of maize seed, grain and other maize products from around the world. For example, AQIS is to conduct pest risk analyses on imports into Australia of sweetcorn seed for direct planting and maize grain for processing and animal consumption from the USA. AQIS is also considering proposals for the importation of maize from the European Union. The Australian list will also be useful in developing market access submissions for exports of Australian maize seed, grain and maize products to various countries.

The Australia list has been prepared using all available sources of information on the occurrence of pathogens on maize in Australia. These include the National Collection of Fungi (NCOF) database, host-pathogen indices for the Northern Territory, South Australia, Tasmania and Western Australia, and other published information. Where possible, records of pathogens based on herbarium specimens have been used for the distribution of pathogens in Australia.

The World list has been prepared from exhaustive searches of available international literature on maize pathogens.

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PART ONE

MAIZE DISEASES OF AUSTRALIA

BACTERIA, FUNGI, NEMATODES AND VIRUSES RECORDED ON MAIZE (*ZEA MAYS* L.) IN AUSTRALIA - AND THEIR DISTRIBUTION

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Bacteria			
Acidovorax avenae subsp. ***avenae*** (Manns) Willems *et al.* 1992 (synonyms: *Pseudomonas avenae* subsp. *avenae* Manns 1909; *Bacterium rubrilineans* (Lee *et al*.) Elliot 1930; *Bacterium setariae* Okabe 1934; *Chlorobacter setariae* (Okabe) Patel & Kulkarni 1951; *Phytobacterium alboprecipitans* (Rosen) Margrou & Prévot 1948; *Phytomonas avenae* (Manns) Bergey *et al.* 1930; *Pseudomonas rubrilineans* (Lee *et al*.) Stapp 1928; *Xanthomonas rubrilineans* (Lee *et al*.) Starr & Burkholder 1942)	**bacterial leaf blight and stalk rot;** BLB	**Qld** (1988: Gatton)	3
Erwinia carotovora subsp. ***carotovora*** (Jones) Bergey *et al.* 1923	**bacterial stalk and top rot;** bacterial soft rot	**ACT** (1981); **NSW** (1970: Arcadia); **Vic.**; **WA** (1976: Manjimup)	9, 10, 14
Erwinia chrysanthemi Burkholder *et al*. 1953	**bacterial stalk and top rot;** stem rot	**Vic.** (1988: Lindenow)	9
Pseudomonas syringae pv. ***syringae*** van Hall 1902 (synonyms: *Pseudomonas syringae* van Hall 1902; *Pseudomonas holci* Kendrick 1926)	**holcus spot;** holcus bacterial spot	**NSW**	8
Xanthomonas vasicola* pv. *holcicola (Elliott) Vauterin *et al.* 1995 (synonym: *Xanthomonas campestris* pv. *holcicola* (Elliott) Dye 1978)	**bacterial leaf spot**	**Qld**	8
Fungi			
Acremoniella verrucosa Tognini		**NSW** (1975: Rydalmere)	9

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Acremonium strictum Gams (synonym: *Cephalosporium acremonium* Auct. non Corda)	**black bundle disease; Cephalosporium kernal rot;** black bundle	**Qld** (1976: Gatton, Parada; 1986: Mount Maria)	9
Acremonium zeae Gams & Sumner	Acremonium stalk rot	**Qld** (1983; 1985: Atherton Tablelands)	9
Alternaria alternata (Fr.:Fr.) Keissl. (synonym: *Alternaria tenuis* Nees)	**minor ear rot; minor leaf spot; root rot;** Alternaria leaf blight	**NSW** (1977: Brushgrove); **Qld** (1975: Kenmore; 1986: Mount Maria)	9
Alternaria longissima Deighton & MacGarvie	stalk rot	**Qld** (1976: Kingaroy; 1986: Walkmin)	9
Aspergillus flavus Link: Fr.	**Aspergillus ear and kernal rot;** seed rot	**Qld** (1983: Atherton Tablelands; 1986: Mount Maria)	9
Aspergillus glaucus Link:Fr. (synonyms: *Aspergillus herbariorum* (Wigg.:Fr.) Fisch.; *Aspergillus minor* (Mangin) Thom & Raper; *Aspergillus umbrosus* Bainier & Sartory; teleomorph: *Eurotium herbariorum* Link:Fr.)	**minor ear rot;** Aspergillus ear rot; yellow mould	**Qld** (Brisbane)	9
Aspergillus niger Tiegh.	**minor ear rot;** Aspergillus ear rot; black mould; seed rot	**NSW** (1983: Finley; 1985: Dubbo)	9
Aureobasidium pullulans (de Bary) Arnaud (synonyms: *Dematium pullulans* de Bary; *Pullularia pullulans* (de Bary) Berkhout; *Aureobasidium vitis* Viala & Boyer; *Exobasidium vitis* (Viala & Boyer) Prill. & Delacr.)	brown spot	**Qld** (1976: Toowoomba)	9

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Bipolaris australiensis (M.B. Ellis) Tsuda & Ueyama (synonyms: *Drechslera australiensis* (Bugnicourt) Subramanian & P.C. Jain ex M.B. Ellis; *Helminthosporium australiensis* Bugnicourt, nom. inval.; teleomorph: *Cochliobolus australiensis* (Tsuda & Ueyama) Alcorn)	leaf spot	**Qld** (1973: Kingaroy)	9
Bipolaris bicolor (Mitra) Shoemaker (teleomorph: *Cochliobolus bicolor* Paul & Parbery)	leaf spot	**Qld** (1973: Kingaroy)	9
Bipolaris cynodontis (Marig.) Shoemaker (synonyms: *Helminthosporium cynodontis* Marignoni; *Drechslera cynondontis* (Marignoni) Subramanian & P.C. Jain; teleomorph: *Cochliobolus cynodontis* Nelson	leaf spot	**Qld** (1972: Mapleton, Kenmore)	9
Bipolaris hawaiiensis (M.B. Ellis) Uchida & Aragaki (synonyms: *Drechslera hawaiiensis* M.B. Ellis; *Helminthosporium hawaiiense* Bugnicourt, nom. inval.)	Helminthosporium leaf spot	**Qld** (1972: Biloela, Coolabunia; 1973: Eumundi, Lawes, Woombye)	9
Bipolaris maydis (Nisikado & Miyake) Shoemaker (synonyms: *Helminthosporium maydis* Nisikado & Miyake; *Drechslera maydis* (Nisikado & Miyake) Subramanian & P.C. Jain; teleomorph: *Cochliobolus heterostrophus* (Drechs.) Drechs.)	**southern corn leaf blight and stalk rot;** southern leaf blight (SLB)	**NSW** (1972: Fairy Hill, Grafton, Murwillumbah; 1976: Castle Hill; 1989: Grafton); **NT** (1972: Berrimah; 1973: Berrimah; 1981: Virginia); **Qld** (1972: Atherton Tablelands, Lakeland, Beaudesert, Picnic Crossing, Gatton, Kairi, Beerwah, Kingsthorpe, Hermitage, Cambooya, Eumundi, Biloela, Kenilworth, Goomeri, Booie, Cooktown, Lakeland Downs, Kingaroy; 1973: Eumundi, Christmas Creek, Kingaroy, Warwick, Kairi, Coulston Lakes, Gurgeena Plateau, Goomeri, Coolabunia, Rockhampton, Samford, Ingham, Kumbia, Yadina; 1974: Kairi, Lawes, Kingaroy, Imbil; 1975: Lawes; 1978: Kairi; 1981; 1982; 1984: Atherton Tablelands; 1985: Stephen Island); **WA** (1972: Perth)	9, 11, 14

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Bipolaris setariae (Sawada) Shoemaker (synonyms: *Helminthosporium setariae* Sawada; *Drechslera setariae* (Swada) Subramanian & P.C. Jain; teleomorph: *Cochliobolus setariae* (Ito & Kuribayashi in Ito) Drechs. Ex Dastur)	spot blotch	**Qld** (1981: Darling Downs)	9
Bipolaris sorghicola (Lefebvre & Sherwin) Alcorn (synonyms: *Helminthosporium sorghicola* Lefebvre & Sherwin; *Drechslera sorghicola* (Butler) Subramanian & P.C. Jain)	target spot	**Qld** (1972: Cooktown; 1973: Christmas Creek)	9
Bipolaris sorokiniana (Sacc.) Shoemaker (synonyms: *Helminthosporium sativum* Pammel *et al*.; *Helminthosporium sorokinianum* Sacc. in Sorokin; *Helminthosporium californicum* Mackie & Paxton; *Drechslera sorokiniana* (Sacc.) Subramanian & Jain; teleomorph: *Cochliobolus sativus* (Ito & Kuribayashi) Drechs. ex Dastur)	**minor leaf spot; seed rot; seedling blight;** Heminthosporium root rot	**Qld** (1972: Rathdowney, Mapleton; 1973: Kingaroy)	9
Bipolaris urochloae (Putterill) Shoemaker (synonyms: *Helminthosporium urochloae* (Putterill); *Drechslera urochloae* (Putterill) Subramanian & P.C. Jain)	leaf spot	**Qld** (1972: Biloela, Kingaroy; 1973: Kingaroy)	9
Bipolaris victoriae (Meehan & Murphy) Shoemaker (synonym: *Helminthosporium victoriae* Meehan & Murphy; teleomorph: *Cochliobolus victoriae* Nelson)	**minor leaf spot**	**Qld** (1972: Kairi; 1973: Christmas Creek)	9

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Bipolaris zeicola (G.L. Stout) Shoemaker (synonyms: *Helminthosporium carbonum* Ullstrup; *Helminthosporium zeicola* G.L. Stout; *Drechslera zeicola* (G.L. Stout) Subramanian & P.C. Jain; *Drechslera carbonum* (Ullstrup) Sivanesan; teleomorph: *Cochliobolus carbonum* R.R. Nelson)	**northern corn leaf spot; Helminthosporium ear rot (race 1); seed rot; seedling blight;** Carbonum leaf spot; northern leaf spot; Helminthosporium leaf spot	**NSW** (1959: Comboyne; 1960: Kempsey; 1964: Taree; 1967: Kempsey); **Qld** (1972: Pechey, Goombungee, Kingaroy Kenmore, Mundubbera; 1973: Christmas Creek, Woombye, Kingaroy, Kairi; 1978: Kairi)	9, 15
Botryosphaeria disrupta (Berk. & Curtis) Arx & Mueller (synonyms: *Phomatospora disrupta* (Berk. & Curtis) Cooke; *Physalospora disrupta* (Berk. & Curtis) Sacc.; *Desmotascus portoricensis* Stevens)	**Diplodia ear rot and stalk rot; Physalospera ear rot; Botriosphaeria ear rot**	**Qld** (1962: Tolga)	15
Botrytis cinerea Pers.:Fr. (synonym: *Botryotinia fuckeliana* (de Bary) Whetzel)	**minor ear rot;** Botrytis stalk rot; seed rot	**Tas.** (1975: Forthside)	9, 13
Cladosporium cladosporioides (Fresen.) De Vries (synonyms: *Hormodendrum cladosporioides* (Fresen.) Sacc.; *Cladosporium herbarum* (Pers.:Fr.) Link; teleomorph: *Mycosphaerella tassiana* (De Not.) Johans.)	**Hormodendrum ear rot; Cladosporium rot**	**NSW** (1989: Scone)	9
Cladosporium herbarum (Pers.:Fr.) Link (synonyms: *Cladosporium caricicola* Corda; *Cladosporium epiphyllum* (Pers.:Fr) Fr.; *Cladosporium fasciculatum* Corda; *Helminthosporium flexuosum* Corda; *Cladosporium fuscatum* Link; *Cladosporium graminum* (Pers.:Fr.) Link; teleomorph: *Mycosphaerella tassiana* (De Not.) Johans.)	**Hormodendrum ear rot; Cladosporium rot;** cob mould	**Qld** (Brisbane; 1977: Toowoomba)	9
Cladosporium macrocarpum Preuss	cob mould	**Tas.** (1975: Cressey)	9, 13

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Colletotrichum graminicola (Ces.) Wils. (synonyms: *Colletotrichum sublineola* Henn. in Kab. & Bubak; *Ellisiella mutica* Wint.; *Vermicularia graminicola* Westend.; teleomorph: *Glomerella graminicola* Politis)	**anthracnose leaf blight; anthracnose stalk rot** (ASR); anthracnose; Colletotrichum stalk rot	**NSW** (1990: Berry); **Qld** (1974: Imbil; 1979: Kairi; 1985: Atherton Tablelands; 1990: Beaudesert)	9
Curvularia brachyspora Boedijn	leaf spot	**Qld** (1972: Kenmore)	9
Curvularia lunata (Wakk.) Boedijn (teleomorph: *Cochliobolus lunatus* Nelson & Haasis)	**Curvularia leaf spot**	**Qld** (1975: Kenmore)	9
Cyathus stercoreus (Schw.) de Toni in Sacc.	bird's nest fungus	**NSW** (1977: Mulamuddy Creek)	9, 10
Diplodia maydis (Berk.) Sacc. (synonym: *Sphaeria maydis* Berk.)	**Diplodia ear rot, stalk rot, seed rot and seedling blight**; diplodiosis	**NSW** (1912: Tamworth; 1931: Richmond; 1934: Tenterfield, Glen Innes; 1936: Tenterfield; 1987: Kangaroo Valley; 1989: Hay); **Qld** (1977: Ravenshoe; 1987: Warwick); **Tas.** (1975: Forthside); **Vic.** (1937; 1990: Orbost)	9, 13, 15
Epicoccum nigrum Link (synonym: *Epicoccum purpurascens* Ehrenb.)	**red kernel disease; ear mold, leaf and seed rot; minor leaf spot;** red kernel	**NSW** (1977: Brushgrove; 1989: Duckenfield); **Tas.** (1975: Forthside)	9, 13
Exserohilum longirostratum (Subramanian) Sivanesan	stalk rot	**Qld** (1985: Atherton Tablelands)	9
Exserohilum monoceras (Drechs.) Leonard & Suggs (synonyms: *Helminthosporium monoceras* Drechs.; *Bipolaris monoceras* (Drechs.) Shoemaker; teleomorph: *Setosphaeria monoceras* Alcorn)	leaf blotch	**Qld** (1973: Brookfield)	9
Exserohilum pedicellatum (Henry) Leonard & Suggs (synonyms: *Helminthosporium pedicellatum* Henry; *Drechslera pedicellata* (Henry) Subramanian & Jain; teleomorph: *Setosphaeria pedicellata* (Nelson) Leonard & Suggs)	**Helminthosporium root rot; seed rot; seedling blight**	**Qld** (1976)	9

PATHOGEN	**DISEASE[1]**	**DISTRIBUTION[2]**	**REF.**
Exserohilum rostratum (Drechs.) Leonard & Suggs (synonyms: *Bipolaris rostrata* (Drechs.) Shoemaker; *Drechslera rostrata* (Drechs.) Richardson & Fraser; *Helminthosporium rostratum* Drechs.; teleomorph: *Setosphaeria rostrata* Leonard)	**Rostratum leaf spot; Helminthosporium leaf disease; ear and stalk rot;** rostratum spot	**Qld** (1972: Norwin, Biloela, Parada, Goomeri, Cooktown, Rathdowney, Kairi; 1976: Lawes, Gatton, Kingaroy; 1986: Atherton Tablelands, Chapel Hill)	9
Exserohilum turcicum (Pass.) Leonard & Suggs (synonyms: *Bipolaris turcica* (Pass.) Shoemaker; *Drechslera turcica* (Pass.) Subramanian & P.C. Jain; *Helminthosporium turcicum* Pass.; teleomorph: *Setosphaeria turcica* (Luttrell) Leonard & Suggs)	**northern corn leaf blight; white blast; crown stalk rot; stripe; seed rot; seedling blight**; northern leaf blight (NLB); Turcicum leaf blight	**NSW** (1917: Eden; 1932: Grafton; 1961: Grafton, Kempsey; 1962: Glen Innes; 1964: Kempsey, Taree; 1970: Wilberforce, Grafton, Maclean, Richmond; 1971: Windsor, Kempsey, Tamworth, Castle Hill, Caroona, Pennant Hills, Hannam Vale; 1972: Moorland; 1975: Kyogle, Grafton, Cowper, Kempsey, Bellingen, Lawrence, Castle Hill, Coldstream; 1976: Singleton, Grafton, Woodville, Castle Hill, Bega; 1982: Richmond; 1989: Maroota South); **Qld** (1900; 1901: Isis Scrub; 1912: Fig Tree Pocket, 1927: Wooroolin, Yalangur, 1935: Long Pocket, 1942: Malanda; 1962: Gatton; 1970: Wooroonlin; 1972: Kenmore, Kairi, Atherton Tablelands, Boonah, Warwick, Kingaroy; 1973: Warwick; 1974: Kingaroy; 1975: Gatton, Kingaroy; 1976: Toowoomba; 1988: Bundaberg; 1990: Gatton, Atherton; 1995: Ayr); **Tas.** (1976: Flinders Is.); **Vic.** (1992; 1993: Orbost)	9, 13
Fusarium acuminatum Ellis & Everh. (teleomorph: *Gibberella acuminata* Wollenweb.)	**minor root rot**; root and stem rot	**Vic.** (1966: Berwick)	9
Fusarium chlamydosporum Wollenweb. & Reinking (synonyms: *Fusarium fusarioides* (Gonz. Frag. & Cif.) Booth; *Dactylium fusarioides* Gonz. Frag. & Cif.)	grain mould	**NT** (1988: Douglas Daly)	10, 11
Fusarium crookwellense Burgess, Nelson & Toussoun	stem rot	**NSW** (1990: Berry)	9
Fusarium culmorum (Wm. G. Sm.) Sacc.	**minor ear rot; seed rot; seedling blight;** stalk rot	**NSW; Tas.** (1980: Devonport)	6, 9

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Fusarium equiseti (Corda) Sacc. (teleomorph: *Gibberella intricans* Wollenweb.)	**minor root rot;** stalk rot	**NSW** (1982: Carrathool)	9
Fusarium graminearum Schwabe (teleomorph: *Gibberella zeae* (Schwein.) Petch)	**Gibberella ear and stalk rot; seed rot; seedling blight;** red ear rot; pink ear rot	**NSW** (1928: Kangaroo Valley; 1933: Nowra; 1934: Gundagai; 1935: Grafton; 1936: Kangaroo Valley; 1956: Grafton; 1977: Grafton, Kempsey; 1983: Anna Bay); **Qld** (1968: Kairi, Tolga, Upper Barron, Walkerman, Wongabel; 1973: Kairi; 1985: Walkamin); **Vic.** (1978: Crooked River)	9, 15
Fusarium moniliforme Sheld. (synonym: *Sporotrichum atropurpureum* Peck; teleomorph: *Gibberella fujikuroi* (Sawada) Ito in Ito & Kimura)	**Fusarium kernal, root and stalk rot; seed rot; seedling blight**; Fusarium ear and stalk rot	**NSW** (1929: Bathurst; 1932: Sydney, Grafton, Bathurst; 1933: Sydney, Bathurst; 1934: Sydney; 1936: Glen Innes; 1966: Duranbah; 1969: Narromine; 1970: Rydalmere; 1971: Armidale, Rydalmere, Castle Hill; 1972: East Maitland; 1981: Coleambally; 1982: Carrathool; 1986: Rydalmere; 1990: Berry); **Qld** (1956: Gympie; 1977: Walkamin; 1985: Darling Downs); **SA**; **Vic.** (1985: Orbost, East Gippsland); **WA** (1959: Bunbury)	2, 9, 14, 15
Fusarium oxysporum Schlechtend.:Fr.	**minor root rot; minor stalk rot;** seed rot	**NSW** (1978: Nemingha); **Qld** (1985: Walhaman); **Tas.** (1980: Devonport)	9
Fusarium pallidoroseum (Cooke) Sacc. (synonyms: *Fusisporium pallidoroseum* Cooke; *Fusarium semitectum* auct. non Berk. & Ravenel)	**minor root rot;** root rot	**Qld** (1985: Yungaburra)	10
Fusarium proliferatum (Matsushima) Nirenberg (Synonym: *Cephalosporium proliferatum* Matsushima)	grain mould; root rot	**NT** (1988: Douglas Daly)	10, 11
Fusarium tricinctum (Corda) Sacc. (synonyms: *Fusarium citriforme* Jamalainen; *Selenosporium tricinctum* Corda)	**minor stalk rot;** ear rot	**NSW** (1969: Glen Innes)	9
Geotrichum candidum Link (synonyms: *Oospora lactis* (Fresen.) Sacc.; *Oospora lactis* (Fresen.) Sacc. Var. *parasitica* Pritchard & Porte; teleomorph: *Galactomyces geotrichum* (Butler & Petersen) Redhead & Malloch)	stalk rot	**NSW**; **Tas.** (1980: Devonport)	6, 9
Leptosphaerulina trifolii (Rostr.) Petr.	leaf spot	**NSW** (1977: Brushgrove)	8

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Macrophomina phaseolina (Tassi) Goidanich (synonyms: *Macrophoma phaseolina* Tassi; *Macrophomina phaseoli* (Maubl.) Ashby; *Rhizoctonia bataticola* (Taubenhaus) Butler)	**charcoal rot; seed rot; seedling blight**	**NSW** (1968: Tamworth; 1975: Trangie; 1980: Darlington Point, Coleambally; 1981: Darlington Point; 1987: Liverpool); **Qld** (1984: Toowoomba)	9, 15
Marasmius graminum (Lib.) Berk. (synonym: *Marasmius tritici* Young)	root and stalk rot; seedling and foot rot	**Qld**	12, 15
Marasmius sacchari Wakk.	Marasmius root and stalk rot	**Qld**	12
Nigrospora oryzae (Berk. & Broome) Petch (teleomorph: *Khuskia oryzae* Hudson)	**dry ear rot; cob, kernel and stalk rot**; Nigrospora ear rot	**NSW** (1964: East Maitland); **SA**; **Vic.** (1993: Orbost)	2, 9
Nigrospora sacchari (Speg.) Mason		**Qld** (1936: Atherton Tablelands; 1985: Walkamin); **Vic.** (1993: Orbost)	9
Nigrospora sphaerica (Sacc.) Mason (synonym: *Trichosporum sphaerica* Sacc.)	stalk rot	**NSW** (1931: Grafton; 1932: Albion Park, Kangaroo Valley); **Qld** (1936: Atherton Tablelands, Tolga)	9, 15
Olpitrichum macrosporum (Farl.) Sumstine (synonyms: *Rhinotrichum macrosporum* Farl.; *Oidium macrosporum* (Farl.) Linder; *Plectrothrix globosa* Shear)		**Qld** (1986: Mount Maria)	9
Penicillium funiculosum Thom		**Qld** (1986: Mt. Maria)	8
Penicillium minioluteum Dierckx	seed rot	**NSW** (1984)	9, 10
Periconia macrospinosa Lefebvre & Johnson in Lefebvre *et al*.		**Qld** (1980: Wyreema)	9
Peronosclerospora maydis (Racib.) Shaw (synonym: *Sclerospora maydis* (Racib.) Butler)	**Java downy mildew;** downy mildew	**NT** (1980: Katherine; 1981: Douglas Daly, Katherine; 1983: Douglas Daly; 1984: Douglas Daly, Sunday Creek; 1989: Douglas Daly); **Qld** (1985; 1987: Dimbulah); **WA** (1980: Kununurra)	9, 11, 14
Peronosclerospora sacchari (Miyake) Shirai & Hara (synonym: *Sclerospora sacchari* (Miyake) Shaw)	**sugarcane downy mildew**	**Qld** (1938: Merenga). Now eradicated.	15

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Phaeocytostroma ambiguum (Mont.) Petr. in Petr. & Syd. (synonym: *Phaeocytosporella zeae* Stout; *Sphaeropsis ambigua* Mont.)	**Phaeocytostroma stalk rot and root rot**; Phaeocytosporella stalk infection; root and stalk rot	**NSW** (1990: Darlington Point, Carrathool)	9
Phaeosphaeria herpotrichoides (De Not.) L. Holm (synonyms: *Leptosphaeria herpotrichoides* De Not.; *Leptosphaeria sparsa* (Fuckel) Sacc.; *Leptosphaeria culmifraga* Auct.; anamorph: *Stagonospora* sp.)	Phaeosphaeria leaf spot	**Qld** (1973: Kairi)	9
Phaeosphaeria maydis (Henn.) Rane, Payak & Renfro (synonym: *Sphaerulina maydis* Henn.)	**Phaeosphaeria leaf spot**	**Qld** (1988: Nambour)	9
Phaeotrichoconis crotalariae (Salam & Rao) Subramanian		**Qld** (1972: Parada)	9
Phoma terrestris Hans. (synonym: *Pyrenochaeta terrestris* (Hans.) Gorenz *et al*.)	**Pyrenochaeta stalk rot and root rot**; pink root	**WA** (1985: Kununurra)	14
***Phomopsis* sp.**	**seed rot; seedling blight;** Phomopsis seed rot	**Qld**	9, 10
Physoderma maydis (Miyabe) Miyabe (synonym: *Physoderma zea-maydis* Shaw in Syd., Syd. & Butler)	**brown spot; black spot; stalk rot**	**NSW** (1985: Tabulam); **Qld** (1960: Atherton Tablelands; 1975: Kingaroy, Taabinga, Gurgeena)	9, 15
Pleurophragmium verruculosum Tiwari		**Qld** (1976: Norwan)	9, 10
Puccinia polysora Underw.	**southern corn rust;** leaf rust; southern rust	**NT** (1973: Tipperary Station; 1974: Katherine; 1975: Camp Creek; 1976: Camp Creek); **Qld** (1959: Atherton Tablelands; 1960: Atherton Tablelands; 1963; 1982: Kairi)	9, 11, 15

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Puccinia sorghi Schwein. (synonym: *Puccinia maydis* Bereng; anamorph: *Aecidium oxalidis* Thuem.)	**common corn rust**; leaf rust; common maize rust	**NSW** (1914; 1918: Grafton; 1920: Grafton; 1924: Dundas; 1927: Manning River; 1931: Bathurst; 1961: West Pennant Hills, Blackalls Park, Penshurst, Armidale; 1963: Armidale; 1964: Kempsey, Upper Mungay Creek; 1968: Nabiac, Macksville; 1970: Windsor, Armidale, Wilberforce; 1971: Windsor, Castle Hill, Galston, Parkes, Kempsey, Caroona; 1972: Wingham, Grafton, Trangie; 1974: Castle Hill, Trangie; 1975: Baulkham Hills, Grafton, Lawrence; 1976: Gundagai; 1979; 1982: Richmond; 1984: Spring Ridge, Cowra, Leeton; 1985: Tabulam; 1986: Nowra, Wauchope; 1987: Hay; 1989: Grafton, Duckenfield; 1996: Forbes); **Qld** (1901; 1927: Yalangur; 1930: Gatton; 1933: Tarampa; 1935: Gatton; 1948: Kingaroy; 1959: Atherton; 1962: Gatton; 1960: Atherton Tablelands; 1970: Nambour; 1978: Bowen; 1979: Inverlaw; 1984: Brisbane; 1991: Bowen); **Tas.** (1977: Sheffield); **Vic.** (1897: Seville; 1956: Kinglake West; 1981: Clayton; 1984: Silvan; 1985; 1987: Orbost); **WA** (1945: Perth)	9, 13, 14
Pyrenochaeta indica Viswanathan	black root rot	**Qld** (1985: Yungaburra)	9
Pyricularia grisea (Cooke) Sacc.	white leaf spot	**NSW** (1978: Carrs Creek); **Qld** (1968: Walkamin)	9
Pythium aphanidermatum (Edson) Fitzp. (synonym: *Pythium butlerii* Subramanian; *Rheosporangium aphanidermatum* Edson; *Nematosporangium aphanidermatum* (Edson) Fitzp.)	**Pythium stalk rot**	**Qld** (1978: Gatton)	9, 15
Pythium myriotylum Drechs.	root rot	**Qld** (1985: Atherton Tablelands; 1988: Toowoomba)	9
Ramulispora sorghi (Ellis & Everh.) Olive & Lefebvre in Olive *et al*. (synonym: *Septorella sorghi* Ellis & Everh.)	brown leaf spot	**NT** (1980: Katherine)	9

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Rhizoctonia solani Kühn (synonyms: *Rhizoctonia microsclerotia* Matz; *Rhizoctonia macrosclerotia* Matz; *Moniliopsis solani* Kühn; teleomorphs: *Thanatephorus cucumeris* (Frank) Donk; *Corticium sasakii* (Shirai) Matsumoto	**Rhizoctonia root rot and stalk rot; banded leaf and sheath spot; Corticium ear rot; seed rot; seedling blight**; root, stem and ear rot	**Qld** (1985: Yungaburra)	9
Rhizoctonia zeae Voorhees (synonym: *Moniliopsis zeae* (Voorhess) Moore; teleomorph *Waitea circinata* Warcup & Talbot)	**Rhizoctonia ear rot, root rot and stalk rot; sclerotial rot; seed rot; seedling blight**	**NSW** (1992: Witton)	9
Rhizopus stolonifer (Ehrenb.:Fr.) Vuill. (synonym: *Rhizopus nigricans* Ehrenb.)	**minor ear rot;** Rhizopus ear rot; gray mould	**Vic.** (1993: Orbost)	9, 10
Sclerophthora macrospora (Sacc.) Thirumalachar, Shaw & Narasimhan (synonyms: *Sclerospora macrospora* Sacc.; *Phytophthora macrospora* (Sacc.) Ito & Tanaka)	**crazy top downy mildew**; crazy top	**NSW** (1929: Temagog; 1960: Glen Innes; 1962: Cobargo; 1971: Tamworth; 1985: Narara; 1986: East Maitland, Fernmount); **Vic.** (1991: Orbost)	9
Sclerotium rolfsii Sacc. (teleomorph: *Athelia rolfsii* (Curzi) Tu & Kimbrough)	**Sclerotium ear rot; southern blight; seed rot; seedling blight;** root rot	**NSW** (1974: Nook Creek); **Qld**	9, 15
Septoria zeicola Stout	**minor leaf spot;** leaf spot	**NSW** (1971: Parkes)	9

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Sporisorium holci-sorghi (Rivolta) Vanky (synonyms: *Sphacelotheca reiliana* (Kühn) Clinton; *Sorosporium reilianum* (Kühn) McAlpine; *Sporisorium reilianum* (Kühn) Langdon & Fullerton; *Ustilago reiliana* Kühn)	**head smut**	**NSW** (1899: Singleton; 1920: Grafton; 1921: Grafton; 1922: Clarence River, Grafton; 1936: Richmond; 1940: Bathurst; 1941: Taree; 1952: Grafton; 1953; 1955: Richmond; 1961: Rydalmere; 1967: Pitt Town; 1968: Penrith; 1970: Wilberforce, Grafton, Pitt Town; 1972: Carrs Peninsula; 1981: Colo; 1987: Kelso); **Qld** (1950: Lawes; 1953: Goomeri; 1963: Kingaroy); **Vic.** (1901: Orbost; 1908: Lindenow; 1910: Burnley, Richmond; 1991: Orbost)	9
Stenocarpella macrospora (Earle) Sutton (synonyms: *Diplodia macrospora* Earle; *Macrodiplodia zeae* (Schwein.) Petrak & Sydow var. *macrospora* (Earle) Petrak & Sydow)	**Diplodia leaf spot or leaf streak; southern leaf spot**; Diplodia ear and stalk rot; dry rot	**NSW** (1964: Upper Mungay Creek, Kempsey; 1971: Taylors Arm; 1972: Aldvilla; 1974: Kempsey); **Qld** (1942: Malanda; 1960: Atherton Tablelands; 1974: Imbil)	9, 15
Stenocarpella maydis (Berk.) Sutton (synonyms: *Diplodia zeae* (Schwein.) Lév.; *Macrodiplodia zeae* (Schwein.) Petrak & Sydow; *Diplodia zeae-maydis* Mekhtijeva)	**White ear rot, root and stalk rot;** Diplodia ear and stalk rot	**NSW** (1931: Richmond; 1934: Glen Innes; 1985; 1987: Kangaroo Valley; 1989: Hay); **Qld** (1929: Yalangur; 1937: Beenleigh; 1987: Warwick); **Vic.** (1937: Orbost; 1990: Orbost)	9
Ustilago zeae (Beckm.) Unger (synonym: *Ustilago maydis* (DC) Corda)	**common smut;** boil smut	**NSW** (1915; 1930; 1935: Bathurst; 1939: Kelsow; 1982: North Coast, Old Bonalbo, Collius Creek, Dryaaba, Grafton, Tatham; 1983: Upper Lansdowne; 1986: Fernmount; 1987: Delungra, Inverell; 1989: Duckenfield; 1990: Glendon, Kootingal, Mount Russel, Nemingha; 1991: Gunnedah; 1992: Windsor; 1994: Dunedoo, Narromine, Dubbo; 1995: Breeza; 1996: Coonabarabran); **Qld** (1982: Rathdowney, Beaudesert; 1984: Beaudesert; 1987: Atherton Tablelands; 1989: Brisbane; 1991: Forest Hill; 1992: Brookstead); **Vic.** (1901: Orbost; 1908: Lindenow)	9, 15
Nematodes			
Criconema mutabile (Taylor) Raski & Luc	**ring nematode**	**NSW** (Windsor)	7

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Filenchus exiguus (de Man) Ebsary (synonym: *Tylenchus exiguus* de Mann)		**Qld** (Beerwah)	7
Filenchus filiformis (Butschli) Ebsary		**SA** (Urrbrae)	7
Gracilacus mutabilis (Colbran) Raski		**Qld** (Beerburrum)	7
Helicotylenchus dihystera (Cobb, 1893) Sher, 1961	**spiral nematode**	**Qld** (Beerwah; Nambour)	7
Helicotylenchus multicinctus (Cobb, 1893) Golden, 1956	**spiral nematode**	**Qld** (Beerwah)	7
Macroposthonia ornata (Raski, 1958) de Grisse & Loof, 1965 (synonym: *Criconemella ornata* (Raski, 1958) Luc & Raski, 1981)	**ring nematode**	**Qld** (Koah)	7
Meloidogyne incognita (Kofold & White, 1919) Chitwood, 1949 (synonyms: *Oxyuris incognita* Kofold & White, 1919; *Meloidogyne incognita* var. *acrita* Chitwood, 1949)	**root-knot nematode**	**NSW** (1969; 1970: Rydalmere)	9
Meloidogyne javanica (Treub, 1885) Chitwood, 1949 (synonyms: *Heterodera javanica* Tueb, 1885; *Tylenchus javanica* (Treub, 1885) Cobb, 1890; *Anguillula javanica* (Tueub, 1885) Lavergne, 1901)	**root-knot nematode**	**NSW** (1969; 1970: Rydalmere); **SA**	2, 9
Neopsilenchus magnidens (Thorne) Thorne & Malek		**Qld** (Coolum)	7
Paratrichodorus lobatus (Colbran, 1965) Siddique, 1974	stubby root nematode	**SA**	2, 7
Paratrichodorus minor (Colbran, 1956) Siddique, 1974 (synonyms: *Nanidorus minor* (Colbran, 1956) Siddique, 1974; *Trichodorus minor* Colbran, 1956; *Trichodorus christiei* Allen, 1957; *Paratrichodorus christiei* (Allen, 1957) Siddiqi, 1974)	**stubby-root nematode**	**Qld** (Koah)	7

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Pratylenchus brachyurus (Godfrey, 1929) Filipjev & Schuurmans Stekhoven, 1941 (synonyms: *Tylenchus brachyurus* Godfrey, 1929; *Anguillulina brachyura* (Godfrey, 1929) Goodey, 1932; *Pratylenchus pratensis* of Thorne, 1940; *Pratylenchus leiocephalus* Steiner, 1949; *Pratylenchus steineri* Lordello et al., 1954)	**lesion nematode;** root lesion nematode	**Qld** (Kingaroy; Koah; Wondai)	7
Pratylenchus zeae Graham, 1951	**lesion nematode;** root lesion nematode	**Qld** (Cooroy)	7
Radopholus similis (Cobb, 1893) Thorne, 1949 (synonyms: *Tylenchus similis* Cobb, 1893; *Anguillulina similis* (Cobb, 1893) Goodey, 1932; *Rotylenchus similis* (Cobb, 1893) Filipjev, 1936; *Tylenchus granulosus* Cobb, 1893; *Anguillulina granulosa* (Cobb, 1893) Goodey, 1932; *Bitylenchus granulosus* (Cobb, 1893) Filipjev, 1934; *Tetylenchus granulosus* (Cobb, 1893) Filipjev, 1936; *Tylenchus acutocaudatus* Zimmermann, 1898; *Anguillulina acutocaudatus* (Zimmermann, 1898) Goodey, 1932; *Tylenchus biformis* Cobb, 1909; *Anguillulina biformis* (Cobb, 1909) Goodey, 1932)	**burrowing nematode**	**Qld** (Nambour)	7
Rotylenchulus parvus (Williams, 1960) Sher, 1961 (synonym: *Helicotylenchus parvus* Williams, 1960)	reniform nematode	**Qld** (Kingaroy; Wooroolin)	7
Viruses			
Cereal chlorotic mottle nucleorhabdovirus (CCMV)	cereal chlorotic mottle	**NSW** (Grafton to Qld border in coastal areas and up to 200 km inland); **Qld** (Cairns to NSW border in coastal areas and up to 200 km inland)	1, 4
Chloris striate mosaic mastrevirus (CSMV) (synonym: Australian wheat striate mosaic virus)	striate mosaic	**NSW** (Newcastle to Qld border); **Qld** (Cairns to NSW border)	1, 10

PATHOGEN	DISEASE[1]	DISTRIBUTION[2]	REF.
Johnsongrass mosaic potyvirus (JGMV) (synonym: maize dwarf mosaic virus - strain O; sugarcane mosaic virus - Australian Johnson grass virus; maize dwarf mosaic – Kansas I strain)	Johnson grass mosaic	**NSW** (North east and north west); **Qld** (South, central and north); **Vic.** (Baccus Marsh, Orbost, Bairnsdale); **WA** (Kununurra)	1, 6
Maize sterile stunt rhabdovirus	maize sterile stunt	**NSW** (Grafton to Qld border along coast and up to 200 km inland); **Qld** (Cairns to NSW border along coast and up to 200 km inland)	1, 5
Maize stripe tenuivirus (MSpV) (synonyms: maize chlorotic stripe virus; maize hoja blanca virus; sorghum chlorosis virus)	maize stripe	**NSW** (Grafton to Qld border in coastal areas); **Qld** (Cairns to NSW border in coastal areas); **NT** (Darwin)	1
Sugarcane mosaic potyvirus (SCMV) (synonyms: grass mosaic virus; maize dwarf mosaic virus strain B; sorghum red stripe virus)	sugarcane mosaic	**NSW** (1970: Merriganowry; 1971: Tumut Plains; 1989: Rydalmere); **NT**; **Qld** (Coastal and subcoastal central and southern areas)	1, 9

1 Standardised common names shown in bold according to ‘Common Names for Plant Diseases 1994. Committee on Standardization of Common Names for Plant Diseases of the American Phytopathological Society 1978-1993’.

2 ACT ………………………………………………. Australian Capital Territory
NSW ……………………………………………. New South Wales
NT ………………………………………………… Northern Territory
Qld ……………………………………………... Queensland
SA ………………………………………………… South Australia
Tas. ..……………………………………………… Tasmania
Vic. ……………………………………………... Victoria
WA ………………………………………………… Western Australia

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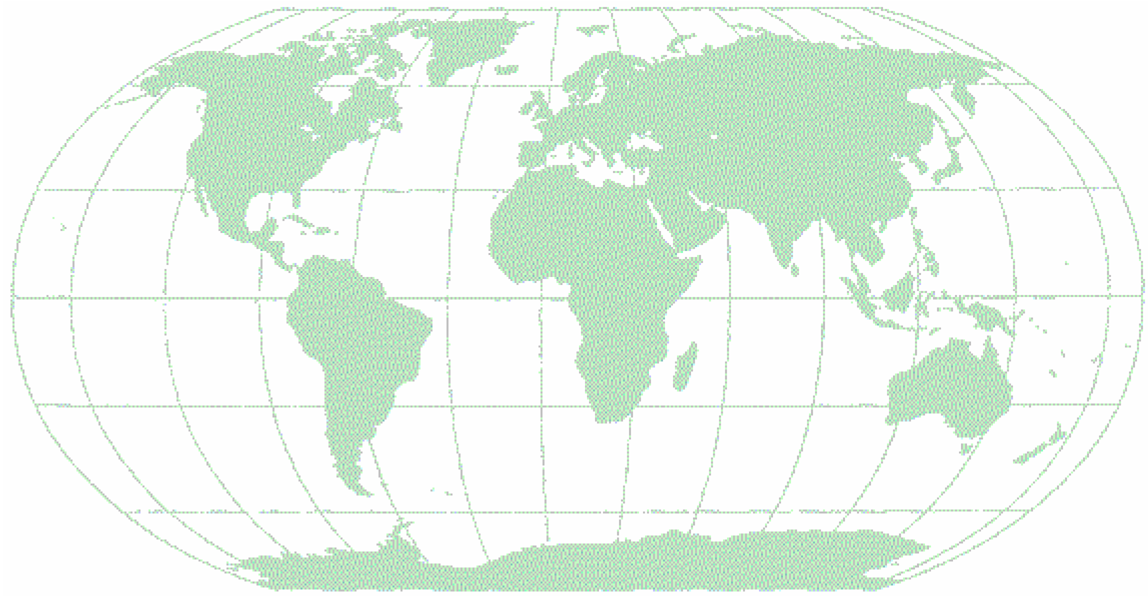
PART TWO

MAIZE DISEASES OF THE WORLD



AN ANNOTATED LIST OF BACTERIA, FUNGI, NEMATODES, PHYTOPLASMAS AND VIRUSES RECORDED ON MAIZE (*ZEA MAYS* L.) IN THE WORLD - THEIR DISTRIBUTION AND SIGNIFICANCE

PATHOGEN	DISEASE[1]	COMMENTS
Bacteria		
Acidovorax avenae subsp. ***avenae*** (Manns) Willems *et al*. 1992 (synonyms: *Pseudomonas avenae* subsp. *avenae* Manns 1909; *Bacterium rubrilineans* (Lee *et al*.) Elliot 1930; *Bacterium setariae* Okabe 1934; *Chlorobacter setariae* (Okabe) Patel & Kulkarni 1951; *Phytobacterium alboprecipitans* (Rosen) Margrou & Prévot 1948; *Phytomonas avenae* (Manns) Bergey *et al*. 1930; *Pseudomonas rubrilineans* (Lee *et al*.) Stapp 1928*; Xanthomonas rubrilineans* (Lee *et al*.) Starr & Burkholder 1942)	**bacterial leaf blight and stalk rot;** BLB	Widespread. The bacterium is ***seed-borne*** and seed to seedling transmission has been demonstrated for maize under laboratory conditions (Dange *et al*., 1978). In most cases conditions of high temperature and high relative humidity favour symptom development (Saddler, 1994). There is evidence to suggest that mature plants, which survive infection in the seedling stage, harbour latent infections. The bacterium is not thought to survive well in soil or plant debris. Alternative hosts such as *Paspalum urvillei* are considered an important inoculum source for BLB outbreaks in maize (Gitaitis *et al*., 1978). The disease has caused significant economic losses on sweetcorn in Florida (Gitaitis *et al*., 1978). Severe to moderate symptoms were observed in 1990, 1992 and 1993 on sweetcorn hybrids grown in Illinois (White *et al*., 1994). Wide host range including maize, sorghum, rice and sugarcane (Saddler, 1994). While Ramundo & Claflin (1990) found no differences between strains in pathogenicity, host range and a number of physiological traits, studies in Japan with five isolates from different hosts and geographical areas on 28 different plants showed a complex pattern of host specificity (Bradbury, 1973). A study conducted in Australia also showed strain variation (Fahy *et al*., 1989). This study on 58 isolates from quarantine outbreak sites, field surveys and seed isolations divided the bacterium into 10 groups, six of which were exotic to Australia. **Recorded** on Saccharum (NSW, Qld, WA), Sorghum (WA) (Moffett, 1983), *Panicum miliaceum*, *Setaria italica* and *Zea mays* (Fahy *et al*., 1989) **in Australia**.
Bacillus subtilis (Ehrenberg) Cohn	**seed rot; seedling blight;** kernel rot	Saprophytic rather than parasitic. Reported from **USA** causing kernel rot of maize (Bradbury, 1986). **Not recorded** on maize or any other plants in **Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Burkholderia andropogonis (Smith) Gillis *et al*., 1995 (synonyms: *Pseudomonas andropogonis* (Smith) Stapp 1928 *Phytobacterium stizolobii* (Wolf) Magrou & Prevot 1948*; Bacterium andropogonis* Smith 1911)	**bacterial stripe;** bacterial stripe of corn and sorghum; bacterial leaf spot (corn)	This disease is of minor importance. It occasionally occurs after extended periods of warm, wet weather (Vidaver & Carlson, 1978). Typical symptoms are amber-coloured to olive-coloured, oil soaked, translucent lesions with parallel sides that tend to elongate and coalesce. The bacterium is seed-borne, with a wide host range including maize, sorghum, *Bougainvillea* sp., teosinte, sudangrass and legumes (Bradbury, 1986). Not recorded on maize, but **recorded** on Bougainvillea, Ceratonia, Cicer, Dianthus, Mucuna, Sorghum, Trifolium and Vicia (NSW, QLD, Vic, WA) **in Australia** (Moffett, 1983; NCOF, 1998).
Clavibacter michiganensis subsp. ***nebraskensis*** (Vidaver & Mandel) Davis *et al*. 1984 (synonyms: *Corynebacterium nebraskense* Vidaver & Mandel 1974; *Corynebacterium michiganense* pv. *nebraskense* (Vidaver & Mandel) Dye & Kemp 1977)	**Goss's bacterial wilt and blight; leaf freckles and wilt;** Goss's wilt; Nebraska leaf freckles and wilt	The pathogen is confined to **USA** and is ***seed-borne*** (Richardson, 1990). Seed-borne inoculum is thought to be of minor significance in the epidemiology of the pathogen in areas where the pathogen is present, as the transmission rate in seed appears to be low. This may explain why the pathogen has not become widespread in the USA and the world (Biddle *et al*. 1990). The bacterium can overwinter in maize crop residues, which are the most important inoculum source (Smidt & Vidaver, 1986). Within fields, the main source of inoculum is plant debris, with the pathogen possibly being dispersed by wind and rain. Seed transmission may spread the disease over large areas. Losses are generally minor, but may be severe in individual fields (Wysong *et al*. 1973). Losses as great as 50% attributable to this disease have been mitigated in field maize in recent years through the use of resistant germ plasm (Smidt & Vidaver, 1986). Variation in pathogenicity (Schuster *et al*. 1972) and the occurrence of different strains has also been reported (Vidaver *et al*., 1981). Maize is the only natural host of this pathogen (Bradbury, 1986). **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Erwinia carotovora subsp. ***carotovora*** (Jones) Bergey *et al.* 1923 (synonym: *Erwinia carotovora* f.sp. *zeae* Sabet 1954)	**bacterial stalk and top rot;** bacterial soft rot	Widespread. The bacterium is carried on seed, but there is no evidence for seed to seedling transmission. It can survive on maize debris and is spread by water (Prasad & Sinha, 1977). It causes a major disease of maize in tropical and subtropical countries. The disease is particularly severe under conditions of high temperature and humidity (Saxena & Lal, 1984). In temperate regions such as USA, it only is a problem in overhead irrigated crops (Otta & Wood, 1977). Maize is the natural host of this pathogen (Bradbury, 1986). **Recorded** on maize (ACT, NSW), and a wide range of other plants **in Australia** (Moffett, 1983; NCOF, 1998).
Erwinia chrysanthemi pv. ***zeae*** (Sabet) Victoria *et al.* 1975 (synonym: *Pectobacterium chrysanthemi* pv. *zeae* (Sabet) Brenner *et al.* 1977)	**bacterial stalk and top rot;** stem rot	Widespread. The bacterium lives saprophytically on crop residue in the soil (Shurtleff, 1980). Yield losses of 92%, induced by artificial inoculation, have been reported in India (Thind & Payak, 1985). This disease is most prevalent and destructive in areas with high rainfall, where plants are watered by sprinkler irrigation (Otta & Wood, 1977), and on land subjected to flooding. It was reported for the first time in Florida in sprinkler irrigated inbreds (Lopes, *et al.* 1986). Maize is the natural host of this pathogen (Bradbury, 1986). Stem rot caused by *Erwinia chrysanthemi* has been recorded in Australia (Vic.), but bacterium was not identified to pathovar (NCOF, 1998). *Erwinia chrysanthemi* pv. *zeae* has **not** been **recorded in Australia**.
Erwinia dissolvens (Rosen) Brenner *et al.*, (synonyms: *Enterobacter dissolvens* (Rosen) Burkholder 1948; *Phytomonas dissolvens* (Rosen) Rosen 1926; *Aerobacter dissolvens* (Rosen) Waldee 1945; *Aplanobacter dissolvens* (Rosen) Rosen 1926)	**bacterial stalk rot**	Reported from **USA** (AL, AZ, AR, CA, FL, IL, IN, KY, LA, MI, MS, MO, NE, NC, ND, OH, OK, TN, TX, WV) and Canada (BC, Ont.), India, Bulgaria and Spain (Bradbury, 1986). It is likely that many records are confused with *Erwinia chrysanthemi* pv. *zeae* (Bradbury, 1986). The bacterium has been reported as a significant problem, but whether it causes a separate disease of maize is questionable (Lal *et al*., 1970). Rotting occurs at ground level, with bacterial ooze present. Transmission by seed has not been reported. Maize, sorghum and tobacco are the natural hosts of this pathogen (Bradbury, 1986). **Not recorded in Australia.**

PATHOGEN	DISEASE[1]	COMMENTS
Erwinia herbicola (Löhnis) Dye 1964 (synonyms: *Bacterium herbicola* (Löhnis) Stapp 1928; *Pseudomonas herbicola* (Löhnis) dé Rossi 1927; *Xanthomonas maydis* Rangaswami *et al*. 1961; *Enterobacter agglomerans* (Beijerinck 1888) Ewing & Fife 1972; *Pantoea agglomerans* (Beijerinck 1888) Gavini *et al.* 1989)	halo blight of corn	Widespread. This bacterium is common on plant surfaces and in lesions as a secondary invader. It is usually considered not to be a plant pathogen (Bradbury, 1986). An *Erwinia* sp., possibly related to *Erwinia herbicola*, was detected in 1976 in Missouri, **USA.** This pathogen was highly virulent when inoculated onto seedlings of several maize inbreds (Gardner & Wallin, 1978). Another strain, identified as *Xanthomonas maydis* (Rangaswami *et al*. 1961) has been reported from India as causing significant problems on maize (Ranganathaiah, *et al.*, 1983). The bacterium is ***seed-borne*** (Richardson, 1990) and seed to seedling transmission has been demonstrated under laboratory conditions (Ranganathaiah, *et al.*, 1983). A *Xanthomonas* sp. which is not seed transmitted also occurs in warm humid areas of Mexico. This species is transmitted by a budworm (Cameno & DeLeon, 1984). Plant pathogenic strains have **not** been **recorded in Australia**.
Pantoea stewartii subsp. ***stewartii*** (Smith) Mergaert *et al*. 1993 (synonyms: *Erwinia stewartii* (Smith) Dye 1963; *Aplanobacter stewartii* (Smith) McCulloch 1918; *Bacterium stewartii* (Smith) Smith 1905; *Bacillus stewartii* (Smith) Holland 1920; *Phytomonas stewartii* (Smith) Bergey *et al.* 1923; *Xanthomonas stewartii* (Smith) Dowson 1939)	**Stewart's disease; bacterial wilt;** Stewart's bacterial wilt; Stewart's wilt; Stewart's leaf blight; maize bacteriosis	Spreads in China, Malaysia, Thailand, Vietnam, Italy, Poland, Romania, Yugoslavia, Canada, Mexico, **USA**, Costa Rica, Puerto Rico, Brazil, and Peru (Bradbury, 1986). The bacterium is ***seed-borne*** (Richardson, 1990) but the seed to seedling transmission rate is very low (Block, *et al.*, 1994). The bacterium overwinters in seed, soil or maize stalks. However, the main means of overwintering is in the corn flea beetle, *Chaetocnema pulicaria* Melsh. (Munkvold, *et al.*, 1996). Variability occurs in pathogenicity (Braun, 1982). Outbreaks of the disease in 1990 and 1992 caused substantial losses to the maize seed industry in Iowa. In 1995, the disease caused heavy losses in Illinios (Pataky *et al.*, 1996). *Tripsacum dactyloides*, *Zea mays* and *Zea mexicana*, are the natural hosts of this pathogen (Bradbury, 1986). **Not recorded in Australia**.
Pseudomonas sp.	yellow leaf blotch	This disease was first observed in Nigeria, and has now spread to other countries; Cameroon, Ghana, Nigeria, Niger and Senegal. There is no information on its economic importance. No report of seed transmission. Hosts of this bacterium include maize, sorghum, millet, wheat and several grasses (Zummo, 1976). Not recorded in the USA. **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Pseudomonas syringae pv ***syringae*** van Hall 1902 (synonyms: *Pseudomonas syringae* van Hall 1902; *Pseudomonas holci* Kendrick 1926)	**holcus spot**; h olcus bacterial spot	Widely distributed and very wide host range (Bradbury, 1986). This disease is occasionally found in northern production areas of **USA**, but is of no economic importance (Arny, 1976). No report of transmission by seed. **Recorded** on maize (NSW), and a wide range of other plants (NSW, Qld, SA, Tas., Vic. WA) **in Australia** (Moffett, 1983; NCOF, 1998).
Pseudomonas syringae pv. ***coronafaciens*** (Elliot) Young *et al*. 1978 (synonym: *Pseudomonas coronafaciens* pv. *zeae* Ribeiro *et al*. 1977)	**chocolate spot**	Chocolate spot is produced by a strain of this pathogen that is pathogenic to maize and timothy (Bradbury, 1986). It is reported only in Wisconsin and Minnesota (**USA**). Chocolate spot only occurs in K-deficient soils. Wounding of leaves by wind whipping appears to promote infection. Dark brown elongated spots surrounded by a broad yellow halo develop on the leaves. It occurs sporadically and is of no economic importance (Bowden & Stromberg, 1982). No report of transmission by seed. Maize, rye, oats, and triticale are the natural hosts of this pathogen (Bradbury, 1986). Not recorded on maize, but **recorded** on Avena (NSW, SA, WA) **in Australia** (Moffett, 1983; NCOF, 1998).
Pseudomonas syringae pv. ***lapsa*** (Ark) Young *et al*. 1978. (synonyms: *Phytomonas lapsa* Ark 1940; *Chlorobacter lapsus* (Ark) Patel & Kulkarni 1951; *Pseudomonas lapsa* (Ark) Starr & Burkholder 1942)	bacterial stalk rot	Distributed in **USA** and India (Bradbury, 1986). The bacterium is ***seed-borne*** (Richardson, 1990), and seed to seedling transmission has been demonstrated under laboratory conditions (Ark, 1941). This bacterium causes rapid decay of leaf and stalk parenchya (Bradbury, 1986). The pathogen can survive in soil and maize debris for at least 9 months (Rangarajan & Chakravarti, 1970). It is of little economic importance (McGee, 1994), although it caused severe losses in California in 1937 (Ark, 1940). *Sorghum bicolor* and *Zea mays* are the natural hosts of this bacterium (Bradbury, 1986). **Not recorded in Australia**.
Xanthomonas vasicola* pv. *holcicola (Elliott) Vauterin *et al*. 1995 (synonym**:** *Xanthomonas campestris* pv. *holcicola* (Elliott) Dye 1978)	**bacterial leaf spot**	**Widespread.** *Sorghum* spp., *Panicum miliaceum* and maize are the natural hosts of this bacterium (Bradbury, 1986). **Recorded** on maize (Qld), and on Sorghum (NSW, Qld) **in Australia** (Moffett, 1983; NCOF, 1998).

1 Standardised common names shown in bold according to ‘Common Names for Plant Diseases 1994. Committee on Standardization of Common Names for Plant Diseases of the American Phytopathological Society 1978-1993’.

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PATHOGEN	DISEASE[1]	COMMENTS
Fungi		
Absidia corymbifera (Cohan) Sacc. & Trott. (synonym: *Absidia ramosa* (Lindt) Lendn.)		Widespread. Isolated primarily from humans and animals. This fungus has been recorded on Carya and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Absidia repens Tiegh		Widespread. Isolated from soil and various kinds of organic matter. This fungus has only been isolated from Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Acremoniella verrucosa Tognini		Not recorded in USA (Farr *et al.*, 1989). **Recorded** on maize (NSW), *Acacia saligna* (WA), *Avena sativa* (NSW), *Babiana* sp., (NSW), *Olea europeae* (NSW), *Paspalum wettsteinii* (NSW) **in Australia** (NCOF, 1998).
Acremonium strictum Gams (synonym: *Cephalosporium acremonium* Auct. non Corda)	**black bundle disease; Cephalosporium kernel rot;** black bundle	Cosmopolitan. Common in soil and on plant surfaces. The pathogen is ***seed-borne*** (Richardson, 1990) and seed transmissible (Sumner, 1966). This is a minor late season disease of common occurrence in the USA and other countries (Hooker & White, 1976). This fungus has been recorded on Sorghum, Triticum and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize **in Australia** (NCOF, 1998).
Acremonium zeae Gams & Sumner	Acremonium stalk rot	The fungus has been recorded on maize in the USA, but its pathogen status is in doubt (Sumner, 1967). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Acrodictys erecta (Ellis & Everh.) M.B. Ellis (synonyms: *Mystrosporium erectum* Ellis & Everh.; *Macrosporium erectum* (Ellis & Everh.) Pound & Clements; *Piricauda serendipita* Moore)		Distributed in central and southern United States and Venezuela. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Actinomucor elegans (Eidam) Benjamin & Hesseltine (synonyms: *Rhizopus elegans* Eidam; *Mucor glomerula* Lendn.)		Widespread. Isolated from soil and various kinds of organic substrates. This fungus is used to ferment several foods. This fungus has been recorded on Zea and Zebrina in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but isolated from soil (Qld) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Alternaria alternata (Fr.:Fr.) Keissl. (synonyms: *Alternaria tenuis* Nees; *Alternaria fasciculata* (Cooke & Ellis) Jones & Grout; *Macrosporium fasciculatum* Cooke & Ellis; *Macrosporium maydis* (Cooke & Ellis)	**minor ear rot; minor leaf spot; minor root rot;** Alternaria leaf blight	**Cosmopolitan**. ***Seed-borne*** (Richardson, 1990) but of minor importance (Trainor & Martinson, 1981). Wide host range (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld), and a wide range of other plants **in Australia** (NCOF, 1998).
Alternaria longissima Deighton & MacGarvie	stalk rot	Distributed in sub-tropical and tropical regions. Recorded in the **USA** on pollen grains of maize, husks and grains of rice and sorghum, and on leaves of various plants, often mixed with other fungi (Farr *et al.*, 1989). **Recorded** on maize (Qld), and a range of other plants (NSW, Qld, Vic.), **in Australia** (NCOF, 1998).
Ascochyta ischaemi Sacc. (synonym: *Ascochyta zeae* Stout).	**yellow leaf blight**	Reported from the **USA** (California and Illinois) Europe and Mauritius (Farr *et al.*, 1989). **Not recorded in Australia**.
Ascochyta maydis Stout.	**minor leaf spot;** Ascochyta leaf blight	Reported from the **USA** (Illinois), Mauritius and Europe (Farr *et al.*, 1989). The fungus is **not seed-borne** and is of no economic importance. Maize is the only reported host (Farr *et al.*, 1989). **Not recorded in Australia**.
Ascochyta tritici Hori & Enjoji	**minor leaf spot**	Western north America (Farr *et al.*, 1989). The status of A. *tritici* is uncertain, as it may be a synonym of *A. hordei*. Triticum and Zea are the reported hosts of this fungus (Farr *et al.*, 1989). **Not recorded in Australia**.
Ascochyta zeicola Ellis & Everh. (synonym: *Ascochyta diedickei* Staritz)	**minor leaf spot;** Ascochyta leaf spot	Reported from the **USA** (New Jersey), Cuba, Venezuela, and Pakistan. This fungus has been recorded on maize in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Panicum simile* (Qld) **in Australia** (NCOF, 1998).
Aspergillus alliaceus Thom & Church		Cosmopolitan. This fungus has been recorded on Allium, Cerus, Citrus, Echinocactus, Opuntia and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but isolated from soil (Qld) **in Australia** (NCOF, 1998).
Aspergillus caespitosus Raper & Thom		Reported on maize from Southwestern **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Aspergillus candidus Link		**Cosmopolitan**. In soil and on a variety of plant materials. This fungus has been recorded on Arachis, Carya, Helianthus, Nicotiana, Triticum and Zea in the **USA** (Farr *et al.*, 1989). Not reported on maize, but **recorded** on *Nicotiana tabacum* and *Pisum sativum* (Qld) **in Australia** (NCOF, 1998).
Aspergillus carbonarius (Bainier) Thom		Widespread. This fungus has been recorded on Zea in the **USA** (Farr *et al.*,

PATHOGEN	**DISEASE**[1]	**COMMENTS**
		1989). Not recorded on maize, but **recorded** from a cannery (Vic.) **in Australia** (NCOF, 1998).
Aspergillus chevalieri (Mangin) Thom & Church var. ***intermedius*** Thom & Raper, nom. illeg.		Widespread. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Aspergillus clavatus Desmaz.		Cosmopolitan. This fungus has been recorded on Malus, Pseudotsuga and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on other hosts (Qld) **in Australia** (NCOF, 1998).
Aspergillus echinulatus (Delacr.) Thom & Church, nom. illeg. (teleomorph: *Eurotium echinulatum* (Declacr.)		Widespread. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Aspergillus elegans Gasp.		Cosmopolitan. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Aspergillus equitis Samson & Gams (synonym: *Aspergillus chevalieri* (Mangin) Thom & Church, nom. illeg.; teleomorph: *Eurotium chevalieri* Mangin)		Cosmopolitan. This fungus has been recorded on Carya and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Triticum aestivum* (Vic.) **in Australia** (NCOF, 1998).
Aspergillus flavipes (Bainier & Sartory) Thom & Church		Widespread. This fungus has been recorded on Helianthus and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **isolated** from soil (Qld) **in Australia** (NCOF, 1998).
Aspergillus flavus Link:Fr.	**Aspergillus ear and kernel rot;** seed rot	Cosmopolitan. Usually a saprophyte or spoilage organism but may become pathogenic to seedlings and animals. Wide host range including Avena, Carya, Citrus, Eichhornia, Glycine, Gossypium, Helianthus, Hordeum, Lycopersicon, Nicotiana, Saccharum, Triticum and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (Qld), and a wide range of other plants (NSW, Qld, Vic.) **in Australia** (NCOF, 1998).
Aspergillus fumigatus Fresen.		Cosmopolitan. This fungus has been recorded on Carya, Glycine, Gossypium, Helianthus, Malus, Saccharum and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Sorghum bicolor* (Qld), *Trifolium repens* (NSW), *Triticum aestivum* (NSW) and *Triticum vulgare* (Vic.) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Aspergillus glaucus Link:Fr. (synonyms: *Aspergillus herbariorum* (Wigg.:Fr.) Fisch.; *Aspergillus minor* (Mangin) Thom & Raper; *Aspergillus umbrosus* Bainier & Sartory; teleomorph: *Eurotium herbariorum* Link:Fr.)	**minor ear rot;** Aspergillus ear rot; yellow mould	Cosmopolitan. *Aspergillus* spp., are a major cause of deterioration of maize stored above 15% moisture content (Christensen, 1980). The disease is important because of production of the carcinogenic compound, aflatoxin, in affected grain. Contamination of maize with *Aspergillus* spp., and the subsequent production of aflatoxin, is prevalent in the midwestern United States during years with drought conditions. Aflatoxin produced by the fungus in kernels, either before or after harvest, is carcinogenic to a number of animal species, and can seriously affect marketing of maize grain. Wide host range including sorghum and maize (Farr *et al.*, 1989). **Recorded** on maize (Qld), and a range of other plants **in Australia** (NCOF, 1998).
Aspergillus hollandicus Samson & Gams (synonym: *Aspergillus amstelodami* (Mangin) Thom & Church, nom. illeg.; teleomorph: *Eurotium amstelodami* Mangin)		Widespread. Most common in subtropical and tropical regions. Isolated from soil and various kinds of organic debris. This fungus has been recorded on Helianthus, Hordeum, Nicotiana, Platanus and Zea in the USA (Farr *et al.*, 1989). Not recorded on maize, but **isolated** from hay (SA) **in Australia** (NCOF, 1998).
Aspergillus mangini Thom & Raper		Widespread. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Aspergillus nidulellus Samson & Gams (synonym: *Aspergillus nidulans* (Eidam) Wint.; teleomorph: *Emericella nidulans* (Eidam) Vuill.)		Cosmopolitan. This fungus has been recorded on Gossypium, Lycopersicon, Saccharum and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on other hosts (Vic.) **in Australia** (NCOF, 1998).
Aspergillus niger Tiegh.	**minor ear rot;** Aspergillus ear rot; black mould; seed rot	Cosmopolitan. *Aspergillus* spp., are a major cause of deterioration of maize stored above 15% moisture content (Christensen, 1980). The disease is important because of production of the carcinogenic compound, aflatoxin, in affected grain. Contamination of maize with *Aspergillus* spp., and the subsequent production of aflatoxin, is prevalent in the midwestern United States during years with drought conditions. Aflatoxin produced by the fungus in kernels, either before or after harvest, is carcinogenic to a number of animal species, and can seriously affect marketing of maize grain. Wide host range including sorghum and maize (Farr *et al.*, 1989). **Recorded** on maize (NSW), and a wide range of other plants **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Aspergillus ochraceus Wilh.		Cosmopolitan. This fungus has been recorded on Carya, Glycine, Gossypium, Helianthus, Lycopersicon, Triticum and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Sorghum bicolor* (NSW) **in Australia** (NCOF, 1998).
Aspergillus parasiticus Speare		Cosmopolitan. Generally an active aflatoxin producer. This fungus has been recorded on Cannabis, Carya, Helianthus, Saccharum and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but isolated from soil (Qld) **in Australia** (NCOF, 1998).
Aspergillus reptans Samson & Gams (synonym: *Aspergillus repens* (de Bary) Fisch. in Engl. & Prantl; teleomorph: *Eurotium repens* de Bary)		Cosmopolitan. This fungus has been recorded on Carya, Gossypium, Nicotiana, Saccharum and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Helianthus annuus* and *Triticum aestivum* (NSW) **in Australia** (NCOF, 1998).
Aspergillus restrictus Sm.		Cosmopolitan. This fungus has been recorded on Avena, Carya, Nicotiana, Triticum and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on other hosts (Vic.) **in Australia** (NCOF, 1998).
Aspergillus rubrobrunneus Samson & Gams (synonym: *Aspergillus ruber* (Koenig *et al.*) Thom & Church, nom. inval.; teleomorph: *Eurotium rubrum* Koenig *et al.*)		Cosmopolitan. This fungus has been recorded on Carya, Nicotiana, Platanus and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Aspergillus stellifer Samson & Gams (synonym: *Aspergillus variecolor* (Berk. & Broome) Thom & Raper, nom. inval.; teleomorph: *Emericella variecolor* Berk. & Broome)		Widespread. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Aspergillus sulphureus (Fresen.) Wehmer		Cosmopolitan. In soil and on a variety of organic substrates. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Aspergillus sydowii (Bainier & Startory) Thom & Church		Cosmopolitan. This fungus has been recorded on Cucumis, Saccharum and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **isolated** from soil (Qld) **in Australia** (NCOF, 1998).
Aspergillus tamarii Kita		Cosmopolitan. This fungus has been recorded on Carya, Helianthus, Lycopersicon, Saccharum, Trifolium and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.

PATHOGEN	**DISEASE[1]**	**COMMENTS**
Aspergillus unguis (Emile-Weil & Gaudin) Thom & Raper		Widespread. This fungus has been recorded on Cucumis and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Aspergillus ustus (Bainier) Thom & Raper		Cosmopolitan. Most common in subtropical and tropical regions. This fungus has been recorded on Carya, Gossypium and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but isolated from soil (Qld) **in Australia** (NCOF, 1998).
Aspergillus versicolor (Vuill.) Tiraboschi (synonyms: *Aspergillus lateralis* (Harkn.) Peek & Solheim; *Theclospora lateralis* Harkn.)		Cosmopolitan. This fungus has been recorded on Carya, Cucumis, Gossypium, Helianthus, Nicotiana and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Cicer arietinum* and *Helianthus annuus* (NSW) **in Australia** (NCOF, 1998).
Aspergillus wentii Wehmer		Widespread in soil and on a variety of organic substrates. This fungus has been recorded on Carya, Helianthus, Malus, Prunus and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Arachis hypogaea* and *Sorghum bicolor* (Qld) **in Australia** (NCOF, 1998).
Aureobasidium pullulans (de Bary) Arnaud (synonyms: *Dematium pullulans* de Bary; *Pullularia pullulans* (de Bary) Berkhout; *Aureobasidium vitis* Viala & Boyer; *Exobasidium vitis* (Viala & Boyer) Prill. & Delacr.)	brown spot	Cosmopolitan. Saprophytic on a wide variety of substrates. Wide host range including Gossypium, Hibiscus, Lycopersicon, Medicago, Phaseolus, Pisum, Triticum, Vicia and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on wide range of other crops (NSW, NT, Qld, Tas., Vic.) **in Australia** (NCOF, 1998).
Aureobasidium zeae (Narita & Hiratsuka) Dingley (synonym: *Kabatiella zeae* Narita & Hiratsuka)	**eye spot**; brown spot	Reported from temperate regions. The fungus normally causes minor losses. It has not been detected in seeds, although husks may be infected (Cassini, 1971) and. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Basidiobotrys pallida (Berk. & Curtis) Hughes (synonyms: *Botrytis pallida* Berk. & Curtis; *Streptothrix glauca* Ellis & Everh.)		Reported from New Jersey, South Carolina and Ohio (**USA**) on Trifolium and Zea (Farr *et al.*, 1989). **Not recorded in Australia**.
Bipolaris australiensis (M.B. Ellis) Tsuda & Ueyama (synonyms: *Drechslera australiensis* (Bugnicourt) Subramanian & P.C. Jain ex M.B. Ellis; *Helminthosporium australiensis* Bugnicourt, nom. inval.; teleomorph: *Cochliobolus australiensis* (Tsuda &	leaf spot	Distributed in Africa, Asia, Australia and **USA** (Farr *et al.*, 1989). **Recorded** on maize (Qld), and a range of other plants including Agropyron, Agrostis, Avena, Bromus, Chloris, Cynodon, Glycine, Helianthus, Lolium, Oryza, Sorghum and Triticum (NWS, Qld, Vic., WA) **in Australia** (NCOF, 1998).

PATHOGEN	**DISEASE[1]**	**COMMENTS**
Ueyama) Alcorn)		
Bipolaris bicolor (Mitra) Shoemaker (teleomorph: *Cochliobolus bicolor* Paul & Parbery)	leaf spot	Not recorded in USA (Farr *et al.*, 1989). **Recorded** on maize (Qld), and a range of other plants including Agropyron, Cenchrus, Gladiolus, Lupinus, Pennisetum, and Triticum (NSW, Qld) **in Australia** (NCOF, 1998).
Bipolaris cynodontis (Marig.) Shoemaker (synonyms: *Helminthosporium cynodontis* Marignoni; *Drechslera cynondontis* (Marignoni) Subramanian & P.C. Jain; teleomorph: *Cochliobolus cynodontis* Nelson	leaf spot	Cosmopolitan. Recorded on Cynodon, Eleusine and Muhlenbergia in the USA (Farr *et al.*, 1989). **Recorded** on maize (Qld) and a range of other plants **in Australia** (NCOF, 1998).
Bipolaris hawaiiensis (M.B. Ellis) Uchida & Aragaki (synonyms: *Drechslera hawaiiensis* M.B. Ellis*; Helminthosporium hawaiiense* Bugnicourt, nom. inval.)	Helminthosporium leaf spot	Tropical and subtropical regions. Reported as a minor disease of maize in India (Misra & Singh, 1971). Not reported as seed-borne. This fungus has been recorded on Chloris, Oryza and Saccharum in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Bipolaris maydis (Nisikado & Miyake) Shoemaker (synonyms: *Helminthosporium maydis* Nisikado & Miyake; *Drechslera maydis* (Nisikado & Miyale) Subramanian & P.C. Jain; teleomorph: *Cochliobolus heterostrophus* (Drechs.) Drechs.)	**southern corn leaf blight and stalk rot;** southern leaf blight (SLB)	Distributed in warm temperate, subtropical and tropical regions of the world. The fungus is ***seed-borne*** (Richardson, 1990) and heterothallic with two mating types (Nelson, 1957). The fungus has two distinct races, designated as T and O, and recently race C has been discovered in China (Wei *et al.*, 1988). There is evidence for seed transmission of race O and seed to seedling transmission of race T has been demonstrated (Boothroyd, 1971). An epidemic, caused by race T, occurred in the USA in 1970 (Ullstrup, 1970). Race O occurs mainly in subtropical and tropical areas, where it causes minor losses. However, yield reductions up to 50% occurred when race O was inoculated onto susceptible lines (Fisher *et al.*, 1976). Yield losses may be severe if susceptible or moderately susceptible cultivars are grown in continuous maize culture with minimum tillage and overhead irrigation (Bekele & Sumner, 1983). This fungus has been recorded on Antirrhinum, Dianthus, Pelargonium, Zea and Sorghum in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NT, NSW, Qld., WA) **in Australia** (NCOF, 1998).
Bipolaris sacchari (Butler) Shoemaker (synonyms: *Helminthosporium sacchari* Butler in Butler & Hafiz Khan; *Drechslera sacchari* (Butler) Subramanian & P.C. Jain)		Distributed in subtropical and tropical regions of the world. This fungus has been recorded on Panicum, Pennisetum, Saccharum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Bipolaris setariae (Sawada) Shoemaker (synonyms: *Helminthosporium setariae* Sawada; *Drechslera setariae* (Swada) Subramanian & P.C. Jain; teleomorph: *Cochliobolus setariae* (Ito & Kuribayashi in Ito) Drechs. Ex Dastur)	spot blotch	Reported from north America, south America, Africa and Asia. Spot blotch and secondary root rot of Setaria. Not recorded on maize in the USA (Farr *et al*., 1989). **Recorded** on maize (Qld), and a range of other plants including Cynodon, Paspalum, Pennisetum, Setaria, Sorghum and Stylosanthus (Qld) **in Australia** (NCOF, 1998).
Bipolaris sorghicola (Lefebvre & Sherwin) Alcorn (synonyms: *Helminthosporium sorghicola* Lefebvre & Sherwin; *Drechslera sorghicola* (Butler) Subramanian & P.C. Jain)	target spot	Worldwide in sorghum-growing regions. This fungus has been recorded on Sorghum and Zea in the **USA** (Farr *et al*., 1989). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Bipolaris sorokiniana (Sacc.) Shoemaker (synonyms: *Helminthosporium sativum* Pammel *et al*.; *Helminthosporium sorokinianum* Sacc. in Sorokin; *Helminthosporium californicum* Mackie & Paxton; *Drechslera sorokiniana* (Sacc.) Subramanian & P.C. Jain; teleomorph: *Cochliobolus sativus* (Ito & Kuribayashi) Drechs. ex Dastur)	**minor leaf spot; seed rot; seedling blight;** Helminthosporium root rot	Temperate regions of the world. It is of no economic importance in maize, but is a major pathogen of other cereals. The pathogen is soil-borne. Wide host range, including barley, grasses, Sorghum, Secale, Pennisetum, Triticum and Zea (Farr *et al.*, 1989). **Recorded** on maize (Qld), and a range of other plants **in Australia** (NCOF, 1998).
Bipolaris urochloae (Putterill) Shoemaker (synonyms: *Helminthosporium urochloae* (Putterill); *Drechslera urochloae* (Putterill) Subramanian & P.C. Jain)	leaf spot	Reported from Hawaii, Australia, South Africa and Zimbabwe (Farr *et al.*, 1989). This fungus has not been recorded on maize in the USA (Farr *et al.*, 1989). **Recorded** on maize (Qld), and on a variety of other plants including Panicum, Pennisetum, Sorghum and Urochloa (Qld) **in Australia** (NCOF, 1998).
Bipolaris victoriae (Meehan & Murphy) Shoemaker (synonyms: *Helminthosporium victoriae* F. Meehan & Murphy; *Drechslera victoriae* (F. Meehan & Murphy) Subramanian & P.C. Jain; teleomorph: *Cochliobolus victoriae* R.R. Nelson)	**minor leaf spot**	Cosmopolitan. This fungus has been recorded on Agropyron, Avena, Chloris, Glycine, Hordeum, Oryza, Paspalum, Phalaris, Setaria, Sorghum and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Bipolaris zeicola (G.L. Stout) Shoemaker (synonyms: *Helminthosporium carbonum* Ullstrup; *Helminthosporium zeicola* G.L. Stout; *Drechslera zeicola* (G.L. Stout) Subramanian & P.C. Jain; *Drechslera carbonum* (Ullstrup) Sivanesan; teleomorph: *Cochliobolus carbonum* R.R. Nelson)	**northern corn leaf spot; Helminthosporium ear rot (race 1); seed rot; seedling blight;** Carbonum leaf spot; northern leaf spot; Helminthosporium leaf spot	Widespread in maize-growing regions of the world. The fungus is ***seed-borne*** (Richardson, 1990) and overwinters as mycelium and as resistant chlamydospores in maize debris in the field. Five pathogenic races (0 through 4) of the fungus have been described (Welz & Leonard, 1993). This disease is of minor economic importance but race 3 is considered to be a significant threat (Hamid *et al.*, 1982), particularly in Pennsylvania and North Carolina (Lodge & Leonard, 1984). Race 1, which produces a host-specific toxin, has become rare in the USA because modern maize hybrids are not sensitive to its toxin (Welz & Leonard, 1993). Race 2 is common in nearly all maize growing areas, but rarely causes significant damage (Leonard & Leath, 1990). Race 3 is more frequent in the Appalachian Mountains from Georgia to Pennsylvania (Welz & Leonard, 1993) in the United States, and has also been reported from China, Japan, Nigeria and Germany (Welz & Geiger, 1995). Race 3 caused concern when it extended its range from mountain areas into eastern maize producing regions of North Carolina (Leonard, 1978). This fungus has been recorded on Sorghum, Tripsacum and Zea in the **USA** (Farr *et al*. 1989). **Recorded** on maize (NSW, Qld) **in Australia** (NCOF, 1998).
Blakeslea trispora Thaxt.		Warm temperate to tropical regions of the world. This fungus has been recorded on Brassica, Dionaea, Gossypium, Sorghum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Botryosphaeria disrupta (Berk. & Curtis) Arx & Mueller (synonyms: *Phomatospora disrupta* (Berk. & Curtis) Cooke; *Physalospora disrupta* (Berk. & Curtis) Sacc.; *Desmotascus portoricensis* Stevens)	ear rot	Reported from Central and South America and central Africa (Farr *et al.*, 1989). This fungus has been recorded on Acacia, Carya, Cocos, Ficus, Magnolia, Rosa, Smilax, Yucca and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Botryosphaeria festucae (Lib.) Arx & Mueller (synonyms: *Physalospora festucae* (Lib.) Sacc. *Physalospora conica* Ellis & Everh.; *Physalospora oxystoma* Sacc. & Ellis; *Pysalospora zeicola* Ellis & Everh.; *Rostrosphaeria phlei* Tehon & Daniels; anamorph: *Diplodia frumenti* Ellis & Everh.)	**Diplodia ear rot and stalk rot; Physalospora ear rot; Botryosphaeria ear rot;** ear rot	Recorded in Australia, Brazil, eastern and southern North America and Europe (Farr *et al.*, 1989). The fungus is ***seed-borne*** (Richardson, 1990) but is a minor disease of maize. This fungus has been recorded on Agropyron, Arachis, Arundinaria, Panicum and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize and *Phalaris aquatica* (NSW) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Botryosphaeria quercuum (Schwein.) Sacc. (synonyms: *Botryosphaeria ambigua* (Schwein.) Sacc.; *Melogramma ambiguum* (Schwein.) Berk.; *Physalospora cydoniae* Arnaud; *P. glandicola* (Schwein.) Stevens; *Amerodothis ilicis* (Cooke) Theiss. & Syd.; *Physalospora thuyoidea* (Cooke & Ellis) Sacc.)	ear rot	Worldwide on branches of woody dicotyledons (Farr *et al.*, 1989). This fungus has been recorded on a wide host range including Beta, Citrus and Zea in the **USA** (Farr *et al.*, 1989). Not reported on maize, but **recorded** on *Pyrus communis* (NSW), **in Australia** (NCOF, 1998).
Botryosphaeria rhodina (Cooke) Arx (synonym: *Physalospora rhodina* Cooke)	ear rot	Widespread in the northern hemisphere. This fungus has been recorded on a wide host range including Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Botryosphaeria zeae (Stout) Arx & Müller (synonym: *Physalospora zeae* Stout; anamorph: *Macrophoma zeae* Tehon & Daniels)	**gray ear rot**	Reported from USA, eastern and southern Africa and France (Farr *et al.*, 1989). The fungus is ***seed-borne*** (Richardson, 1990) but is of no economic importance (Ullstrup, 1973). This fungus has been recorded on Triticum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Botrytis cinerea Pers.: Fr. (teleomorph: *Botryotinia fuckeliana* (de Bary) Whetzel)	**minor ear rot;** Botrytis stalk rot; seed rot	**Cosmopolitan**. The fungus is seed-borne (Richardson, 1990) but is a minor pathogen of maize (Shurtleff, 1980). **Recorded** on maize (Tas.), and a wide range of other plants **in Australia** (NCOF, 1998).
Byssochlamys nivea Westling (anamorph: *Paecilomyces niveus* Stolk & Samson)		Reported from temperate regions of the world. Isolated from soil and various organic substrates. This fungus has been recorded on Acer and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Candida albicans (Robin) Berkhout (synonym: *Oidium albicans* Robin)		Cosmopolitan. Isolated from a wide variety of substrates. This fungus has been recorded on Prunus and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Candida guilliermondii (Castellani) Langeron & Guerra (synonym*: Endomyces guilliermondii* Castellani)		Cosmopolitan. Isolated from various substrates. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Candida intermedia (Cif. & Ashford) Langeron & Guerra (synonym*: Blastodendrion intermedium* Cif. & Ahford)		Widespread, but uncommon. Isolated from varied and unusual substrates (Farr *et al.*, 1989). This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Candida krusei (Castellani) Berkhout (synonym*: Saccharomyces krusei* Castellani)		Widespread. Isolated from various substrates. This fungus has been recorded on Citrus and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Citrus paradisi* (NSW) **in Australia** (NCOF, 1998).
Candida parapsilosis (Ashford) Langeron & Talice (synonym*: Monilia parapsilosis* Ashford)		Widespread. Isolated from various substrates. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Candida pseudotropicalis (Castellani) Basgal (synonym*: Endomyces pseudotropicalis* Castellani)		Cosmopolitan. Isolated from a variety of substrates. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Cephalosporium maydis Samra, Sabet & Hingorani	**late wilt;** slow wilt	Egypt (Gala *et al.*, 1979) and India (Payak *et al.*, 1970). The fungus is **soil** and ***seed-borne***. The fungus is capable of surviving as sclerotia on maize debris (Dawood *et al.*, 1979). This is a late season disease in Egypt, with 100% infection reported in some fields (Gala *et al.*, 1979). It does **not** occur **in** the **USA**, but is considered to be a potentially important pathogen (Warren, 1983). Pathogenic variation has been reported (Samara *et al.*, 1971). **Not recorded in Australia**.
Ceratocystis paradoxa (Dade) Moreau (synonyms: *Ceratostomella paradoxa* Dade; *Endoconidiophora paradoxa* (De Seyn.) Davidson; *Ophiostoma paradoxum* (Dade) Nannf.; anamorph: *Chalara paradoxa* (De Seyn.) Sacc.)	leaf spot	Reported from subtropical and tropical regions of the world. A minor disease of maize. Soil-borne, with chlamydospores playing an important part in the long-term propagation of the fungus. Not seed-borne. Spread by rain splash and wind. On a variety of hosts causing root and stem rots and leaf spots. Most frequently on Ananas, Coccus, Musa and Saccharum (Morgan-Jones, 1967). Not recorded on maize, but **widespread** on wide range of other plants **in Australia** (NCOF, 1998).
Cercospora sorghi Ellis & Everh. (synonym: *Cercospora sorghi* Ellis & Everh. var. *maydis* Ellis & Everh.)	**gray leaf spot; Cercospora leaf spot; minor root rot; minor stalk rot**	Cosmopolitan. Gray leaf spot of sorghum, sudan grass and broom corn. This fungus has been recorded on Echinochloa, Sorghum and Zea in the USA (Farr *et al*., 1989). Not recorded on maize, but **recorded** on *Heteropogon contortus*, *Sorghum bicolor* and *Sorghum vulgare* (NT, Qld) **in Australia** (NCOF, 1998).
Cercospora zeae-maydis Tehon & Daniels	**gray leaf spot**	Reported from southeastern USA, West Indies and South America. The disease has been increasing in importance in the USA (Latterell & Rossi, 1983). Pathogenic variation has also been reported (Bair & Eyers, 1986). The fungus overwinters in the debris of previously diseased maize plants remaining on the soil surface. In spring, conidia are produced and disseminated to maize plants by wind and rain splashing. Conidia for secondary spread are produced from

PATHOGEN	DISEASE[1]	COMMENTS
		two to four weeks after initial leaf infection. Tillage systems that leave previously diseased crop residue on the soil surface provide sufficient primary inoculum to produce severe levels of gray leaf spot (de Nazareno *et al*., 1993). This fungus has only been recorded on Zea in the **USA** (Farr *et al*., 1989). **Not recorded in Australia**.
Chaetomium bostrychodes Zopf		Widespread in the northern hemisphere. This fungus has been recorded on Capsicum, Lycopersicon and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Chaetomium brasiliense Batista & Pontual		Widespread. This fungus has only been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Chaetomium dolichptrichum Ames		Reported from mid-western USA and Canada (Farr *et al.*, 1989). This fungus has only been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Chaetomium funicola Cooke		Cosmopolitan. This fungus has been recorded on Alnus, Arachis, Gossypium, Malus, Pseudotsuga, Spartina and Zea in the **USA** (Farr *et al.*, 1989). Not reported on maize, **recorded** on *Eucalyptus viminalis* (ACT), **in Australia** (NCOF, 1998).
Chaetomium globosum Kunze:Fr. (synonyms: *Chaetomium cochliodes* Palliser; *Chaetomium olivaceum* Cooke & Ellis).		Cosmopolitan. This fungus has been recorded on Alnus, Arachis, Beta, Brassica, Cucumis, Cucurbita, Glycine, Gossypium, Helianthus, Lens, Lycopersicon, Malus, Phaseolus, Pinus and Zea in the **USA** (Farr *et al.*, 1989). Not reported on maize, but **recorded** on *Agaricus* sp., *Cicer arietinum*, and *Medicago sativa* (NSW, Vic.), **in Australia** (NCOF, 1998).
Chaetomium indicum Corda (synonym: *Chaetomium melioloides* Cooke & Peck)		Cosmopolitan. The fungus has been recorded on Helianthus and Zea in the **USA** (Farr *et al.*, 1989). Not reported on maize, but **recorded** on *Avena* sp., (NSW) **in Australia** (NCOF, 1998).
Chaetomium murorum Corda		Widespread in the northern hemisphere. This fungus has been recorded on Abies, Beta, Cucurbita, Populus and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Chaetomium torulosum Bainier		Reported from USA (New England), Canada (Ontario) and Japan on Zea (Farr *et al.*, 1989). **Not recorded in Australia**.
Chrysonilia sitophilia (Mont.) Arx (synonym: *Monilia sitophila* (Mont.) Sacc.;		Cosmopolitan. This fungus has been recorded on Cucumis, Saccharum and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on bread

PATHOGEN	DISEASE[1]	COMMENTS
teleomorph: *Neurospora sitophila* Shear & Dodge)		(NSW) **in Australia** (NCOF, 1998).
Ciccinella muscae (Sorokin) Berl. & DE Toni		Widespread. Isolated from soil, dung, nuts and other organic substrates. This fungus has only been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Cladosporium cladosporioides (Fresen.) De Vries (synonyms: *Penicillium cladosporioides* Fresen.; *Hormodendrum cladosporioides* (Fresen.) Sacc.)	**Hormodendrum ear rot; Cladosporium rot**	Cosmopolitan. A secondary pathogen of a wide variety of plants; a common saprophyte on dead plant material (Farr *et al.*, 1989). Extensive variability exists in this fungus. The disease is of minor importance (Hoppe, 1953) and has been associated with frost damage (Hoppe, 1964). This fungus has been recorded on a wide host range including Zea in the USA (Farr *et al.*, 1989). **Widespread in Australia** (NCOF, 1998).
Cladosporium herbarum (Pers.:Fr.) Link (synonyms: *Cladosporium caricicola* Corda; *Cladosporium epiphyllum* (Pers.:Fr) Fr.; *Cladosporium fasciculatum* Corda; *Helminthosporium flexuosum* Corda; *Cladosporium fuscatum* Link*; Cladosporium graminum* (Pers.:Fr.) Link; teleomorph: *Mycosphaerella tassiana* (De Not.) Johans.)	**Hormodendrum ear rot; Cladosporium rot;** cob mould	Cosmopolitan. This fungus has been recorded on a wide range of hosts including Avena, Citrus, Echinochloa, Glycine, Hordeum, Lens, Setaria, Sorghum, Triticum and Zea in the **USA** (Farr *et al.*, 1989). **Widespread in Australia** (NCOF, 1998).
Cladosporium macrocarpum Preuss	cob mould	Cosmopolitan, more prevalent in temperate regions. Saprobic on plant debris or in soil. This fungus has been recorded on Alnus, Pseudotsuga and Spinacia in the USA (Farr *et al.*, 1989). **Recorded** on maize (Tas.), and range of other plants including Allium, Avena, Beta, Brassica, Carthamus, Lupinus, Malus, Medicago, Papaver, Pisum, Sorghum and Triticum (ACT, NSW, Vic., SA, Tas.) **in Australia** (NCOF, 1998).
Cladosporium tenuissimum Cooke		Cosmopolitan, especially common in tropical regions. On many plant species, including Zea, also isolated from soil (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Arachis hypogaea* and Gomphocarpus, and isolated from chitin-amended soil (NSW, Qld) **in Australia** (NCOF, 1998).
Cladosporium zeae Peck		A single record from USA (New York). This fungus has only been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Claviceps gigantea Fuentes *et al.* (anamorph: *Sphacelia* sp.)	**ergot; horse's tooth; diente de caballo**; ergot of maize	The disease is endemic to in high, humid mountain valleys **in central Mexico**. The fungus overwinters as sclerotia on the ground or mixed with seed. Infection on 46-53% of ears has been detected (Fucikovesky & Moreno, 1971). Though no specific estimates are given for yield losses, the disease destroys some 5 to 10 percent of the grains in infected heads. Germination can be reduced by 50% in seeds from infected ears. Ergots are not toxic to humans or animals. **Not recorded in Australia**.
Colletotrichum cereale Manns in Selby & Manns		Reported from central and eastern United States. This fungus has been recorded on Dactylis and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded on maize in Australia**.
Colletotrichum graminicola (Ces.) Wils. (synonyms: *Vermicularia graminicola* Westend.; *Ellisiella mutica* Wint.; *Colletotrichum sublineola* Henn. in Kab. & Bubak; teleomorph: *Glomerella graminicola* Politis)	**anthracnose leaf blight; anthracnose stalk rot** (ASR); anthracnose; Colletotrichum stalk rot	**Cosmopolitan**. The pathogen is ***seed-borne*** (Richardson, 1990) and can survive 3 years in seeds without loosing its viability (Warren, 1977). Seedling infection has been correlated with the level of seed infection (Warren & Nicholson, 1975). Once considered economically unimportant, ASR has caused considerable yield losses in maize in recent years in the **USA** (Muiba-kankolongo & Bergstrom, 1992). Yield reductions are attributed to reduction in grain weight, as well as to increased stalk lodging, which reduces harvestability. Reduced seedling density is a serious problem caused by anthracnose-infected kernels. This fungus has a wide host range including maize (Farr *et al.*, 1989). The fungus causes red stalk rot, red leaf spot, leaf anthracnose and seedling blight of sorghum, other cereals and legumes. However, Sutton (1980) applied this name only to the fungus pathogenic on maize (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld), and a range of other plants **in Australia** (NCOF, 1998).
Coniothyrium scirpi Trail (synonyms: *Coniothyrium zeae* Stout; teleomorph: *Paraphaeosphaeria michotii* (Westend.) Eriksson)	leaf spot	Reported from temperate regions of the northern hemisphere, mostly on grasses and rushes. This fungus has been reported on Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Eragrostis interrupta* and *Lupinus angustifolius* (NSW, Qld) **in Australia** (NCOF, 1998).
Corynascus sepedonium (Emmons) Arx (synonym: *Thielavia sepedonium* Emmons)		Cosmopolitan. In soil This fungus has only been recorded on Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Gossypium hirsutum* (NSW), **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Cryptococcus laurentii (Kuff.) Skinner		Widespread. Isolated from various kinds of substrates. The fungus has been recorded on Triticum and Zea in the **USA** (Farr *et al*., 1989). **Not recorded in Australia**.
Curvularia brachyspora Boedijn	leaf spot	Reported from subtropical and tropical regions of the world. This fungus has been recorded on Oryza in the USA (Farr *et al.*, 1989). **Recorded** on maize (Qld), and a wide range of other plants including, Axonopus, Brachiaria, Capsicum, Carthamus, Cynodon, Digitaria, Eichhornia, Eragrostis, Ipomoea, Leptospermum, Lupinus, Magnifera, Oryza, Paspalum, Saccharum, Setaria, Silybum, Spathodea and Themeda (NSW, Qld, WA), **in Australia** (NCOF, 1998).
Curvularia clavata P.C. Jain	**Curvularia leaf spot**	This fungus has been recorded on maize in the **USA** (APS 1994). **Not recorded on maize in Australia.**
Curvularia eragrostidis (Henn.) Meyer (synonym: *Curvularia maculans* (Bancroft) Boedijn; teleomorph: *Cochliobolus eragrostidis* (Tsuda & Ueyama) Sivanesan)	**Curvularia leaf spot**	Occurs in subtropical and tropical regions. Curvularia leaf spot is prevalent in hot, humid, maize-growing areas, and can significantly damage crops (Shurtleff, 1980). Not recorded on maize, but **recorded** on a wide range of other plants (NSW, Qld) **in Australia** (NCOF, 1998).
Curvularia geniculata (Tracy & Earle) Boedijn (synonym: *Helminthosporium geniculatum* Tracy & Earle)	Curvularia leaf spot	Cosmopolitan, most common in tropical. Occurs on a wide variety of plants including maize (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on wide range of other plants (Qld) **in Australia** (NCOF, 1998).
Curvularia gudauskasii (Morgan-Jones & Karr)	leaf spot	Reported on maize from **USA** (Alabama) and Tanzania (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Capillipedium spicigerum* and *Dichanthium aristatum* (Qld) **in Australia** (NCOF, 1998).
Curvularia inaequalis (Shear) Boedijn (synonyms: *Helminthosporium inaequale* (Shear); *Acrothecium arenarium* Moreau & Mme. Moreau)	**Curvularia leaf spot**	Temperate regions. Commonly isolated from grain and roots of wheat. Occurs on a wide variety of plants including Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on Shirohie millet and *Triticum aestivum* (SA) and also isolated from soil (Qld) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Curvularia intermedia Boedijn (teleomorph: *Cochliobolus intermedius* Nelson)	**Curvularia leaf spot**	This fungus has been reported from North America, Africa and Asia. Curvularia leaf spot can cause significant crop damage (Shurtleff, 1980). Not recorded on maize, but **recorded** on *Annona squamosa, Carex pumila, Chrysalidocarpus elata, Digitaria ammophila, Digitaria ciliaris, Digitaria didactyla, Digitaria singuinalis, Digitaria violascens, Echinochloa telmatophila, Panicum maximum, Setaria sphacelata, Sorghum bicolor, Thaumastochola rariflora, Themeda triandra* and *Vigna parkeri,* (NT, Qld) **in Australia** (NCOF, 1998).
Curvularia lunata (Wakk.) Boedijn (teleomorph: *Cochliobolus lunatus* Nelson & Haasis)	**Curvularia leaf spot**	Cosmopolitan. Most common in tropical regions and the most prevalent of the *Curvularia* species. Curvularia leaf spot is prevalent in hot, humid, maize-growing areas and can damage crops significantly (Shurtleff, 1980). Occurs on a wide variety of plants, including Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (Qld) and a wide range of other plants, **in Australia** (NCOF, 1998).
Curvularia pallescens Boedijn (synonyms: *Curvularia leonensis* M.B. Ellis; teleomorph: *Cochliobolus pallescens* (Tsuda & Ueyama) Sivanesan)	**Curvularia leaf spot; minor ear rot;** leaf spot of maize; corn leaf spot	Reported from **USA** (Iowa) and tropical regions of the world (Farr *et al.*, 1989). The fungus is ***seed-borne*** and overwinters in soil and maize debris. This is a late season disease that can cause serious losses in tropical regions. Yield losses of 60% have been observed in inoculated plots (Grewal & Payak, 1976). It is a minor disease in temperate regions. Maize and grasses are common hosts of this fungus (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Agrostis* sp., *Daphne odora,* and *Saccharum officinarum* (NSW, Qld, Vic.), **in Australia** (NCOF, 1998).
Curvularia senegalensis (Speg.) Subramanian (synonyms: *Brachysporium senegalense* Speg.; *Curvularia falcata* (Tehon) Boedijn; *Acrothecium falcatum* Tehon)	**Curvularia leaf spot**	Occurs in subtropical and tropical regions. It is a minor disease of maize (Shurtleff, 1980). Not recorded on maize, but **recorded** on *Agrostis* sp., *Eichhornia crassipes, Licuala ramsayii, Magnifera indica, Musa* sp., *Paspalum paniculatum, Setaria sphacelata* and *Sorghum bicolor* (Qld, Vic), **in Australia** (NCOF, 1998).
Curvularia tuberculata P.C. Jain (teleomorph: *Cochliobolus tuberculatus* Sivanesan)	**Curvularia leaf spot**	This fungus has been reported from USA, France and tropical regions (Farr *et al..*, 1989). Recorded on maize (APS, 1994), grasses and other substrates (Farr *et al.,* 1989) in the **USA. Not reported in Australia**.
Cyathus stercoreus (Schw.) de Toni in Sacc	bird's nest fungus	This fungus has not been recorded in the USA (Farr e*t al.*, 1989). **Recorded** on maize (NSW) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Dendrophoma zeae Tehon		This fungus has been reported only from **USA** (Illinois) on Zea (Farr *et al.*, 1989). **Not reported in Australia**.
Diaporthe phaseolorum (Cooke & Ellis) Sacc. (synonyms: *Diaporthe batatatis* Harter & Field; *Diaporthe soja* Lehman; anamorph: *Phomopsis phaseoli* (Desmaz.) Sacc.)	seedling blight	Cosmopolitan. Occurs on a wide variety of plants, including Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Glycine max* (NSW), **in Australia** (NCOF, 1998).
Dictyochaeta fertilis (Hughes & Kendrick) Holubova-Jechova (synonym: *Codinaea fertilis* Hughes & Kendrick)	**minor root rot;** root rot	Reported from North America, Europe and New Zealand on a variety of dead plant materials. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Sorghum bicolor* (Qld), **in Australia** (NCOF, 1998).
Dictyochora gambellii Fairm.		This fungus has been reported only from **USA** (New York) on Zea (Farr *et al.*, 1989). **Not reported in Australia**.
Didymella exitialis (Morini) Mueller	**Didymella leaf spot**	Reported only from India as a minor disease of maize (Payak & Renfro, 1966). Not seed-borne. **Not reported in Australia**.
Didymium iridis (Ditmar) Fr.		Cosmopolitan. This fungus has only been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not reported in Australia**.
Didymosphaeria graminicola Ellis & Everh. (synonym: *Microthelia graminicola* (Ellis & Everh.) Kuntze)		This fungus has been reported only from **USA** (Georgia and Kansas) on Zea (Farr *et al.*, 1989). **Not reported in Australia**.
Diplodia maydis (Berk.) Sacc. (synonym: *Sphaeria maydis* Berk.)	**Diplodia ear rot, stalk rot, seed rot; seedling blight;** white ear rot; diplodiosis; dry rot	Occurs in North America, Europe and Australia. The fungus is ***seed-borne***. Variability in pathogenicity has been reported (Young *et al.*, 1959). North American isolates have generally proved most pathogenic in the state of origin, but in the USSR, an isolate from North America proved more pathogenic to seeds and plants than a local one (Anon, 1980). At least 24 strains have been reported from the USA. Variability appears to be related to temperature requirements corresponding to the geographical origin (Anon, 1980). The pathogen is reported to cause between 5% and 37% loss in germination (Nwigwe, 1974). Furthermore, infected grain has been reported to cause mycotoxicosis when fed to cattle and sheep. This fungus has been reported on Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld, Tas, Vic.) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Doratomyces stemonitis (Per.:Fr.) Morton & Sm. (synonyms: *Cephalotrichum stemonitis* (Per.:Fr.) Link; *Stysanus stemonitis* (Pers.:Fr.) Corda; *Stysanus tubericola* Ellis & Dearn.)	**minor ear rot**; ear rot	Cosmopolitan. Saprophytic on many organic substrates. This fungus has been recorded on Zea in the **USA** (Farr *et al.,* 1989). Not recorded on maize, but **recorded** on orchid (NSW) **in Australia** (NCOF, 1998).
Epicoccum nigrum Link (synonym: *Epicoccum purpurescens* Ehrenb.)	**red kernel disease; ear mold, leaf and seed rot; minor leaf spot;** red kernel	Cosmopolitan. The fungus has been reported on sweetcorn kernels (Wright & Billeter, 1974) but is of no economic importance. This fungus has been recorded on a wide host range including Pennisetum, Triticum and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW, Tas.), and a wide range of other plants **in Australia** (NCOF, 1998).
Exserohilum longirostratum (Subramanian) Sivanesan	stalk rot	This fungus has not been recorded in the USA (Farr *et al*., 1989). **Recorded** on maize (Qld), and also on Areca, Cymbopogon, Eleusine, and Spinifex (NSW, NT, Qld) **in Australia** (NCOF, 1998).
Exserohilum monoceras (Drechs.) Leonard & Suggs (synonyms: *Helminthosporium monoceras* Drechs.; *Bipolaris monoceras* (Drechs.) Shoemaker; teleomorph: *Setosphaeria monoceras* Alcorn)	leaf blotch	Reported from temperate North America, Asia, Australia, and Israel. This fungus has been recorded on Echinochloa, Panicum and Setaria in the **USA** (Farr *et al*., 1989). **Recorded** on maize (Qld), and on Echinochloa and Setaria (NT, Qld) **in Australia** (NCOF, 1998).
Exserohilum pedicellatum (Henry) Leonard & Suggs (synonyms: *Helminthosporium pedicellatum* Henry; *Drechslera pedicellata* (Henry) Subramanian & P.C. Jain; teleomorph: *Setosphaeria pedicellata* (Nelson) Leonard & Suggs)	**Helminthosporium root rot; seed rot; seedling blight**	Occurs in temperate North America, Egypt, India and Pakistan. Not seed-borne and of no economic importance. This fungus has bee recorded on *Triticum* and *Zea* in the USA (Farr *et al.*, 1989). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Exserohilum prolatum Leonard & Suggs (synonym: *Drechslera prolata* (Leonard & Suggs) Sivanesan; teleomorph: *Setosphaeria prolata* Leonard & Suggs)	**minor leaf spot;** Exserohilum leaf spot	Occurs in southern USA, Central America and eastern Africa. The fungus is ***seed-borne*** but of no economic importance. This fungus has been recorded on Einkorn, Agropyron, Arundinaria, Panicum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia.**

PATHOGEN	DISEASE[1]	COMMENTS
Exserohilum rostratum (Drechs.) Leonard & Suggs (synonyms: *Helminthosporium rostratum* Drechs.; *Bipolaris rostrata* (Drechs.) Shoemaker; *Drechslera rostrata* (Drechs.) Richardson & Fraser; *Bipolaris halodes* (Drechs.) Shoemaker; *Drechslera halodes* (Drechs.) Subramanian & P.C. Jain; *Exserohilum halodes* (Drechs.) Leonard & Suggs; teleomorph: *Setosphaeria rostrata* Leonard)	**Rostratum leaf spot; Helminthosporium leaf disease, ear and stalk rot;** rostratum spot	Cosmopolitan. The fungus is ***seed-borne***, but is a minor disease in southern states of USA (Kucharek, 1973). Infected weeds are a significant inoculum source (Young *et al.*, 1947). This fungus has been recorded on a wide host range including Pennisetum, Saccharum, Sorghum and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Exserohilum turcicum (Pass.) Leonard & Suggs (synonyms: *Helminthosporium turcicum* Pass.; *Bipolaris turcica* (Pass.) Shoemaker; *Drechslera turcica* (Pass.) Subramanian & P.C. Jain; *Helminthosporium inconspicuum* Cooke & Ellis; teleomorph: *Setosphaeria turcica* (Luttrell) Leonard & Suggs)	**northern corn leaf blight; white blast; crown stalk rot; stripe; seed rot; seedling blight**; northern leaf blight (NLB); Turcicum leaf blight	Cosmopolitan. The fungus is heterothallic with two mating types (Fallah, Moghaddam & Pataky, 1994), **doubtfully *seed-borne*** in maize although known to be seed-borne in sorghum. The fungus overwinters as conidia and /or mycelia in infected plant debris or on Johnson grass (Levy, 1984). Five races have been reported to overcome specific *Ht* resistance gene in the USA (Lipps *et al.*, 1997). When epidemics begin before silking and environmental conditions favour disease development, yield losses may exceed 40% (Perkins & Pedersen, 1987). NBL is a major disease of maize in USA (Lipps *et al.*, 1997), Uganda and Africa (Adipala *et al.*, 1993). Epidemics of NLB occur regularly in the spring in south Florida (Pataky, 1994) and also occur in the summer in upstate New York and the northern corn belt (Meyer *et al.*, 1991). This fungus has been recorded on grasses, Sorghum and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld, Tas., Vic.) **in Australia** (NCOF, 1998).
Fusarium acuminatum Ellis & Everh. (teleomorph: *Gibberella acuminata* Wollenweb.)	**minor root rot**; root and stem rot	Cosmopolitan. This fungus has been isolated from many plants and insects (Farr *et al.*, 1989), and has been reported on Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (Vic.) **in Australia** (NCOF, 1998).
Fusarium avenaceum (Fr.: Fr.) Sacc. (synonyms: *Fusisporium avenaceum* Fr.: Fr.; *Fusarium roseum* Link f.sp. *cerealis* (Cook) Snyder & Hans; teleomorph: *Gibberella avenacea* Cooke)	**Fusarium stalk rot; seedling root rot; seed rot; seedling blight;** Fusarium root rot	Cosmopolitan, most common in temperate regions. This disease is the most destructive of the maize stalk rots, particularly on the Atlantic seaboard, and the corn belt of the **USA** (Christensen & Wilcoxson, 1966). Mycotoxins produced by the fungus cause economic losses (Neish *et al.*, 1983). Not reported on maize, but **recorded** on wide range of other crops **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Fusarium chlamydosporum Wollenweb. & Reinking (synonyms: *Fusarium fusarioides* (Gonz. Frag. & Cif.) Booth; *Dactylium fusarioides* Gonz. Frag. & Cif.)	grain mould	Cosmopolitan. In soil and on a wide variety of plant materials. This fungus has been recorded on Carya, Gossypium and Helianthus in the USA (Farr *et al.*, 1989). **Recorded** on maize (NT), Cucumis, Triticum, Zinnia and also isolated from soil (NSW, NT, Qld, Vic.) **in Australia** (NCOF, 1998).
Fusarium crookwellense Burgess, Nelson & Toussoun	stem rot	Widespread. Isolated from various kinds of plant debris. This fungus has been recorded on Potamogeton in the **USA** (Farr et al., 1989). **Recorded** on maize (NSW), and a wide range of other plants (NSW, SA, Vic.) **in Australia** (NCOF, 1998).
Fusarium culmorum (Wm. G. Sm.) Sacc.	**minor ear rot; seed rot; seedling blight;** stalk rot	Cosmopolitan. Seedling blight, foot rot, ear blight, stalk rot, and other diseases of cereals, grasses, and a wide variety of monocots and dicots. This fungus has been recorded on Agropyron, Agrostis, Avena, Beta, Bromus, Cucumis, Dactylis, Dianthus, Echinochloa, Hordeum, Lolium, Poa, Secale, Solanum, Sorghum, Triticum, Vicia and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW, Tas.), and a wide range of other plants **in Australia** (NCOF, 1998).
Fusarium episphaeria (Tode) Snyder & Hans.	**minor stalk rot;** stalk rot	Widespread. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). Not **recorded** on maize, but isolated from soil (NSW) **in Australia** (NCOF, 1998).
Fusarium equiseti (Corda) Sacc. (synonyms: *Fusarium roseum* Link f.sp. *gibbsom* Snyder & Hans.; *Fusarium scirpi* Lambotte & Fautery; teleomorph: *Gibberella intricans* Wollenweb.)	**minor root rot;** stalk rot	Cosmopolitan. Most common in tropical regions. Causes rots of a wide variety of plants, including stalk rot of maize, in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW)**,** and a wide range of other plants **in Australia** (NCOF, 1998).
Fusarium graminearum Schwabe (teleomorph: *Gibberella zeae* (Schwein.) Petch)	**Gibberella ear and stalk rot; seed rot; seedling blight;** red ear rot; pink ear rot	Cosmopolitan. The fungus is ***seed-borne*** (Richardson, 1990). This disease is widely distributed in the **USA** and is more prevalent in the northern and eastern parts of the country. Several mycotoxins are produced in infected ears and kernels, including zearalone, which has oestrogen like effects in pigs and cattle; and vomitoxine, which is associated with feed refusal and skin disorders in animals. The fungus becomes increasingly important in areas where maize is grown in rotation with wheat (Windels *et al.*, 1988). It has been recorded on Hordeum, Secale, Triticum and Zea in the USA (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld, Vic.) and a wide range of other plants **in Australia** (NCOF.).

PATHOGEN	DISEASE[1]	COMMENTS
Fusarium merismoides Corda (synonym: *Fusarium rimosum* (Peck) Sacc.)	**minor stalk rot;** stalk rot	Cosmopolitan. Usually considered a soil saprophyte but commonly isolated from a wide variety of plant materials including Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Lycopersicon esculentum* (NSW) **in Australia** (NCOF, 1998).
Fusarium moniliforme Sheld. (synonym: *Sporotrichum atropurpureum* Peck; teleomorph: *Gibberella fujikuroi* (Sawada) Ito in Ito & Kimura)	**Fusarium ear and stalk rot; seed rot; seedling blight**; Fusarium kernel rot	Cosmopolitan. The fungus is ***seed-borne*** (Richardson, 1990), and seed-transmitted strains of the fungus can develop systemically to infect the kernels (Munkvold *et al.*, 1997). Corn rootworm beetles help spread the fungus (Gilbertson *et al.*, 1986). Grains infested with the fungus are known to be toxic to animals (Marasas *et al.*, 1979). Although yield is not greatly affected, kernel infection is of concern because of reduced seed quality and the potential occurrence of fumonisin and other mycotoxins (Munkvold & Desjardins, 1997). The fungus consists of at least seven distinct mating populations, designated A through G; A, D and E mating populations are the most common on maize (Leslie, 1995). This fungus has a wide host range, including Zea, in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld, SA, Vic., WA) and a wide range of other plants **in Australia** (NCOF, 1998).
Fusarium oxysporum Schlechtend.:Fr.	**minor root rot; minor stalk rot;** root rot	Cosmopolitan. The most frequently recorded *Fusarium* species in soil (Farr *et al.*, 1989). The fungus has been reported to be seed-borne on maize (Richardson, 1990). **Recorded** on maize (NSW, Tas), and a wide range of other plants **in Australia** (NCOF, 1998).
Fusarium pallidoroseum (Cooke) Sacc. (synonyms: *Fusisporium pallidoroseum* Cooke; *Fusarium semitectum* auct. non Berk. & Ravenel)	**minor root rot;** root rot	Common in subtropical and tropical regions (Farr *et al.*, 1989). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Fusarium poae (Peck) Wollenweb. (synonym: *Fusarium tricinctum* (Corda) Sacc. f.sp. *poae* (Peck) Snyder & Hans.)	**minor root rot; minor stalk rot;** white cob rot; silver top	Found in temperate regions. Common on grasses and herbaceous plants (Farr *et al.*, 1989). The fungus has been reported to be seed-borne on maize (Richardson, 1990). Not recorded on maize, but **recorded** on *Brassica oleracea*, *Dactylis glomerata*, *Dianthus caryophyllus*, *Hordeum vulgare* and *Triticum aestivum* (NSW, Vic.), **in Australia** (NCOF, 1998).
Fusarium proliferatum (Matsushima) Nirenberg (synonym: *Cephalosporium proliferatum* Matsushima)	grain mould; root rot	Widespread. Causes rots of a wide variety of plants, including stalk rot of Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on Allium, Asparagus and Cymbidium (SA, Vic.) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Fusarium roseum Link: Fr.	**minor root rot; minor stalk rot;** root rot	Widespread. Occurs on a wide variety of plants, including Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Biota* sp., *Citrus sinensis, Dianthus caryophyllus, Hoya carnosa, Passiflora edulis, Prunus armeniaca, Thuja orientalis*, and *Washingtonia filifera* (NSW, Qld, Vic.) **in Australia** (NCOF, 1998).
Fusarium sacchari (Butler) Gams (synonym: *Cephalosporium sacchari* Butler in Butler & Hafiz Khan)		This fungus has been reported on Zea from subtropical and tropical regions of the world (Farr *et al.*, 1989). **Not recorded on maize in Australia**.
Fusarium solani (Mart.) Sacc. (synonyms: *Fusarium lathyri* Taubenhaus, *Fusarium malli* Taubenhaus; teleomorph: *Nectria haematococca* Berk. & Broome)	**minor stalk rot;** stalk rot	Cosmopolitan. Isolated mostly from soil and plant debris. On a wide variety of plants including Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on wide range of other plants **in Australia** (NCOF, 1998).
Fusarium subglutinans (Wollenweb. & Reinking) Nelson *et al*. (synonym: *Fusarium moniliforme* Sheld. var. *subglutinans* Wollenweb. & Reinking)	**Fusarium ear and stalk rot**	Cosmopolitan (Farr *et al.*, 1989). The pathogen is commonly associated with stalk rots (Gilbertson *et al*., 1985). Its role as a primary or secondary stalk invader remains unclear (McGee, 1994). **Recorded** on maize (Vic.) and a wide range of other plants (NSW, Qld, Vic.) **in Australia** (NCOF, 1998).
Fusarium tricinctum (Corda) Sacc. (synonyms: *Selenosporium tricinctum* Corda; *Fusarium citriforme* Jamalainen)	**minor stalk rot;** root rot	Cosmopolitan. A common soil-inhabitant fungus. On a wide variety of plants including Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Calamagrostis epigejos*, *Dianthus caryophyllus* and *Isopogon ceratophyllus* (NSW, Vic.) **in Australia** (NCOF, 1998).
Fusisporium cerealis Cooke		Only one record for **USA** (Florida) on Zea (Farr *et al.*, 1989). **Not recorded in Australia**.
Gaeumannomyces graminis (Sacc.) Arx & Olivier (synonym: *Ophiobolus graminis* (Sacc.) Sacc. in Roum. & Sacc.; anamorph: *Phialophora radicicola* Cain)	**sheath rot;** root rot	Worldwide. Crown and sheath rot of Poaceae. Although maize roots can be naturally infected, the pathogen is of minor economic importance in maize (Robinson & Lucas, 1967). The fungus has been reported to be seed-borne on maize (Richardson, 1990). *Phialophora radicicola* is reported to be the conidial stage of this fungus (Simonsen, 1971). **Recorded** on maize (NSW, WA) and a wide range of other plants **in Australia** (NCOF, 1998).
Geotrichum candidum Link (synonyms: *Oospora lactis* (Fresen.) Sacc.; *Oospora lactis* (Fresen.) Sacc. var. *parasitica* Pritchard & Porte; teleomorph: *Galactomyces geotrichum* (Butler & Petersen) Redhead &	stalk rot	Cosmopolitan on a variety of organic substrates. This fungus has been recorded on Citrus, Cucumis, Daucus, Lycopersicon and Prunus in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW, Tas.), and a wide variety of other plants (NSW, Qld, Vic., WA) **in Australia** (NCOF, 1998).

PATHOGEN	**DISEASE[1]**	**COMMENTS**
Malloch)		
Gibberella cyanogena (Desmaz.) Sacc. (synonyms: *Sphaeria cyanogena* Desmaz., *Gibberella saubinetti* (Mont.) Sacc.; anamorph: *Fusarium sulphureum* (Schlechtend.)	**minor root rot;** root rot	Widespread as a facultative pathogen (Farr *et al.*, 1989). Isolated from soil, debris, and wide range of herbaceous plants (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Calamus* sp. (Qld) **in Australia** (NCOF, 1998).
Gibberella pulicaris (Fr.:Fr.)Sacc.	root rot	Reported from the northern hemisphere, north Africa, Australia, and New Zealand on a wide variety of plants including Zea (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Prunus armeniaca* (Vic.) **in Australia** (NCOF, 1998).
Glabrocyphella ellisiana Cooke (synonym: *Cyphella bananae* Cooke)		Reported form USA (Florida) on Zea (Farr *et al.*, 1989). **Not recorded Australia**.
Gloeocercospora sorghi Bain & Edgerton ex Deighton	**zonate leaf spot**	Reported from southern USA, Central and South America, tropical Africa, Australia, India and Japan (Farr *et al.*, 1989). This is a minor disease of maize but a more serious disease of sorghum. No report of being seed-borne on maize, but it is seed-borne on sorghum (Cassarone, 1949). This fungus has been recorded on Pennisetum, Saccharum, Sorghum, and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded on maize in Australia**.
Glomerella tucumanensis (Speg.) Arx & Mueller (synonym: *Physalospora tucumanensis* Speg.; anamorph: *Glomerella falcatum* Went)	**anthracnose leaf blight; anthracnose stalk rot;** red rot of sugarcane	Reported from subtropical and tropical regions of the world. This fungus has been recorded on Saccharum, Sorghum and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Saccharum officinarum* (Qld) **in Australia** (NCOF, 1998).
Gonatobotrys simplex Corda	**minor ear rot;** Gonatobotrys seed rot	Cosmopolitan. Associated with rotting maize seed (McGee, 1994). A mycoparasite (Farr *et al.*, 1989) recorded on *Alternaria alternata* (NSW) in Australia. Not recorded on maize, but **recorded** on *Avena sativa* and *Sorghum vulgare* (NSW), **in Australia** (NCOF, 1998).
Gonatobotrys zeae Futrell & Bain	Gonatobotrys seed rot	Recorded from **USA** (Mississippi), (Farr *et al.*, 1989). There is no definitive evidence that this fungus causes a disease of maize, as it has been reported on both healthy and rotted seeds (McGee, 1994). A mycoparasite (Farr *et al.*, 1989). **Not recorded in Australia**.
Graphium penicillioides Corda	**minor leaf spot;** leaf spot	Reported on maize from **USA** (Louisiana) and Europe (Farr *et al.*, 1989). **Not recorded in Australia**.
Hansenula anomala (Hans.) Syd. & Syd.		Widespread. This fungus has been recorded on Triticum and Zea in the USA

PATHOGEN	DISEASE[1]	COMMENTS
		(Farr *et al.*, 1989). The fungus has also been isolated from soil and various kinds of organic debris. **Not recorded in Australia**.
Harzia acremonioides (Harz) Costantin (synonym: *Acremoniella atra* (Corda) Sacc.)		Cosmopolitan. Isolated from a variety of plant materials. This fungus has been recorded on Vicia and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Lolium* sp. (NSW, Vic.) **in Australia** (NCOF, 1998).
Helminthosporium ahmadii M.B. Ellis		Reported only from USA (New York), and Pakistan. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Hyalothyridium maydis Latterell & Rossi	**Hyalothyridium leaf spot;** round blotch	Distributed in Latin America and can be severe in rainy seasons (Latterell & Rossi, 1984). **Not recorded in Australia**.
Illosporium pallidum Cooke		Recorded only once on Zea from **USA** (South Carolina) (Farr *et al.*, 1989). **Not recorded in Australia**.
Isariopsis subulata Ellis & Everh.		Recorded only once on Zea from Louisiana (**USA**) (Farr *et al.*, 1989). **Not recorded in Australia**.
Lasiodiplodia theobromae (Pat) Griffon & Maubl. (synonym: *Botryodiplodia theobromae* Pat.)	**black kernel rot**	Worldwide in warm regions. The pathogen is ***seed*** as well as ***soil-borne*** (Kumar & Shetty, 1983). The disease occurs in tropical countries (De Leon, 1984), and has caused extensive losses in the Karnataka region of India (Kumar & Shetty, 1983). This fungus has been recorded on a wide host range including Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Annona squamosa*, *Arachis hypogaea*, *Chrysalidocarpus lutescens*, *Garcinia mangostana*, *Gossypium hirsutum*, *Macadamia integrifolia*, *Mangifera indica*, *Phoenix canariensis* and *Theobroma cacao* (NT, Qld) **in Australia** (NCOF, 1998).
Lecanidion atratum (Hedw.) Rabenh. (synonym: *Patellaria atrata* (Hedw.) Fr.		Reported from temperate regions of the world. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Robinia pseudoacacia* (NSW), **in Australia** (NCOF, 1998).
Leptosphaeria macrospora (Fuckel) Thuem. (anamorph: *Scolecosporiella bernardiana* (Sacc.) Sivanesan)	leaf spot	Reported from temperate North America and Europe on herbaceous stems. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Leptosphaeria maydis Stout	**minor leaf spot**; leaf spot	Recorded only once on Zea from **USA** (Illinois) (Farr *et al.*, 1989). **Not recorded in Australia**.
Leptosphaeria variisepta Stout	Leptosphaeria leaf spot	Recorded only once on Zea from Illinois (**USA)** (Farr *et al.*, 1989). This disease is of economic importance in Nepal (De Leon, 1984). No reports of being seed-borne. **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Leptosphaerulina trifolii (Rostr.) Petr. (synonyms: *Sphaerulina trifolii* Rostr.; *Pseudoplea trifolii* (Rostr.) Petr.; *Leptosphaerulina australis* McAlpine; *Leptosphaerulina briosiana* Pollacci; *Pleosphaerulina zeicola* Stout)	leaf spot	Cosmopolitan. This fungus has been recorded on Agropyron, Arachis, Glycine, Medicago, Oryza, Panicum, Phaseolus, Trifolium, Vigna and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Trifolium repens* and *Trifolium subterraneum* (NSW, Vic.) **in Australia** (NCOF, 1998).
Leptothyrium zeae Stout	**minor leaf spot**; leaf spot	Reported only once on Zea from **USA** (Illinois) (Farr *et al.*, 1989). **Not recorded in Australia**.
Ligniera junci (Schwartz) Maire & Tison (synonym: *Sorosphaera junci* Schwartz)		This fungus has been reported from Eastern United States and England. Recorded on Amaranthus, Panicum, Physalis, Polygonum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Lophiosphaera zeicola Ellis & Everh.		Reported only once on Zea from **USA** (Kansas) (Farr *et al.*, 1989). **Not recorded in Australia**.
Lophiostoma arundinis (Pers.:Fr.) Ces. & De Not.)		Reported from temperate North America and Europe. This fungus has been recorded on Agropyron, Scirpus and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Macrophomina phaseolina (Tassi) Goidanich (synonyms: *Macrophoma phaseolina* Tassi; *Macrophoma phaseoli* Maubl.; *Botryodiplodia phaseoli* (Maubl.) Thirumalachar; *Sclerotium bataticola* Taubenhaus; *Rhizoctonia bataticola* (Taubenhaus) Butler)	**charcoal rot; seed rot; seedling blight**	Cosmopolitan. Most common in subtropical and tropical regions. The fungus is ***seed-borne*** and is a problem only in hot dry areas, developing best at 37^{o}C. A Nebraska survey showed some fields with 70% infection of stalks (Cook *et al.*, 1973). In an Illinois survey, the pathogen was isolated from 11% of the rotted stalks from 62 fields (Hooker & White, 1976). This fungus has been recorded on a wide host range, including Sorghum and Zea in the USA (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld), and a wide range of other plants, **in Australia** (NCOF, 1998).
Macrosporium maculatum Cooke & Ellis in Sumstein, nom. nud.		Recorded only once on Zea from **USA** (Delaware) (Farr *et al.*, 1989). **Not recorded in Australia**.
Marasmiellus sp**.**	**borde blanco**	Not known to occur naturally on maize in the USA (APS, 1994). **Not recorded on maize in Australia.**
Marasmius graminum (Lib.) Berk. & Broome (synonym: *Marasmius tritici* Young)	root and stalk rot; seedling and foot rot	Cosmopolitan. Saprobic or facultatively parasitic on stems, leaves, and roots of grasses. This fungus has been recorded on Agrostis, Avena, Hordeum, Secale and Triticum in the USA (Farr *et al*., 1989). The fungus has been reported to be seed-borne on maize in Germany (Richardson, 1990). **Reported** on maize (Qld) **in Australia** (Pont, 1973).

PATHOGEN	DISEASE[1]	COMMENTS
Marasmius sacchari Wakk.	Marasmius root and stalk rot	Reported from southern USA and Hawaii on Saccharum (Farr *et al.*, 1989). No report of being seed-borne. The disease is prevalent in humid areas of Mexico and central America where it is considered as a, potentially serious, leaf and sheath disease (McGee, 1994). Stalk and root rots can be severe in Queensland, Australia, and Egypt under hot dry conditions (McGee, 1994). Up to 32% stalk infection has been **reported in Australia** (Pont, 1973).
Mariannaea elegans (Corda) Samson (synonyms: *Penicillium elegans* Corda; *Paecilomyces elegans* (Corda) Mason & Hughes)	**minor stalk rot**; stalk rot	Reported from northern temperate regions (Farr *et al.*, 1989). On rotting coniferous bark and isolated from forest soil and other organic debris (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Eucalyptus fastigata* (ACT) **in Australia** (NCOF, 1998).
Massarina arundinacea (Sowerby:Fr.) Leuchtmann (synonym: *Leptosphaeria arundinacea* (Sowerby:Fr.) Sacc.)		Reported from Central and eastern USA, and Europe. This fungus has been recorded on Arundinaria, Spartina and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Melanospora zamiae Corda (synonyms: *Melanospora pampeana* Speg.; *Melanospora townei* Griffiths)		Reported from warm-temperate and tropical regions. Common on rotting vegetation, possibly parasitic on other fungi (Farr *et al.*, 1989). This fungus has been recorded on Eichhornia, Salsola and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Microascus cinereus (Emile-Weil & Gaudin) Curzi (anamorph: *Scopulariopsis cinereus* Emile-Weil & Gaudin)		Reported from temperate regions of the world. Often isolated from soil, decaying matter, flowers and seeds. This fungus has been recorded on Helianthus and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia** (NCOF, 1998).
Microascus cirrosus Curzi		Reported from temperate regions of the world. Isolated from soil and organic debris, most recently from seeds. This fungus has been recorded on Helianthus and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Microascus desmosporus (Lechmere) Curzi		Reported from USA (Iowa) and Europe. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Microascus longirostris Zukal (synonym: *Microascus variabilis* Massee & Salmon; anamorph: *Scopulariopsis* sp.)		Reported from temperate regions of the world. Isolated from soil and stored grains. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Microdochium bolleyi (Sprague) De Hoog & Hermanides-Nijhof (synonyms: *Gloeosporium bolleyi* Sprague; *Aurobasidium bolleyi* (Sprague) Arx)	**minor root rot;** Microdochium root rot	Reported from central and western North America. *Not seed-borne*. It is a part of a complex of fungi associated with roots (Rogdaki-Papadaki & Kruger, 1980). This fungus has been recorded on a wide host range, including Hordeum, Secale, Setaria, Triticum and Zea in the **USA** (Farr *et al.*, 1989). Not

PATHOGEN	DISEASE[1]	COMMENTS
		recorded on maize, but **recorded** on *Agrostis capillaris*, *Agrostis pallustris* and *Poa pratensis* (NSW, Vic) **in Australia** (NCOF, 1998).
Microdochium nivale (Fr.) Samuels & Hallett (synonyms: *Fusarium nivale* Ces. Ex Berl. & Voglino; *Gerlachia nivalis* (Ces. Ex Berl. & Voglino) Gams & Mueller; teleomorph: *Monographella nivalis* (Schaffnit) Mueller)	Microdochium root rot	Cosmopolitan. Cereal and turf diseases. This fungus has been recorded on a wide host range, including Hordeum, Secale, Setaria, Triticum and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Agrostis capillaris*, *Agrostis* sp., and *Poa annua* (NSW) **in Australia** (NCOF, 1998).
Monascus purpureus Went	**silage mold**	Cosmopolitan, the fungus has been recorded on Oryza, Sorghum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded on maize in Australia**.
Monascus ruber Tiegh. (anamorph: *Basipetospora rubra* J.R. Cole & Kendrick)	**silage mold**	Widespread in the USA. Mainly isolated from silage, deteriorating grain, and soil. This fungus has been recorded on Helianthus (Farr *et al.*, 1989) and on Zea in the **USA** (APS, 1994). **Not recorded on maize in Australia**.
Mucor circinelloides Teigh. (synonym: *Mucor ambiguus* Vuill.)		Cosmopolitan. In soil and on a variety of organic substrates. This fungus has been recorded on Lycopersicon and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Cicer arietinum* (Vic.) **in Australia** (NCOF, 1998).
Mucor fragilis Bainier	seedling rot	Widespread. Isolated from soil and various organic substrates. This fungus has been recorded on Helianthus and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Eucalyptus fastigata* (ACT) in Australia (NCOF, 1998).
Mucor heimalis Wehmer		Cosmopolitan. Common soil saprobe. This fungus has been recorded on Carya, Helianthus, Lycopersicon and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Mucor mucedo P. Mich. ex Saint-Amans		Cosmopolitan. This fungus has been recorded on Malus, Nicotiana and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Mucor plumbeus Bonord.		Cosmopolitan. This fungus has been recorded on Carya and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Ipomoea batatas* (WA) **in Australia** (NCOF, 1998).
Mucor racemosus Fresen.		Cosmopolitan. Storage rot of fruits and vegetables. The fungus has been recorded on Carya, Citrus, Malus, Nicotiana and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Eucalyptus fastigata* and

PATHOGEN	DISEASE[1]	COMMENTS
		Macadamia integrifolia (ACT, NSW) **in Australia** (NCOF, 1998).
Mycosphaerella zeae (Sacc.) Woronow (synonym: *Mycosphaerella zeicola* Stout)	leaf blight	Reported from temperate regions of the northern hemisphere. This fungus has been recorded on Secale and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Myrothecium cinctum (Corda) Sacc. (synonym: *Fusarium cintum* Corda)	root rot	Cosmopolitan. On dead plant material, particularly grasses, and also isolated from soil (Farr *et al*., 1989). This fungus has been recorded on Zea in the **USA** (Farr *et al*., 1989). Not recorded on maize, but **isolated** from soil (Qld) **in Australia** (NCOF, 1998).
Myrothecium gramineum Lib.	**shuck rot**	Widespread. On grasses and occasionally on other plants, also isolated from soil (Farr *et al*., 1989). This fungus has been recorded on Zea in the **USA** (Farr *et al*., 1989). **Not recorded in Australia**.
Myrothecium verrucaria (Albertini & Schwein.) Ditmar.:Fr. (synonyms: *Gliocladium fibriatum* Gilman & Abbott; *Metarhizium glutinosum* Pope)	root rot	Cosmopolitan. Especially common in soil (Farr *et al*., 1989). This fungus has been recorded on Zea in the **USA** (Farr *et al*., 1989). Not recorded on maize, but **recorded** on *Brassica napus*, *Glycine max*, *Oxalis tuberosa*, *Pennisetum clandestinum*, *Phaseolus vulgaris*, and *Trifolium subterraneum* (NSW, Vic., WA) **in Australia** (NCOF, 1998).
Nigrospora oryzae (Berk. & Broome) Petch (teleomorph: *Khuskia oryzae* Hudson)	**dry ear rot; cob, kernel and stalk rot**; Nigrospora ear rot	Subtropical and tropical regions, including **USA** (Farr *et al.*, 1989). Saprophyte or weekly parasitic on a wide variety of plants. The fungus is ***seed-borne*** (Richardson, 1990) and survives on maize residues in the field (Dawood, 1980). It attacks ears only after plants are weakened or killed prematurely by frost, drought, root injury, leaf blights, or other stalk rot fungi (Shurtleff, 1980). The disease is common, but losses are minor. The fungus has been recorded on Panicum, Oryza, Sorghum, Saccharum and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW, SA, Vic.) **in Australia** (NCOF, 1998).
Nigrospora sacchari (Speg.) Mason		This fungus has not been recorded in the USA (Farr *et al.*, 1989). **Recorded** on maize (Qld, Vic.), and Anigozanthos, Brachiaria, Digitaria, Eragrostis, Micraira, Paspalum and Stachys (Qld) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Nigrospora sphaerica (Sacc.) Mason (synonym: *Trichosporum sphaerica* Sacc.)	stalk rot	Cosmopolitan. Saprobic or weakly parasitic on a wide variety of plants. Ear and stalk rot of grasses. This fungus has been recorded on Acacia, Avena, Beta, Carya, Cynodon, Eichhornia, Gossypium, Helianthus, Juncus, Malus, Secale, Setaria, Sorghum, Triticum and Zea in the **USA** (Farr *et al.*, 1989). This fungus has been reported to be seed-borne on maize in Malaya (Richardson, 1990). **Recorded** on maize (NSW, Qld) and a wide range of other plants (NSW, Qld) **in Australia** (NCOF, 1998).
Olpitrichum macrosporum (Farl.) Sumstine (synonyms: *Rhinotrichum macrosporum* Farl.; *Oidium macrosporum* (Farl.) Linder; *Plectrothrix globosa* Shear)		Distributed in eastern North America and Australia. Often associated with cotton-ball decay. This fungus has been recorded on Buxus, Eucalyptus, Ficus, Gossypium and Vaccinium in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Olpitrichum tenellum (Berk. & Curtis) Holubova-Jechova (synonyms: *Rhinotrichum tenellum* Berk & Curtis; *Acladium tenellum* (Berk. & Curtis) Subramanian; *Gonatobotrys cucumerinum* (Berk. & Curtis) Sumstine)		Reported from temperate North America and Europe, on various plants. The fungus has been reported to be a mycoparasite. This fungus has been recorded on Allium, Gossypium, Pennisetum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Ophiosphaerella herpotricha (Fr.:Fr.) Walker (synonyms: *Ophliobolus herpotrichus* (Fr.:Fr.) Sacc. & Roum; *Phaeosphaeria herpotricha* (Fr.:Fr.) Holm; *Ophiobolus oryzae* Miyabe; anamorph: *Scolecosporiella* sp.)	**minor leaf spot**	Cosmopolitan. This fungus has been recorded on Agropyron, Oryza and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Paraphaeosphaeria michotii (Westend.) Eriksson (synonyms: *Leptosphaeria michotii* Westend.; *Leptosphaeria zeae* Stout; anamorph: *Coniothyrium scirpi* Trail)	**minor leaf spot**; leaf spot	Reported from temperate regions of the northern hemisphere. On leaves of monocots, mainly grasses. The fungus has also been recorded on Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Eragrostis interrupta* and *Lupinus angustifolius* (NSW, Qld) **in Australia** (NCOF, 1998).
Penicillium aurantiogriseum Dierckx		Cosmopolitan. In soil and on a variety of plant materials (Farr *et al.*, 1989). This fungus has been recorded on wide range of hosts, including Zea, in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but recorded on Asparagus, Helianthus, and wood (NSW) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Penicillium brevicompactum Dierckx		Cosmopolitan. On a variety of organic materials (Farr *et al.*, 1989). The fungus has also been recorded on Acer, Carya, Citrus, Platanus and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on Brassica, Isopogon, Macadamia and wood (NSW, Vic.) **in Australia** (NCOF, 1998).
Penicillium canescens Sopp		Cosmopolitan. This fungus has been recorded on Acacia, Cheirodendron, Metrosideros and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on Eucalyptus (ACT) **in Australia** (NCOF, 1998).
Penicillium chrysogenum Thom	**Penicillium ear rot; blue eye; blue mold**	Cosmopolitan. On a variety of organic materials. This fungus has also been recorded on Carya, Hordeum, Pinus, Pyrus and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on Arachis, Brassica, Eucalyptus, earthworm, wood and silage (NSW, Qld, Tas., Vic.) **in Australia** (NCOF, 1998).
Penicillium citrinum Thom		Cosmopolitan. In soil and on a variety of organic materials. This fungus has been recorded on a wide range of hosts, including Zea, in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on Gahnia, Musa, wood and soil (NSW, Qld, Vic.) **in Australia** (NCOF, 1998).
Penicillium clarviforne Bainier		Worldwide but rare (Farr *et al.*, 1989). Primarily in soil. Also recorded on Beta and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Penicillium crustosum Thom		Cosmopolitan. Associated with spoilage of stored plant products, especially pome fruits. This fungus has also been recorded on Carya, Pyrus and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on Arachis and Eucalyptus (ACT, Qld) **in Australia** (NCOF, 1998).
Penicillium expansum Link (synonym: *Coremium glaucum* Link; *Penicillium glaucum* Link)	**Penicillium ear rot; blue eye, blue mold**	Cosmopolitan, commonly associated with fruit and a variety of plant materials (Farr *et al.*, 1989). This fungus has been recorded on Agropyron, Avenae, Carya, Cucumis, Cydonia, Daucus, Eucalyptus, Hordeum, Panicum, Prunus, Saccharum, Sorghum, Triticum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded on maize in Australia.**
Penicillium felludanum Biourge (synonym: *Penicillium charlesii* G.Sm.)		Cosmopolitan, in soil and on plant material (Farr *et al*., 1989). This fungus has been recorded on Carya and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded on maize in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Penicillium funiculosum Thom		Widespread. Common in soil. This fungus has been recorded on Ananas, Beta, Carya, Cucumis, Prunus, Quercus and Zea in the **USA** (Farr *et al.,* 1989). **Recorded** on maize (Qld), Ananas and Isopogon (NSW, Vic.) **in Australia** (NCOF, 1998).
Penicillium glabrum (Wehmer) Westling (synonym: *Penicillium frequentans* Westling)		Cosmopolitan. In soil and on a variety of plant materials. This fungus has been recorded on Acacia, Acer, Carya, Cucumis and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium granulatum Bainier		Widespread. This fungus has been recorded on Acer and Zea in the USA (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium grisefulvum Dierckx (synonym: *Penicillium urticae* Bainier)		Cosmopolitan on a variety of plant materials. This fungus has been recorded on Acer, Cucumis, Metrosideros and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium herquei Bainier & Sartory		Widespread. This fungus has been recorded on Acer, Cucumis, Metrosideros and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium implicatum Biourge		Widespread. This fungus has been recorded on Acer, Camellia, Carya, Cucumis and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium janthinellum Biourge		Widespread. This fungus has been recorded on Acacia, Arachis, Cucumis, Metrosideros and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia** (NCOF, 1998).
Penicillium minioluteum Dierckx	seed rot	This fungus has **not** been recorded **in the USA** (Farr *et al*., 1989). **Recorded** on maize (NSW) **in Australia** (NCOF, 1998).
Penicillium oxalicum Currie & Thom	**Penicillium ear rot; blue eye; blue mold**	Cosmopolitan, in soil and on decaying plant material. This fungus has been recorded on Cucumis, Sorghum and Zea in the **USA** (Farr *et al*., 1989). Pathogenic variability has also been reported (Caldwell *et al*., 1981). **Not recorded on maize in Australia**.
Penicillium puberulum Bainier (synonyms: *Penicillim commune* Thom; *Penicillium lannosum* Westling)		Worldwide, but rare. This fungus has been recorded on Beta, Carya, Malus, Pyrus and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium purpurogenum O. Stoll (synonym: *Penicillium rubrum* O. Stoll)		Cosmopolitan, primarily in soil. This fungus has been recorded on Carya, Pinus and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Penicillium roquefortii Thom		Widespread on a variety of organic substrates. This fungus has been recorded on Carya, Pyrus and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium rugulosum Thom (synonym: *Penicillium chrysitis* Biourge)		Widespread. This fungus has been recorded on Camellia, Cucumis, Pyrus and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium sclerotiorum Van Beyma (synonym: *Penicillium multicolor* Grigorieva-Manoilova & Poradielova *sensu* Raper & Thom)		Worldwide, but rare. This fungus has been recorded on Acer and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium thomii Maire		Cosmopolitan in soil and on a variety of organic substrates. This fungus has been recorded on Acer, Carya, Cucumis and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium variabile Sopp		Cosmopolitan. This fungus has been recorded on Carya, Cucumis, Vitis and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium verrucosum Dierckx		Widespread. Common in foodstuffs and also in soil. This fungus has been recorded on Malus and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium viridicatum Westling (synonyms: *Penicillium olivinoviride* Biourge; *Penicillium palitans* Westling)		Cosmopolitan. Associated with grains and grain products. This fungus has been recorded on Malus and Zea in the **USA** (Farr *et al*., 1989). **Not recorded on maize in Australia**.
Penicillium waksmanii Zaleski		Widespread. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded on maize in Australia**.
Perichaena vermicularis (Schwein.) Rostr.		Cosmopolitan. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **isolated** from bark (NSW) **in Australia** (NCOF, 1998).
Periconia circinata (Mangin) Sacc.	minor root rot; root rot	Reported from central North America, and Europe (Farr *et al.*, 1989). This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). The pathogen is soil-borne and causes milo root rot on sorghum and wheat. Not recorded on maize, but **recorded** on *Sorghum bicolor, Sorghum vulgare* and *Triticum aestivum* (NSW, Qld, SA) **in Australia** (NCOF, 1998).
Periconia macrospinosa Lefebvre & Johnson in Lefebvre *et al*.		Distributed in temperate regions. This fungus has been recorded on Sorghum and Triticum in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (Qld), Pennisetum, Sorghum and Triticum (NSW, Qld) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Perisporium zeae Berk. & Curtis		Reported only once from **USA** (South Carolina) on Panicum and Zea (Farr *et al.,* 1989). **Not recorded in Australia**.
Peronosclerospora heteropogoni Sirdhana *et al*.	Rajasthan downy mildew	This disease is confined to India, where it is a significant problem in the Rajasthan region (Bonde, 1982). *Heteropogon contortus* and *Zea mays* are the reported hosts of this fungus. No report of being seed-borne. This fungus has not been recorded in the USA (Farr *et al*., 1989). **Not recorded in Australia**.
Peronosclerospora maydis (Racib.) Shaw (synonym: *Sclerospora maydis* (Racib.) Butler)	**Java downy mildew;** downy mildew	The fungus has been reported from Australia (NT and WA) (Morschell, 1980) and Indonesia. This is a serious disease of maize in Indonesia, where yields may be reduced by 40% (Frederiksen & Renfro, 1977). Late planted, early rainy-season maize is damaged more severely than later plantings, with the inoculum originating from dry-season maize crops in irrigated fields. The closer the irrigated maize fields, the higher the incidence of infection in the rainy-season crop (Frederiksen & Renfro, 1977). The fungus is ***seed-borne*** (Richardson, 1990). Transmission to seedlings occurred when freshly harvested seeds from diseased plants were planted in sterile soil, but no transmission occurred from seeds dried in the sun (Bonde *et al.,* 1992). Maize, teosinte, and teosinte x maize hybrids are the only hosts of this pathogen (Shurtleff, 1980). **Recorded** on maize (NT, Qld, WA) **in Australia** (NCOF, 1998).
Peronosclerospora philippinensis (Weston) Shaw (synonym: *Sclerospora philippinensis* Weston)	**Philippine downy mildew**	The disease is confined to parts of Asia. It is a major problem in the Philippines, India and Nepal (Frederiksen & Renfro, 1977). The fungus is ***seed-borne*** (Richardson, 1990). Seed transmission occurred at the rate of 11% to seedlings in sterilised soil from seeds harvested at 36-38% moisture, but no transmission occurred from seeds at 14% moisture (Bonde, 1982). Hosts of this pathogen include Saccharum, Sorghum and Zea (Shurtleff, 1980). This fungus has not been recorded in the USA (Farr *et al*., 1989). **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Peronosclerospora sacchari (Miyake) Shaw (synonym: *Sclerospora sacchari* Miyake)	**sugarcane downy mildew**	The pathogen has been reported from Australia, Fiji, India, Japan, Nepal, New Guinea, Philippines, Taiwan and Thailand (Bonde, 1982). The fungus is ***seed-borne*** (Richardson, 1990) and seed transmissible. No transmission occurs from seeds dried to less than 20% moisture (Bonde *et al.,* 1992). Saccharum and Zea are the hosts of this fungus (Shurtleff, 1980). This fungus has not been recorded in the USA (Farr *et al*., 1989). **The pathogen has been eradicated from Australia** (Morschell, 1980).
Peronosclerospora sorghi (Weston & Uppal) Shaw (synonyms: *Sclerospora sorghi* Weston & Uppal; *S. graminicola* var. *andropogonis-sorghi* Kulk.)	**sorghum downy mildew**	The pathogen has been reported from USA, Latin America, North, Central and South America, Southeast Asia, India, Israel, Italy and Africa (Shurtleff, 1980). The fungus is ***seed-borne*** (Richardson, 1990). Transmission to seedlings was found when seeds from infected plants were planted immediately after harvest. It has never been found in seeds dried to 15% moisture content and below. This is a serious disease in the tropics and subtropics. Severe outbreaks have occurred in India, Israel, Mexico, Thailand, Texas and Venezuela (Frederiksen & Renfro, 1977). Worldwide, there appears to be at least two strains of *S. sorghi*, one is the sorghum-maize strain and the other is the maize-strain (Pupipat, 1975). The sorghum-maize strain infects both sorghum and maize and is present in southern India (Karnataka, Maharashtra and Tamil Nadu), Israel, Mexico, USA, Central South America and some regions of Africa (Frederiksen & Renfro, 1977). The maize strain is present in Northwestern India (Rajasthan) and Thailand (Bonde, 1982). The fungus has been recorded on Sorghum and Zea in the **USA** (Farr *et al*., 1989). **Not recorded in Australia**.
Peronosclerospora spontanea (Weston) Shaw (synonym: *Sclerospora spontanea* Weston)	**spontaneum downy mildew**	This disease was a serious problem on maize in the Philippines in about 1920, but has been rare in recent years (Shurtleff, 1980). Thailand is the only other country where this fungus has been reported on maize (Frederiksen & Renfro, 1977). No report of being seed-borne. Hosts includes maize, wild and cultivated sugarcane, teosinte and *Miscanthus japonicus* (Shurtleff, 1980). This fungus has not been recorded in the USA (Farr *et al*., 1989). **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Phaeocytostroma ambiguum (Mont.) Petr. in Petr. & Syd. (synonym: *Phaeocytosporella zeae* Stout; *Sphaeropsis ambigua* Mont.)	**Phaeocytostroma stalk rot and root rot**; Phaeocytosporella stalk infection; root and stalk rot	Distributed in central USA, Europe and Australia (Farr *et al*., 1989). The fungus is ***seed-borne*** and seed to seedling transmission has been demonstrated under laboratory conditions (Kruger, 1968). The disease is of no economic importance (Hooker & White, 1976). This fungus has been recorded on Zea in the USA (Farr *et al*., 1989). **Recorded** on maize (NSW) **in Australia** (NCOF, 1998).
Phaeosphaeria eustoma (Fuckel) Holm (synonym: *Pleospora eustoma* Fuckel; *Leptosphaeria eustoma* (Fuckel) Sacc.; anmorph: *Stagonospora* sp.)	Phaeosphaeria leaf spot	Reported from central and southern USA and Europe (Farr *et al*., 1989). Common on leaves of grasses and other monocots (Farr *et al*., 1989). Not recorded on maize, but **recorded** on *Bromus unioloides* and *Hordeum vulgare* (NSW, Vic.), **in Australia** (NCOF, 1998).
Phaeosphaeria herpotrichoides (De Not.) L. Holm (synonyms: *Leptosphaeria herpotrichoides* De Not.; *Leptosphaeria sparsa* (Fuckel) Sacc.; *Leptosphaeria culmifraga* Auct.; anamorph: *Stagonospora* sp.)	Phaeosphaeria leaf spot	This was common on grasses and maize in **Florida** in 1972, but is of no economic importance. It was originally confused with *Bipolaris maydis* (Schenck, 1972). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Phaeosphaeria maydis (Henn.) Rane, Payak & Renfro (synonym: *Sphaerulina maydis* Henn.)	**Phaeosphaeria leaf spot**	This disease is restricted to certain areas of Asia and Latin America (India, Brazil, Colombia, Ecuador, Mexico) where rainfall is high and night temperatures are low (De Leon, 1984). This fungus has not been recorded in the USA (Farr *et al*., 1989). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Phaeotrichoconis crotalariae (Salam & Rao) Subramanian (synonym: *Trichoconis crotalariae* Salam & Rao)		Widespread in tropical regions on various plants and also isolated from air and soil. This fungus has been recorded on Caryota, Chamaedorea, Chrysalidocarpus, Gronophyllum, Rhapis and Strelitzia in the **USA** (Farr *et al*., 1989). **Recorded** on maize (Qld), Acacia, Eichhornia and Xanthium (NT, Qld, WA) **in Australia** (NCOF, 1998).
Phoma americana Morgan-Jones & White	root rot	Reported from southeastern USA. This fungus has been recorded on Triticum and Zea in the **USA** (Farr *et al*., 1989). **Not recorded in Australia**.
Phoma terrestris Hans. (synonym: *Pyrenochaeta terrestris* (Hans.) Gorenz *et al*.)	**Pyrenochaeta stalk rot and root rot**; pink root	Worldwide. Most common in subtropical and tropical regions (Farr *et al*., 1989). It is of little economic importance. No report of being seed-borne. Frequently isolated from soil. Wide host range (Farr *et al*., 1989). **Recorded** on maize (WA), *Allium cepa*, Chrysanthemum, *Sorghum vulgare* and *Triticum*

PATHOGEN	DISEASE[1]	COMMENTS
		aestivum (NSW, Tas., Vic.) **in Australia** (NCOF, 1998).
Phoma zeicola Ellis & Evrh.	root rot	Reported from Central and eastern USA on Zea (Farr *et al.*, 1989). **Not recorded in Australia**.
Phomopsis sp.	**seed rot; seedling blight;** Phomopsis seed rot	Reported from **USA**, Kenya, and Australia. The fungus is ***seed-borne.*** This is an unimportant disease (Nwigwe, 1974). Germination reduction of 19 to 34% has been claimed, but the evidence was circumstantial (Nwigwe, 1974). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Phycomyces nitens Kunze		Widespread. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). Also isolated from soil, dung, and various organic substrates. Not recorded on maize, but **recorded** on *Oryza sativa* and *Trichocereus vulpecula* (NSW) **in Australia** (NCOF, 1998).
Phyllachora maydis Maubl.	**tar spot**	This is an important disease in relatively cool, humid areas of tropical Central America (Schieber, 1968). While cultivated varieties can suffer fairly severe leaf damage under suitable environmental conditions, it is rarely a serious pathogen. No report of being seed-borne. Host is *Zea mays* (Parbery, 1967). This fungus has not been recorded in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Phyllosticta maydis Arny & Nelson (teleomorph: *Mycosphaerella zeae-maydis* Mukunya & Boothroyd)	**yellow leaf blight**	Reported from central and eastern United States and southern Canada (Farr *et al.*, 1989). This is a minor disease reported in different parts of the world. No report of being seed-borne. The pathogen survives on maize crop residues from which ascospores are dispersed by wind (Castor *et al.*, 1977). This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Phyllosticta zeae Stout	Phyllosticta leaf spot	This is a minor disease reported in different parts of the world and eastern United States (Farr *et al.*, 1989). No report of being seed-borne. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Phymatotrichopsis omnivora (Duggar) Hennebert (synonyms: *Phymatotrichum omnivorum* Dugger; *Ozonium omnivorum* Shear)	Texas root rot	Reported from southwestern United States and Mexico, reports from elsewhere require confirmation (Farr *et al.*, 1989). A serious root pathogen on more than 2000 plant species. The identification of the basidial teleomorph as *Sistotrema brinkmanii* (Bres.) Eriks. is considered doubtful. *Phymatotrichum fungicola* Zeller may be a synonym. This fungus has been recorded on a wide host range including Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Physalospora abdita (Berk. & Curtis) Stevens in Voorhees (synonyms: *Anthostomella abdita* (Berk. & Curtis) Sacc.; *Physalospora fusca* Stevens)		Reported from southeastern United States. This fungus has been recorded on wide host range including Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Physarum pusillum (Berk. & Curtis) List.	slime mould	**Cosmopolitan.** This fungus has been recorded on Zea (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Pennisetum clandestinum* (NSW, Vic.), in Australia (NCOF, 1998).
Physoderma maydis (Miyabe) Miyabe (synonym: *Physoderma zeae-maydis* Shaw in Syd., Syd. & Bulter)	**brown spot; black spot; stalk rot**	Cosmopolitan. The fungus is ***seed-borne*** (Richardson, 1990). This is an important disease in areas of abundant rain and high temperatures. Yield losses of 20% have been reported in India (Lal & Charkravarti, 1976). In 1971, a severe outbreak occurred in white maize in Illinois, with 80% lodging in some fields (Burns & Shurtleff, 1973). This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld) **in Australia** (NCOF, 1998).
Physopella pallescens (Arth.) Cumins & Ramachar (synonyms: *Angiopsora pallescens* (Arth.) Mains; *Uredo pallida* Dietel & Holw.)	**tropical corn rust**	Reported from USA (Florida), Mexico to Colombia. This fungus has been recorded on Tripsacum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Physopella zeae (Mains) Cummins & Ramachar (synonym: *Angiopsora zeae* Mains)	**tropical corn rust;** tropical rust	Reported from USA (Florida), West Indies, Central and South America (Farr *et al.*, 1989). This disease is of minor importance and two races have been reported (Robert, 1962). Wind-blown spores are the major inoculum source. No report of being seed-borne. This pathogen has been eradicated from Florida. Recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Phytophthora cactorum (Lebert & Cohn) Schroet.	**minor root rot;** root rot	Reported from temperate regions of the world. (Farr *et al.*, 1989). On at least 154 genera of vascular plants in 54 families (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on wide range of other plants **in Australia** (NCOF, 1998).
Phytophthora drechsleri Tucker	**minor root rot;** root rot	Cosmopolitan. This fungus attacks a variety of plants including maize in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Brassica actinophylla, Cajanus cajan, Carthamus lanatus, Carthamus tinctorius, Citrus limon, Cymbidium sp., Eucalyptus maculata, Helianthus annuus, Leptospermum petersonii, Lunaria annua* and *Westringia fructicosa* (NSW, Qld, Tas., WA) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Phytophthora nicotianae Breda de Haan var. ***parasitica*** (Dastur) Waterhouse (synonym: *Phytophthora parasitica* Dastur)	**minor root rot;** root rot	Cosmopolitan. This fungus causes damping-off, crown rot, leaf blight and fruit rot, of a wide variety of plants. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on wide range of other plants **in Australia** (NCOF, 1998).
Pithoascus intermedius (Emmons & Dodge) Arx (synonym: *Microascus intermedius* (Emmons & Dodge)		Reported from temperate regions of the world. This fungus has been recorded on Helianthus and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Pithoascus schumachrei (Hans.) Arx (synonyms: *Microascus schumacheri* (Hans.) Cruzi; *Rosellinia schumacheri* (Hans.) Sacc.)		Reported from temperate regions of the world. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Pithomyces maydicus (Sacc.) M.B. Ellis (synonym: *Clasterosporium maydicum* Sacc.)	**minor ear rot;** ear rot	Widespread in tropical regions of the world. On leaves and other parts of various plants. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Pleospora straminis Sacc. & Speg.		Reported from eastern North America and Europe. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Pleurophragmium verruculosum Tiwari		This fungus has not been recorded in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Podospora minor Ellis & Everh. (synonyms: *Pleurage minor* (Ellis & Everh.) Griffiths; *Sordaria minor* (Ellis & Everh.) Sacc. & Syd.)		This fungus has only been reported from **USA** (Kansas) on Zea (Farr *et al.*, 1989). **Not recorded in Australia**.
Polyschema olivacea (Ellis & Everh.) M.B. Ellis (synonyms: *Clasterosporium olivacea* Ellis & Everh.; *Clasterosporium elaeodes* Pound & Clements; *Torula elaeodes* (Pound & Clements) Hughes; *Clasoterosporium zeae* Sacc. & Syd.)		This fungus has only been reported from **Eastern United States** on Zea (Farr *et al.*, 1989). **Not recorded in Australia**.
Puccinia polysora Underw.	**southern corn rust;** leaf rust; southern rust	Reported from USA, Central and South America, Central Africa, southeastern Asia. The disease is common in the USA, particularly in the south, where it caused substantial losses in late-planted crops (Schall *et al.*, 1983). Yield losses up to 45% have been reported (Rodriguez-Ardon *et al.*, 1980). Several races have been reported (Schall *et al.*, 1983). The fungus has been recorded on Saccharum, Tripsacum and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on

PATHOGEN	DISEASE[1]	COMMENTS
		maize (NT, Qld) **in Australia** (NCOF, 1998).
Puccinia sorghi Schwein. (anamorph: *Aecidium oxalidis* Thuem.)	**common corn rust**; leaf rust; common maize rust	Worldwide in maize growing areas (Farr *et al.*, 1989). ***Seed-borne*** (Richardson, 1990). One report implied, but did not prove seed transmission, when rust developed in a new area after seeds from severely infected plants were grown. This fungus has been recorded on Oxalis and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld, Tas., Vic., WA) **in Australia** (NCOF, 1998).
Pyrenochaeta indica Viswanathan	black root rot	This fungus has not been recorded in the USA (Farr *et al.*, 1989). **Recorded** on maize (Qld) **in Australia** (NCOF, 1998).
Pyricularia grisea (Cooke) Sacc. (synonyms: *Pyricularia oryzae* Briosi & Cavara; *Trichothecium griseum* Cooke; teleomorph: *Magnaporthe grisea* (Hebert) Yaegashi & Udagawa)	white leaf spot	Distributed in North and South America, Africa and Asia. Blast or gray spot of grasses. This fungus has been recorded on Agrostis, Andropogon, Cladium, Commelina, Cynodon, Digitaria, Eichhornia, Eragrostis, Glycine, Oryza, Panicum, paspalum, Poa, Setaria and Sorghum in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld) **in Australia** (NCOF, 1998). This fungus is distinct from the rice blast fungus, *Pyricularia oryzae* Cavara.
Pyronema omphalodes (Bull.:Fr.) Fuckel (synonym: *Pyronema confluens* (Pers.:Pers.) Tul. & Tul.)		Cosmopolitan. On burned areas, charcoal beds, and steamed soil in glasshouses. This fungus has been recorded on Sequoia and Zea in the USA (Farr *et al.*, 1989). Not recorded on maize, but **isolated** from soil (NSW, Vic.) **in Australia** (NCOF, 1998).
Pythium acanthium Drechs.	root rot	Cosmopolitan. On roots and seedlings of a wide variety of plants. This fungus has been recorded on Citrullus, Fragaria, Solanum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Pythium adhaerens Sparrow	root rot	Distributed in the **USA** and Malaysia. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Pythium angustatum Sparrow	root rot	Widespread. Generally not pathogenic but found to cause root-rot of maize under certain environmental conditions (Farr *et al.*, 1989). **Not recorded on maize in Australia**.
Pythium aphanidermatum (Edson) Fitzp. (synonyms: *Pythium butleri* Subramanian; *Rheosporangium aphanidermatum* Edson; *Nematosporangium aphanidermatum* (Edson) Fitzp.)	**Pythium stalk rot**	Cosmopolitan, especially common in warm regions (Farr *et al.*, 1989). The pathogen is soil-borne. It is a minor disease in the US maize belt but is more serious in China and in tropical areas (Xu, 1985). This fungus has been recorded on a wide host range including Agrostis, Avena, Beta, Capsicum, Citrus, Cucumis, Cynodon, Glycine, Gossypium, Gypsophila, Hordeum, Lolium, Medicago, Nicotiana, Oryza, Pelargonium, Phaseolus, Pinus, Pisum,

PATHOGEN	DISEASE[1]	COMMENTS
		Saccharum, Secale, Solanum, Spinacia, Triticum and Zea in the **USA** (Farr *et al*., 1989). **Recorded** on maize (Qld), *Beta vulgaris, Capsicum annuum*, Chloris, *Cucumis melo, Cucumis sativus, Gossypium* sp., *Gypsophila paniculata,* Lablab, *Lycopersicon esculentum, Pelargonium zonale, Phaseolus vulgaris, Sinapis alba, Solanum tuberosum* and Stylosanthus (NSW, Qld, WA) **in Australia** (NCOF, 1998).
Pythium arrhenomanes Drechs.	**Pythium root rot;** root rot	Cosmopolitan. Common on grasses. This fungus has recorded on wide host range including Agropyron, Agrostis, Ananas, Andropogon, Avena, Bromus, Commelina, Eichhornia, Hordeum, Lycopersicon, Musa, Panicum, Saccharum, Secale, Setaria, Solanum, Sorghum, Triticum, Vicia, Vigna, Vulpia and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Digitaria didactyla*, *Oryza sativa* and *Triticum aestivum* (NSW, Qld) **in Australia** (NCOF, 1998).
Pythium graminicola Subramanian	**Pythium root rot;** root rot	Cosmopolitan. Pathogenic on many grasses. This fungus has been recorded on a wide range of plants including Agropyron, Agrostis, Ananas, Andropogon, Avena, Bromus, Dactylis, Eichhornia, Eragrostis, Hordeum, Lolium, Oryza, Panicum, Pisum, Saccharum, Secale, Setaria, Sorghum, Triticum, Vicia and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Oryza sativa*, *Saccharum officinarum* and *Triticum aestivum* (NSW, Qld, Vic.), **in Australia** (NCOF, 1998).
Pythium irregulare Buisman (synonyms: *Pythium dactyliferum* Drechs. in Rands; *Pythium fabae* Cheney; *Pythium polymorphon* Sideris)	Pythium root rot, Pythium seedling blight, damping off	Cosmopolitan and soil-borne (Farr *et al.*, 1989). *Pythium* spp. can cause serious establishment problems (Pedersen *et al.*, 1986). Not recorded on maize, but **recorded** on wide range of other plants, **in Australia** (NCOF, 1998).
Pythium myriotylum Drechs.	root rot	Worldwide in warm regions. Pathogenic on a wide variety of plants. This fungus has been recorded on Arachis, Caladium, Cucumis, Glycine, Lolium, Lycopersicon, Phaseolus, Robinia, Solanum and Triticum in the USA (*Farr et al.*, 1989). **Recorded** on maize (Qld), Alocasia, Arachis, Carthamus, Lycopersicon, Medicago, Nymphaea, Oryza, Solanum, Sorghum and Vigna (NSW, NT, Qld), **in Australia** (NCOF, 1998).
Pythium paroecandrum Drechs.	root rot	Cosmopolitan. Isolated from soil. This fungus has recorded on Allium, Chrysanthemum, Daucus, Impatiens, Medicago, Sanguinaria and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on *Adiantum* sp.,

PATHOGEN	DISEASE[1]	COMMENTS
		Papaver somniferum, *Ranunculus* sp., and *Triticum aestivum*, (NSW, SA, Tas.) **in Australia** (NCOF, 1998).
Pythium pulchrum Minden (synonym: *Pythium epigynum* Hoehn.)	root rot	Reported from northern hemisphere. Saprobic on insects and plant debris. This fungus has recorded on Antirrhinum, Medicago, Pyrus and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Pythium rostratum Butler	root rot	Cosmopolitan. Common in soil. Generally considered to be non-pathogenic or weakly parasitic. This fungus has recorded on a Allium, Ananas, Antirrhinum, Avena, Cajanus, Citrus, Helianthus, Hordeum, Ipomoea, Medicago, Oryza, Panicum, Phaseolus, Saccharum, Solanum, Spinacia, Vicia and Zea in the **USA** (Farr *et al.*, 1989). Not **recorded** on maize, but recorded on *Hordeum vulgare*, *Oryza sativa*, and *Triticum aestivum* (NSW, SA) **in Australia** (NCOF, 1998).
Pythium splendens Braun	root rot	Worldwide. This fungus has been recorded on a wide variety of plants, including Zea, in the **USA** (Farr *et al.*, 1989). **Not recorded on maize in Australia**.
Pythium sylvaticum Campbell & Hendrix	seed rot	Cosmopolitan. Seed-borne and considered to be responsible for seed rot of maize in Japan (Kondo et al., 1986). This fungus has been recorded on Allium, Daucus, Fragaria, Juniperus, Lactuca and Triticum (Farr *et al.*, 1989). **Not recorded on maize in Australia**.
Pythium ultimum Trow		Cosmopolitan. Pathogenic on a wide variety of plants. This fungus has been recorded on a wide range of plants including Agropyron, Allium, Arachis, Avena, Beta, Brassica, Capsicum, Cicer, Citrus, Cucumis, Cynodon, Dactylis, Eichhornia, Eragrostis, Glycine, Gossypium, Hordeum, Lycopersicon, Panicum, Phaseolus, Nicotiana, Pisum, Saccharum, Secale, Solanum, Sorghum, Triticum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded on maize in Australia**.
Pythium zeae	Pythium leaf spot	This is a minor disease reported only once in India (Singh, 1972). This fungus has not been recorded in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Ramulispora sorghi (Ellis & Everh.) Olive & Lefebvre in Olive *et al*. (synonym: *Septorella sorghi* Ellis & Everh.)	brown leaf spot	Worldwide. Sooty blotch or leaf stripe. This fungus has been recorded on Agrostis and Sorghum in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NT) and Sorghum (NT, Qld) **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Rhizoctonia solani Kühn (synonyms: *Rhizoctonia microsclerotia* Matz; *Rhizoctonia macrosclerotia* Matz; *Moniliopsis solani* Kühn; teleomorphs: *Thanatephorus cucumeris* (Frank) Donk; *Corticium sasakii* (Shirai) Matsumoto	**Rhizoctonia root rot and stalk rot; banded leaf and sheath spot; Corticium ear rot; seed rot; seedling blight**; root, stem and ear rot	Cosmopolitan. The fungus is ***seed-borne*** (Richardson, 1990) but not seed transmissible (Michail *et al.*, 1977). The fungus has been recognised as a component of the complex causing root rot in irrigated maize crops in Georgia (Sumner & Dowler, 1983). Recorded on a wide-host range including *Zea* in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (Qld) and a wide range of other plants, **in Australia** (NCOF, 1998).
Rhizoctonia solani Kühn f.sp. ***sasakii*** Shirai	banded leaf and sheath spot	Reported from Europe, Africa and Asia (Ahuja & Payak, 1981). The fungus is ***seed-borne*** and is particularly important in India (Ahuja & Payak, 1982). Losses up to 40% have been induced after artificial inoculation (Lal *et al.*, 1980). Infected seeds are small and shrivelled. This fungus has not been recorded in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Rhizoctonia zeae Voorhees (synonym: *Moniliopsis zeae* (Voorhess) Moore; teleomorph *Waitea circinata* Warcup & Talbot)	**Rhizoctonia ear rot; sclerotial rot; Rhizoctonia root rot and stalk rot; seed rot; seedling blight**	Temperate regions. The fungus is ***seed-borne*** (Richardson, 1990). The disease occurs mainly in the tropics as a minor disease. It is recognised as a component of the complex causing root rot in irrigated maize crops in Georgia (**USA**) (Sumner & Dowler, 1983). This fungus has been recorded on Avena, Pennisetum, Triticum and Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW), Avena, Papaver and Sorghum (NSW, Tas.) **in Australia** (NCOF, 1998).
Rhizopus arrhizus Fischer (synonyms: *Rhizopus oryzae* Went & Prinsen Geerligs; *Rhizopus maydis* Bruderlein)	**minor root rot;** Rhizopus ear rot; gray mould	Cosmopolitan (Farr *et al.*, 1989). Soft rot of fruit and vegetables (Lunn, 1977d). Very common seed contaminant. The fungus grows from seeds to seedlings in laboratory germination tests. This disease is of minor economic importance (McGee, 1994). Not recorded on maize, but **recorded** on *Helianthus annuus* and *Prunus persica* (NSW, Vic.) **in Australia** (NCOF, 1998).
Rhizopus microsporus Tiegh.	**minor ear rot;** Rhizopus ear rot; gray mould	Widespread**.** Isolated from soil and various organic substrates (Lunn, 1977b). Very common seed contaminant. The fungus grows from seeds to seedling in laboratory germination tests. This disease is of minor economic importance (McGee, 1994). **Not recorded in Australia**.
Rhizopus microsporus Tiegh. var. ***rhizopodiformis*** (Cohn) Schipper	Rhizopus ear rot; gray mould	This fungus has been reported from temperate regions. Isolated from sawdust, stored grains, and various organic substrates (Lunn, 1977a). Very common seed contaminant. The fungus grows from seeds to seedlings in laboratory germination tests. This disease is of minor economic importance (McGee, 1994). **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Rhizopus stolonifer (Ehrenb.:Fr.) Vuill. (synonym: *Rhizopus nigricans* Ehrenb.)	**minor ear rot;** Rhizopus ear rot; gray mould	Cosmopolitan. Soft rot of fruit and vegetables (Lunn, 1977c). Very common seed contaminant. The fungus grows from seeds to seedlings in laboratory germination tests. This disease is of minor economic importance (McGee, 1994). **Recorded** on maize (Vic.) and wide range of other plants **in Australia** (NCOF, 1998).
Rhopographus zeae Pat.	**minor stalk rot;** stalk rot	Reported from USA (Georgia) and Ecuador. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Sclerophthora macrospora (Sacc.) Thirumalachar, Shaw & Narasimhan (synonyms: *Sclerospora macrospora* Sacc.; *Phytophthora macrospora* (Sacc.) Ito & Tanaka)	**crazy top downy mildew**; crazy top	Reported from USA, Mexico, Canada, Europe, Africa, Australia and Asia (Jones, 1980). The fungus is ***seed-borne*** (Richardson, 1990) and seed to seedling transmission has been demonstrated under laboratory conditions (Ullstrup & Sun, 1969). This disease is found in most maize growing areas of the world with temperate to warm-temperate climates. It is widespread in USA but of minor economic importance (Jones, 1980). Reported on at least 46 genera of the Poaceae, and Cyperus in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW) **in Australia** (NCOF, 1998).
Sclerophthora rayssiae Kenneth *et al.*, var. ***zeae*** Payak & Renfro	**brown stripe downy mildew**	This pathogen is confined to India, Nepal, Pakistan, Sikkim and Thailand (Frederiksen & Renfro, 1977). The pathogen is ***seed-borne*** and seed transmissible (Singh *et al.*, 1968). The disease is common and destructive in India, with losses ranging from 20 to 90% (Payak & Renfro, 1967). It tends to be most severe in areas of 100 to 200 cm rainfall, declining in severity as rainfall declines (Frederiksen & Renfro, 1977). This fungus has not been recorded in the USA (Farr *et al.*, 1989). **Not recorded in Australia**.
Sclerospora graminicola (Sacc.) J. Schröt. (synonym: *Peronospora graminicola* Sacc.)	**Green ear downy mildew Graminicola downy mildew;** green ear	Widespread on all continents except Australia (Farr *et al.*, 1989). It has been found on maize only in USA and Israel (Shurtleff, 1980; Frederiksen & Renfro, 1977). It is a major disease of pearl millet (Bonde, 1982). Not recorded as seed-borne in maize, but is seed-borne in pearl millet (Shetty *et al.*, 1980). This fungus has been recorded on Pennisetum, Sorghum and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Sclerotinia sclerotiorum (Lib) de Bary (synonyms: *Sclerotinia libertiana* Fuckel; *Whetzelinia sclerotiorum* (Lib.) Korf & Dumont)	Sclerotinia stalk rot	Worldwide. Most common in cool moist regions. The fungus is ***seed-borne*** (Richardson, 1990). Not recorded on maize, but **recorded** on wide range of other plants **in Australia** (NCOF, 1998).

PATHOGEN	DISEASE[1]	COMMENTS
Sclerotium rolfsii Sacc. (teleomorph: *Athelia rolfsii* (Curzi) Tu & Kimbrough)	**Sclerotium ear rot; southern blight; seed rot; seedling blight;** root rot	Cosmopolitan. Leaf blight, stem canker, damping-off, crown and root rot on a wide variety of hosts. The fungus is ***seed-borne*** (Richardson, 1990). The disease has only been reported from Pakistan (Ahmad *et al.*, 1984) and India (Sharma *et al.*, 1976), where it has causes significant losses. This fungus has been recorded on a wide host range of plants including Zea in the USA (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld) and a wide range of other plants **in Australia** (NCOF, 1998).
Scopulariopsis brevicaulis (Sacc.) Bainier	ear rot	Cosmopolitan. Isolated from air, soil, animals, wood and various plants, and is used for the detection of arsenic (Farr *et al.*, 1989). This fungus has been recorded on Alnus, Helianthus and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize**,** but **recorded** on Brassica, Medicago, Phaseolus, Triticum and soil (ACT, NSW, Qld) **in Australia** (NCOF, 1998).
Scopulariopsis brumptii Salvanet-Duval (synonym: *Marssoniella grisea* (Sm.) Sm.)	**minor ear rot**; ear rot	Cosmopolitan. Isolated from air, soil, straw, and various plants (Farr *et al.*, 1989). Not recorded on maize, but has been **isolated** from soil (Qld) **in Australia** (NCOF, 1998).
Septoria maydis	Septoria leaf blotch	This is a minor disease in cool, humid environments in Central America (De Leon, 1984). This fungus has not been recorded in the USA (Farr *et al.*, 1989). No report of being seed-borne. **Not recorded in Australia**.
Septoria zeae Stout	**minor leaf spot;** leaf spot	Reported from Illinois, Europe and Asia. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Septoria zeicola Stout	**minor leaf spot;** leaf spot	This fungus has only been reported from Illinois **(USA)** on Zea (Farr *et al.*, 1989). **Recorded** on maize (NSW) **in Australia** (NCOF, 1998).
Septoria zeina Stout	**minor leaf spot;** leaf spot	This fungus has only been reported from Illinois **(USA)** on Zea (Farr *et al.*, 1989). **Not recorded in Australia**.
Sphaerella paulula Cooke		This fungus has only been reported from **USA** (Florida) on Zea (Farr *et al.*, 1989). **Not recorded in Australia**.
Sporidesmium folliculatum (Corda) Mason & Hughes (synonym: *Helminthosporium folliculatum* Corda)		Reported from USA (West Virginia) and Europe. On dead wood of various trees. This fungus has recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.

PATHOGEN	**DISEASE[1]**	**COMMENTS**
Sporisorium holci-sorghi (Rivolta) K. Vanky (synonyms: *Sphacelotheca reiliana* (Kühn) Clinton; *Sorosporium reilianum* (Kühn) McAlpine; *Sporisorium reilianum* (Kühn) Langdon & Fullerton; *Ustilago reiliana* Kühn)	**head smut**	Cosmopolitan. Mainly soil-borne but seed transmission also believed to occur (Richardson, 1990). This is a systemic disease and seedlings are infected by soil-borne teliospores during or after emergence (Matyac, 1985). One population of the fungus attacks maize and another attacks maize and sorghum (Al -Sohaily *et al.*, 1963). Losses generally are minor, but losses of 30 to 50% may occur in individual fields (Frederiksen *et al.*, 1976). In north America it occurs only in Minnesota (Stromberg *et al.*, 1985), Ontario (Lynch *et al.*, 1980), Texas (Frederiksen *et al.*, 1976), Iowa and the pacific coast. **Recorded** on maize (NSW, Qld, Vic.) **in Australia** (NCOF, 1998).
Stachybotrys zeae Morgan-Jones & Karr		This fungus has been reported only from **USA** (Alabama) on Zea (Farr *et al.*, 1989). **Not recorded in Australia**.
Stauronema cruciferum (Ellis) Syd et al. (synonyms: *Dinemasporium cruciferum* Ellis; *Dinemasporium bicristatum* Cooke)		Reported from South Carolina (USA), India and Pakistan. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Stenocarpella macrospora (Earle) Sutton (synonyms: *Diplodia macrospora* Earle; *Macrodiplodia zeae* (Schwein.) Petrak & Sydow var. *macrospora* (Earle) Petrak & Sydow; *Stenocarpella zeae* Sydow)	**Diplodia leaf spot or leaf streak; southern leaf spot;** dry rot; Diplodia ear and stalk rot; Diplodia leaf stripe	Cosmopolitan. The fungus is ***seed borne*** (Richardson, 1990) and overwinters as viable pycnidia and mycelium on maize debris in the soil or on the seed. This is a minor ear, stalk and leaf disease in the southeastern USA (Turner & Bell, 1978). Greater losses occur as a leaf and ear disease in central America (Llano & Schieber, 1980). The disease has the potential to be more serious under minimal tillage (Latterell & Rossi, 1983). The mycotoxin, diplodiol, can develop in grain, but is of minor importance (Cutler *et al.*, 1980). This fungus has been recorded only on Zea in the **USA** (Farr *et al.*, 1989). **Recorded** on maize (NSW, Qld) **in Australia** (NCOF, 1998).
Stenocarpella maydis (Berk.) Sutton (synonyms: *Diplodia zeae* (Schwein.) Lev.; *Macrodiplodia zeae* (Schwein.) Petrak & Sydow; *Diplodia zeae-maydis* Mekhtijeva)	**white ear rot, root and stalk rot;** Diplodia ear and stalk rot	Cosmopolitan (Farr *et al.*, 1989). Seed-borne (Richardson, 1990). This fungus has been recorded only on Zea in the **USA** (Farr *et al.*, 1989). It is currently a serious disease in South Africa (Flett & McLaren, 1994). **Recorded** on maize (NSW, Qld) **in Australia** (NCOF, 1998).
Sterile white basidiomycete *(SWB)*	SWB root rot	The pathogen is part of a complex associated with root disease of maize in **USA** (Georgia) and causes minor losses (Bell & Sumner, 1984). No report of being seed-borne. **Not recorded in Australia**.
Stictis radiata Pers.:Fr. (synonym: *Stictis annulata* Cooke & Phillips)		Cosmopolitan (Farr *et al.*, 1989). On bark, wood and plant debris. This fungus has been recorded on a wide host range including Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Stictis stellata Schwein.		Reported only from southeastern United States (Farr *et al.*, 1989). On herbaceous stems, occasionally on wood. This fungus has been recorded on Arundinaria, Phytolacca and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on Senecio (NSW) **in Australia** (NCOF, 1998).
Syncephalastrum racemosum Cohn ex Schrot		Widespread. Isolated from soil and various organic substrates (Farr *et al.*, 1989). This fungus has been recorded on Carya, Juncus and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on Oryza (Vic.) **in Australia** (NCOF, 1998).
Talaromyces luteus (Zukal) Benjamin		Worldwide but rare (Farr *et al.*, 1989). This fungus has been recorded on Alnus, Gossypium and Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Talaromyces stipitatus (Thom) Benjamin		Widespread. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Thamnidium elegans Link:Fr		Widespread. Isolated from soil and various organic substrates. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Trichoderma koningii Oudem. (teleomorph: *Hypocrea ceramica* Ellis & Everh.)		Cosmopolitan. In soil. This fungus has been recorded on Acer, Carya, Ipomoea, Platanus, Pyrus and Zea in the **USA** (Farr *et al.*, 1989). In the **USA,** the fungus was isolated from maize samples from Iowa and Oregon (Farr *et al.*, 1989). The fungus has been reported to be seed-borne in maize (Richardson, 1990). Not recorded on maize, but **recorded** on Agricus, Eucalyptus, Lentinula and Sclerotinia (NSW, Vic.) **in Australia** (NCOF, 1998).
Trichoderma viride Pers.:Fr. (synonym: *Trichoderma lignorum* Tode; teleomorph: *Hypocrea* sp.)	**Trichoderma ear rot and root rot;** root, seed and stalk rot;	Cosmopolitan. On a wide range of organic substrates. This fungus has been recorded on a wide host range, including Zea in the **USA** (Farr *et al.*, 1989). On maize seed and meal in 12 states of the USA (Farr *et al.*, 1989). Infection levels of ears of 25% have been reported from India (Kumar & Shetty, 1985). Not recorded on maize, but **recorded** on *Agaricus bisporus, Cicer arietinum, Citrus* sp., *Eucalyptus viminalis, Medicago truncatula, Poria* sp., and *Salix* sp.(NSW, Qld, SA, Vic.) **in Australia** (NCOF, 1998).

PATHOGEN	**DISEASE[1]**	**COMMENTS**
Trichothecium roseum (Pers.:Fr.) Link (synonym: *Cephalothecium roseum* Corda)	pink mould	Cosmopolitan. On a wide variety of organic substrates This fungus has been recorded on a wide host range, including Zea in the **USA** (Farr *et al.*, 1989). On maize seed and meal in 26 states of USA (Farr *et al.*, 1989). The fungus has been reported to be seed-borne in maize (Richardson, 1990). Not recorded on maize, but **recorded** on range of other plants **in Australia** (NCOF, 1998).
Tritirachium oryzae (Vincens) De Hoog (synonyms: *Beauveria oryzae* Vincens; *Tritirachium roseum* Van Beyma)		Worldwide, most common in tropical areas. Isolated from various organic substrates. Isolated in the **USA** from maize samples in Iowa (Farr *et al.*, 1989). **Not recorded in Australia**.
Tubeufia cylindrothecia (Seaver) Höhn (synonym: *Ophionectria cylindrothecia* Seaver)		Cosmopolitan. Often on monocotyledonous debris. Recorded on maize in the **USA** in Ohio (Farr *et al.*, 1989). **Not recorded in Australia**.
Typhula phacorrhiza (Reichard:Fr.) Fr. (synonyms: *Clavaria phacorrhiza* Reichard:Fr.; *Typhula complanata* de Bary; *Typhula juncea* (Fr.) Karst.; synanamorphs: *Sclerotium complanatum* Tode; *Sclerotium scutellatum* Albertini & Schwein.)	snow mould	Eastern and western United States, Europe and Asia. On old leaves, petioles, herbaceous stem, and grass. This fungus has been recorded on Acer, Alnus, Aster, Dactylis, Solidago and Zea in the **USA** (Farr *et al.*, 1989). Recorded in the USA on Zea in New York (Farr *et al.*, 1989). **Not recorded in Australia**.
Ulocladium lanuginosum (Harz.) Simmons (synonyms: *Stemphylium lanuginosum* Harz; *Alternaria lanuginosa* (Harz) Sacc.; *Pseudostemphylium lanuginosum* (Harz) Subramanian)		Widespread. This fungus has been recorded on Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.
Ustilaginoidea virens (Cooke) Takah. (synonyms: *Ustilaginoidea oryzae* (Pat.) Brefeld.; *Tilletia oryzae* Patouillard; *Ustilago virens* Cooke; teleomorph: *Claviceps virens* (Cke.) Sakurai ex Nakata.	**false smut;** green smut	Worldwide in rice growing regions. The fungus has been reported to be **seed-borne** in maize (Richardson, 1990). A minor disease that is favoured by hot wet weather (Sharma & Verma, 1979). This fungus has been recorded on Oryza and Zea in the USA (Farr *et al.*, 1989). False sumt is generally a minor disease of rice, but epidemics of the disease have been reported in India, Burma, Peru, and the Philippines. The fungus also infects *Digitaria adscendens*, *Panicum trypheron*, and wild *Oryza* spp. (Webster & Gunnell, 1992). **Not recorded in Australia**.

PATHOGEN	DISEASE[1]	COMMENTS
Ustilago zeae (Beckm.) Unger (synonyms: *Lycoperdon zeae* Beckm.; *Ustilago maydis* (DC.) Corda)	**common smut;** boil smut; blister smut	Widespread. This fungus has been recorded on Zea and related genera in the **USA** (Farr *et al.*, 1989). The fungus has been reported to be **seed-borne** in maize (Richardson, 1990). During harvest, kernels become contaminated with teliospores. Teliospores are also soil borne and can be carried from field to field by contaminated machinery. Losses generally are minor, but individual fields may lose 30 to 50% of yield (Kommedahl & Windels, 1977). A minor disease **in Australia** (Jones, 1982) and England (Cook, 1977). Boil smut is present in northern NSW and Queensland. Official controls are in place to prevent the spread of boil smut in Australia.
Verticillium tenerum (Pers.:Fr.) Link (synonyms: *Verticillium cinnabarinum* (Corda) Reinke & Berthier; *Verticillium lateritium* (Ehrenb.) Rabenh.; teliomorph: *Nectria inventa* Pethybr.)		Cosmopolitan. On organic debris. This fungus has been recorded on Sambucus, Solanum, Tulipa, and Zea in the **USA** (Farr *et al.*, 1989). Not recorded on maize, but **recorded** on Eucalyptus, Lactuca, Phytolacca and Solanum (NSW) **in Australia** (NCOF, 1998).
Wolfiporia cocos (Wolf) Ryvarden & Gilbertson (synonyms: *Poria cocos* Wolf; *Macrohyporia cocos* (Wolf) Johansen & Ryvarden; *Merulius albus* Burt; anamorph: *Sclerotium cocos* Schwein.:Fr.)	wood rot	**North America**. Occurs on wood. Usually found only in the sclerotial stage or isolated from wood. This fungus has been recorded on a wide host range including Zea in the **USA** (Farr *et al.*, 1989). **Not recorded in Australia**.

1 Standardised common names shown in bold according to 'Common Names for Plant Diseases 1994. Committee on Standardization of Common Names for Plant Diseases of the American Phytopathological Society 1978-1993'.

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PATHOGEN	DISEASE[1]	COMMENTS
Nematodes		
Belonolaimus longicaudatus Rau, 1958	**sting nematode**	Migratory ectoparasite inhabiting and restricted to light sandy soils. Nematode feeds ectoparasitically at the root tips and along the sides of the roots, resulting in a reduced root system, often with short stubby branches. In maize, gall like enlargements may be produced at the end of the main roots by the repeated killing of newly formed branches. Symptoms include severe stunting, leaf chlorosis and sometimes death (Orton Williams, 1974a). Even small populations can cause serious damage, as the nematode produces a powerful phytotoxic enzyme while feeding (Shurtleff, 1980). Major plant parasite in southeastern **USA**. Hosts include cereals, cotton, grasses, field crops, forage crops, fruit trees, ornamentals, trees, vegetables and weeds (Orton Williams, 1974a). Not recorded on maize, but **recorded** on citrus (NSW) and couch grass (WA), **in Australia** (McLeod *et al*., 1994).
Criconema mutabile (Taylor) Raski & Luc	**ring nematode**	Migratory ectoparasite. Recorded in Argentina (Brugni & Chaves, 1994), Bulgaria (Peneva & Choleva, 1987), Cameroon (Sakwe & Geraert, 1993), Canary Islands (Bello *et al*., 1994), India (Deswal & Bajaj, 1987), Italy (Coiro *et al*., (1991), Spain (Bello *et al*., 1988) and **USA** (McKenry *et al*., 1990). Recorded in association with apricot, banana, cypress, grapevine and Quercus. No information is available on the economic importance of this nematode. **Recorded** on maize (NSW) **in Australia** (McLeod *et al*., 1994).
Ditylenchus dipsaci (Kühn, 1857) Flipjev, 1936 (synonyms: *Anguillula dipsaci* Kühn, 1857; *Tylenchus dipsaci* (Kühn, 1857) Bastian, 1865; *Ditylenchus allii* (Beijerinck, 1883) Filipjev & Sch. Stek., 1941; *Ditylenchus phloxidis* Kirjanova, 1951; *Ditylenchus fragariae* Kirjanova, 1951; *Ditylenchus trifolii* Skarbilovich, 1958)	**bulb and stem nematode**	Migratory endoparasite that feeds on parenchymatous tissue in stems and bulbs, causing breakdown of the cell wall. Feeding often causes swellings and distortion of aerial plant parts, and necrosis or rotting of stem bases, bulbs, tubers and rhizomes. One of the most devastating plant parasitic nematodes, especially in temperate areas. Serious pest in Europe, Russia, **North** and South **America** and Australia. Known to attack over 450 plant species, including many weeds (Hooper, 1972). More than 10 biological races occur, some of which have a limited host range. The principal hosts are faba bean, garlic, *Hyacinthus orientalis*, leek, lucerne, maize, *Narcissus pseudonarcissus*, oat, onion, pea, *Phlox* spp., potato, rye, strawberry, sugarbeet, tobacco, clovers and tulip (Smith *et al*., 1997). Infested seed is produced in faba bean, clovers, lucerne, onion and teasel (Hooper, 1972). Not recorded on maize, but **recorded** on wide range of other crops **in Australia** (McLeod *et al*., 1994).

PATHOGEN	DISEASE[1]	COMMENTS
Dolichodorus heterocephalus Cobb, 1914	**awl nematode**	Ectoparasite normally inhabiting wet locations such as swamps, marshes and the edges of lakes and streams. This nematode has been recorded principally in the **USA**, where it is mainly confined to the eastern States, particularly Florida. Also recorded in South Africa. Although *Dolichodorus heterocephalus* can be devastating where it occurs, outbreaks are localised and it does not seem to be common or widespread enough to make it a pest of major importance. Field damage has been noted on celery, sweetcorn and water chestnut (Orton Williams, 1974b). Severe damage can result from relatively small populations (Shurtleff, 1980). **Not recorded in Australia**.
Filenchus exiguus (de Man) Ebsary (synonym: *Tylenchus exiguus* de Mann)		Migratory ectoparasite. No information is available on the economic importance of this nematode. **Recorded** on maize (Qld) **in Australia** (McLeod *et al*., 1994).
Filenchus filiformis (Butschli) Ebsary		Migratory ectoparasite. Recorded in the former Czechoslovakia (Saly, 1980), Lithuania (Shlepetene and Slepetiene, 1974), Russia (Pavlyuk, 1972) and Turkey (Ozturk & Okten, 1996). No information is available on the economic importance of this nematode. **Recorded** on maize (SA) **in Australia** (McLeod *et al*., 1994).
Gracilacus mutabilis (Colbran) Raski, 1962		Sedentary ectoparasite. No information is available on the economic importance of this nematode. **Recorded** on maize (Qld) **in Australia** (McLeod *et al*., 1994).
Helicotylenchus dihystera (Cobb, 1893) Sher, 1961 (synonyms: *Tylenchus dihystera* Cobb, 1893; *Tylenchus olaae Cobb, 1906*; *Tylenchus spiralis* Cassidy, 1930; *Aphelenchus dubius* var. *peruensis* Steiner, 1920; *Helicotylenchus nannus* Steiner, 1945; *Helicotylenchus crenatus* Das, 1960)	**spiral nematode**	Ecto or semi-endoparasite of the roots, with large populations occurring in the soil. It is an almost cosmopolitan and polyphagous nematode, and has been recorded in both **USA** and Australia. Wide host range, including maize (Siddiqi, 1972). Ring nematodes are considered to be moderate pathogens of maize at most, but may contribute to overall damage (Shurtleff, 1980). **Recorded** on maize (Qld) and a range of other plants (NSW, NT, Qld, SA, Tas., Vic., WA) **in Australia** (McLeod *et al*., 1994).
Helicotylenchus multicinctus (Cobb, 1893) Golden, 1956 (synonyms: *Tylenchus multicinctus* Cobb, 1893; *Tylenchorhynchus multicinctus* (Cobb, 1893) Micoletzky, 1922; *Anguillulina multicincta* (Cobb, 1893) T. Goodey, 1932; *Rotylenchus multicinctus*	**spiral nematode**	Parasite of the roots, occurring in the outer layers of the cortical tissue as well as in the adjacent soil. Widely distributed, including **USA** and Australia. This nematode is an important parasite of banana throughout the banana growing areas of the world. It is also recorded on avocado, cassava, citrus, cocoa, coffee, couch grass, grapevine, maize, mango, oilpalm, pawpaw, rice, rubber, sugarcane, sweet potato and tea (Siddiqi, 1973a). Ring nematodes are

PATHOGEN	DISEASE[1]	COMMENTS
(Cobb, 1893) Filipjev, 1936; *Rotylenchus iperoiguensis* Carvalho, 1956; *Helicotylenchus iperoiguensis* (Carvalho, 1956) Andrássy, 1958)		considered to be moderate pathogens of maize at most, but may contribute to overall damage (Shurtleff, 1980). **Recorded** on maize (Qld) and a range of other plants (NSW, NT, Qld, SA, WA) **in Australia** (McLeod *et al*., 1994).
Helicotylenchus pseudorobustus (Steiner, 1914) Golden, 1956 (synonyms: *Tylenchus pseudorobustus* Steiner, 1914; *Tylenchorhynchus robustus* var. *pseudorobustus* (Steiner, 1914) Micoletzky, 1922; *Helicotylenchus microlobus* Perry in Perry et al., 1959; *Helicotylenchus bradys* Thorne & Malek, 1968; *Helicotylenchus phalerus* Anderson, 1974)	spiral nematode	Has a worldwide distribution in both temperate and tropical countries, including Australia and **USA**. It is often associated with wild graminaceous plants. Hosts include maize, oats, barley, rye and wheat, as well as sugarbeet, red clover, soybean and potato. The nematode prefers fine textured soils with high percentages of silt and clay (Fortuner, 1985). Not recorded on maize, but **recorded** on Lycium (Vic.) and apple (WA) **in Australia** (McLeod *et al*., 1994).
Heterodera avenae Wollenweb., 1924 (synonyms: *Heterodera schachtii* var. *avenae* Wollenweber, 1924; *Heterodera schachtii* subsp. *maior* O. Schmidt, 1930; *Heterodera maior* (O. Schmidt, 1930) Franklin, 1940)	**cyst nematode;** cereal cyst nematode	Cosmopolitan. Occurs in **North America**, Europe, Western Siberia, India, Israel and North Africa. Maize is sometimes attacked, but it is not usually a good host (Williams & Siddiqi, 1972). This is an important pathogen of winter cereals in southeast Australia on Avena, Hordeum, Secale and Tricticum. Not recorded on maize, but **recorded** on winter cereals (NSW, SA, Tas., Vic., WA) **in Australia** (McLeod *et al*., 1994).
Heterodera zeae Koshy *et al*., 1970	**cyst nematode**; corn cyst nematode	Reported on maize in Egypt (Kheir *et al*., 1989), India (Bajaj & Gupta, 1994), Pakistan (Maqbool, 1981), Thailand (Chinnasri *et al*., 1995), and Maryland (Sardanelli *et al*., 1981) and Virginia (Eisenback *et al*., 1993) in the **USA**. Races of the nematode have been reported (Bajaj & Gupta, 1994). **Not recorded in Australia**.
Hoplolaimus columbus Sher, 1963	**lance nematode; Columbia nematode**	Root parasite exhibiting both ecto and endoparasitic habits. This nematode is an important parasite of soybean and cotton in Georgia and South Carolina in the **USA** (Fassuliotis, 1976). Weeds and cover crops serve as overwintering hosts (Fassuliotis, 1976). Wide host range, including maize (Lewis & Smith, 1976). **Not recorded in Australia**.
Hoplolaimus galeatus (Cobb, 1913) Thorne, 1935 (synonyms: *Nemonchus galeatus* Cobb, 1913; *Hoplolaimus coronatus* Cobb, 1923; *Hoplolaimus tylenchiformis* of Andrássy,	**lance nematode**	Ecto, semiendo, and endoparasite. Widely distributed in the USA on a variety of hosts, especially woody or graminaceous plants. Also recorded in Canada, Central America and India. It can cause serious damage to cotton, pine, oak, wheat and turf grasses (Orton Williams, 1973b). It has been associated with

PATHOGEN	DISEASE[1]	COMMENTS
1958)		reduction in yield of maize in Iowa in the USA (Norton & Hinz, 1976). Particularly abundant on maize in sandy soils (Shurtleff, 1980). **Not recorded in Australia**.
Longidorus breviannulatus Norton & Hoffman, 1975	**needle nematode**	Ectoparasite. It can be a devastating pathogen of maize. Occurs mainly in temperate regions around the world. *Longidorus breviannulatus* is known to attack maize in Delaware, Illinois and Iowa in the **USA**. Maize, grasses, potato, celery, grape, lettuce, and many other plants are hosts of this nematode (Shurtleff, 1980). **Not recorded in Australia**.
Macroposthonia ornata (Raski, 1958) de Grisse & Loof, 1965 (Synonym: *Criconemella ornata* (Raski, 1958) Luc & Raski, 1981)	**ring nematode**	Ectoparasite. This nematode has a wide host range and causes damage on several crops. Although it frequently occurs in abundance on maize, particularly in the southeastern **USA**, the extent of damage by this nematode to maize crops has not been determined (Shurtleff, 1980). **Recorded** on maize (Qld), citrus, ginger and a range of other crops **in Australia** (McLeod *et al*., 1994).
Meloidogyne arenaria (Neal, 1889) Chitwood, 1949 (synonym: *Anguillula arenaria* Neal, 1889)	root-knot nematode	Sedentary endoparasite. Found in most of the warmer regions of the world ranging from parts of Canada, the **USA**, Central and South America, through the countries bordering on the Mediterranean, Central and South Africa, the Middle East, India, Malaysia to Japan and Australia. In cooler climates it is frequently found in greenhouses. Although widespread, it is not as common as *Meloidogyne incognita* and *Meloidogyne javanica*. Hosts include cereals, field crops, grasses, ornamentals, pasture legumes, and vegetables (Orton Williams, 1975). Can be a serious pest of maize (Shurtleff, 1980). Not recorded on maize, but **recorded** on a wide range of other plants **in Australia** (McLeod *et al*., 1994).
Meloidogyne chitwoodi Golden *et al*., 1980	**root-knot nematode**	Sedentary endoparasite. Major problem in potato crops in Pacific Northwest of **USA**. Infects wheat and maize grown in rotation with potatoes. This nematode can reproduce on maize and reduce its productivity (Jepson, 1985). **Not recorded in Australia**.
Meloidogyne incognita (Kofold & White, 1919) Chitwood, 1949 (synonyms: *Oxyuris incognita* Kofold & White, 1919; *Meloidogyne incognita* var. *acrita* Chitwood, 1949)	**root-knot nematode**	Sedentary endoparasite. This nematode is of major economic significance throughout the tropics and warmer regions of the world. Distribution includes Africa, Australia, Central and South America, India, Japan, Malaysia, **USA** and glasshouses in northern Europe, Canada and USSR. Attacks many cereals, grasses, ornamentals, pasture legumes, potato, shrubs and trees, sugarcane,

PATHOGEN	DISEASE[1]	COMMENTS
		tobacco, vegetables and weeds (Orton Williams, 1973a). In tropical areas, root-knot nematodes are usually the most serious nematode pathogens of maize, and *Meloidogyne incognita* is the most important species (Shurtleff, 1980). **Recorded** on maize (NSW), and widespread on a variety of plants, **in Australia** (McLeod *et al*., 1994).
Meloidogyne javanica (Treub, 1885) Chitwood, 1949 (synonyms: *Heterodera javanica* Treub, 1885; *Tylenchus javanica* (Treub, 1885) Cobb, 1890; *Anguillula javanica* (Treub, 1885) Lavergne, 1901)	**root-knot nematode**	Sedentary endoparasite. Widely distributed in warm and tropical climates where it is often the dominant root-knot nematode at higher altitudes. Range includes Africa, Australia, Brazil, Sri Lanka, Colombia, Cyprus, India, Israel, Malaysia, Pakistan, Spain, Trinidad, **USA** and glasshouses in northern Europe. Over 770 host species or varieties are recorded, many of economic importance such as cereals, fruit trees, grapevines, many legumes, ornamentals, potato, tea, tobacco, tomato and vegetables (Orton Williams, 1972). Has been recorded damaging maize in almost all maize growing regions of the world (Luc *et al*., 1990). **Recorded** on maize (NSW, SA), and widespread on a variety of plants **in Australia** (McLeod *et al*., 1994).
Nacobbus dorsalis Thorne & Allen	**false root-knot nematode**	There is little information on the significance and distribution of this nematode. It has been reported on maize (APS, 1994) in the **USA** and has caused severe damage to sugar beet crops in California (Steele, 1984). **Not recorded in Australia**.
Neopsilenchus magnidens (Thorne) Thorne & Malek		No information is available on the economic importance of this nematode. **Recorded** on maize (Qld) **in Australia** (McLeod *et al*., 1994).
Paratrichodorus christiei (Allen, 1957) Siddiqi, 1974 (synonym: *Trichodorus christie* Allen, 1957)	**stubby-root nematode**	An ectoparasite found mainly in sandy soil. Widespread in the **USA**, with a wide host range. Also recorded in Afghanistan, Belgium, Brazil, Germany, New Zealand, Philippines, Puerto Rico, South Africa and Taiwan (Heyns, 1975). Feeding at or near root tips, this nematode can be very damaging to maize by devitalising the root tips and causing extensive “stubby-root” symptoms. Stubby-root and sting nematodes frequently occur together, the two forms comprising the most serious nematode pathogens of maize in southeastern **USA** (Shurtleff, 1980). **Not recorded in Australia**. Some authorities consider that this species is a junior synonym of *Paratrichodorus minor* (Hooper, 1977).
Paratrichodorus lobatus (Colbran, 1965) Siddique, 1974	stubby root nematode	Ectoparasite. Recorded in Australia (Stirling, 1976), New Zealand (Sturhan *et al*., 1997) and South Africa rice (Van den Berg & De Waele, 1989). Hosts

PATHOGEN	DISEASE[1]	COMMENTS
		include apricot, citrus, peach (Stirling, 1976) and rice (Van den Berg *et al*., 1989). **Recorded** on maize (SA), and a wide range of other plants (NSW, Qld, SA, Vic., WA), **in Australia** (McLeod *et al*., 1994).
Paratrichodorus minor (Colbran, 1956) Siddiqi, 1974 (synonym: *Trichodorus minor* Colbran, 1956)	**stubby-root nematode**	A migratory root ectoparasite that occurs mainly in warmer soils. Recorded in Australia, Brazil, Egypt, Indonesia, Japan, India, Israel, Mauritania, Netherlands, Nicaragua, Senegal, Sweden, Switzerland, Trinidad and Venezuela. Causes severe stubby root damage to tomato. Although found associated with a wide selection of plants, they are not necessarily all hosts, and apart from tomato, there is little evidence of *Paratrichodorus minor* causing much root damage. However, as it is polyphagous, it should be regarded as a potentially serious root pathogen (Hooper, 1977). **Recorded** on maize (Qld), and widespread on a variety of plants, **in Australia** (McLeod *et al*., 1994).
Pratylenchus brachyurus (Godfrey, 1929) Filipjev & Schuurmans Stekhoven, 1941 (synonyms: *Tylenchus brachyurus* Godfrey, 1929; *Anguillulina brachyura* (Godfrey, 1929) Goodey, 1932; *Pratylenchus pratensis* of Thorne, 1940; *Pratylenchus leiocephalus* Steiner, 1949; *Pratylenchus steineri* Lordello *et al*., 1954)	**lesion nematode;** root lesion nematode	Widely distributed throughout the tropics (Corbett, 1976). This endoparasite is a well-known pathogen of maize in **USA**. Poor root growth, necrotic root lesions, root decay, and moderate stunting are the typical symptoms. Maize, grasses, cereals, sugarcane, legumes, tobacco, tomato, potato, strawberry, tree fruits, and pines are hosts of this nematode (Shurtleff, 1980). **Recorded** on maize (Qld), and widespread on a variety of plants **in Australia** (McLeod *et al*., 1994).
Pratylenchus crenatus Loof	**lesion nematode**	An endoparasitic nematode recorded on maize in the **USA** (APS, 1994), and South Africa (Jordaan *et al*., 1989). Not recorded on maize, but **recorded** on *Lolium perrenne*, *Vitis vinifera* (NSW), *Vicia faba* (Tas.), *Acer palmatum*, *Daucus carota*, *Humulus lupulus*, *Malus domestica*, *Prunus avium*, *Telopea speciosissima*, *Vitis vinifera* (Vic.), and *Avena sativa* (WA) **in Australia** (McLeod *et al*., 1994).
Pratylenchus hexincisus Taylor & Jenkins, 1957	**lesion nematode;** root lesion nematode	This endoparasitic nematode has been associated with maize yield reductions in Iowa (**USA**) (Norton & Hinz, 1976) Maize, grasses, soybean, tomato and tree fruits are hosts of this nematode (Shurtleff, 1980). Not recorded on maize, but **recorded** on wheat (NSW) **in Australia** (McLeod *et al*., 1994).
Pratylenchus neglectus (Rensch, 1924) Filipjev & Schuurmans Stekhoven, 1941	**lesion nematode;** root lesion nematode	Migratory endoparasite. Found in temperate regions and reported from Australia, Canada, Europe, India, Japan, South Africa and **USA**. Primarily a

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(synonyms: *Aphelenchus neglectus* Rensch, 1924; *Tylenchus neglectus* (Recsch, 1924) Steiner, 1928; *Anguillulina neglectus* (Rensch, 1924) W. Schneider, 1939; *Pratylenchus minyus* Sher & Allen, 1953)		parasite of grasses including cereals, forage, turf and wild grasses. Also attacks a range of other crops such as crucifers, flowers, fruit trees, legumes, peppermint, strawberry and tobacco (Townshend & Anderson, 1976). This nematode has been found on maize in **USA**, but is not a pathogen (Shurtleff, 1980). Not recorded on maize, but **widespread** on a variety of plants **in Australia** (McLeod *et al*., 1994).
Pratylenchus penetrans (Cobb, 1917) Chitwood & Oteifa, 1952 (synonyms: *Tylenchus gulosus* Kühn, 1890; *Tylenchus penetrans* Cobb, 1917; *Tylenchus pratensis* Steiner, 1927; *Anguillulina pratensis* in Goodey, 1932 & 1933)	**lesion nematode;** root lesion nematode	Recorded on over 350 hosts, mainly in temperate areas, in Australia, Canada, Egypt, Europe, India, Japan, New Zealand, Peru, Philippines, Rhodesia, Russia, South Africa, Tunisia and **USA**. It is a major pest of fruit and conifer nurseries and causes serious losses in tobacco, apple, cherry and roses. It is frequently associated with "soil sickness" and some forms of "replant disease". This nematode is essentially a parasite of the root cortex, but in later stages of attack it penetrates and damages the vascular tissues of some hosts (Corbett, 1973). It is a well-known pathogen of maize, causing poor root growth, necrotic root lesions, root decay, and moderate stunting (Shurtleff, 1980). Not recorded on maize, but **widespread** on a variety of plants, **in Australia** (McLeod *et al*., 1994).
Pratylenchus scribneri Steiner, 1943	**lesion nematode;** root lesion nematode	Widespread in the **USA**. Also recorded in Africa, Bulgaria, Egypt, India, Israel, Japan, Mexico, Netherlands, Nigeria, Sweden and Turkey. Wide host range including apple, barley, cowpea, fescue, lucerne, maize, onion, peach, potato, roses, strawberry, sorghum, soybean, Sudan grass, sugarcane, sweet potato, tobacco, tomato, water melon and white clover. Maize is reported to be a good host of this nematode (Loof, 1985). **Not recorded in Australia**.
Pratylenchus thornei Sher & Allen, 1953	**lesion nematode;** root lesion nematode	Occurs in Australia, Belgium, Egypt, Germany, Iran, Italy, Japan, Mexico, Netherlands, South Africa, **USA** and Yugoslavia. It is an important root parasite of wheat. Occurs on a range of other hosts, including maize (Fortuner, 1977). Not recorded on maize, but **widespread** on a variety of plants **in Australia** (McLeod *et al*., 1994).
Pratylenchus zeae Graham, 1951	**lesion nematode;** root lesion nematode	Occurs in Brazil, Cuba, Egypt, Hawaii, India, Iraq, Ivory Coast, Madagascar, Panama, Rhodesia, Senegal, South Africa, Trinidad and **USA**. *Pratylenchus zeae* is a pest of maize, rice, sugarcane and tobacco, and also occurs on a wide range of other plants. It is a migratory endoparasite of the root cortex (Fortuner, 1976). It is a well-known pathogen of maize in **USA** (Shurtleff,

PATHOGEN	DISEASE[1]	COMMENTS
		1980). **Recorded** on maize (Qld), and a wide range of other plants (NSW, NT, Qld and Vic.), **in Australia** (McLeod *et al*., 1994).
Punctodera chalcoensis Stone *et al*., 1976	**cyst nematode**	Reported only from Mexico on maize. Only other known host is *Zea mexicana*. Maize crops are damaged in heavily infested fields (Stone *et al*., 1976). **Not recorded** in **USA** or **Australia**.
Quinisulcius acutus (Allen, 1955) Siddiqi (synonym: *Tylenchorhynchus acutus* Allen, 1955)	**stubby-root nematode**	Reported from subtropical **USA** on maize, sorghum, soybean, sweet potato and wheat. **Not recorded in Australia**.
Radopholus similis (Cobb, 1893) Thorne, 1949 (synonyms: *Tylenchus similis* Cobb, 1893; *Anguillulina similis* (Cobb, 1893) Goodey, 1932; *Rotylenchus similis* (Cobb, 1893) Filipjev, 1936; *Tylenchus granulosus* Cobb, 1893; *Anguillulina granulosa* (Cobb, 1893) Goodey, 1932; *Bitylenchus granulosus* (Cobb, 1893) Filipjev, 1934; *Tetylenchus granulosus* (Cobb, 1893) Filipjev, 1936; *Tylenchus acutocaudatus* Zimmermann, 1898; *Anguillulina acutocaudatus* (Zimmermann, 1898) Goodey, 1932; *Tylenchus biformis* Cobb, 1909; *Anguillulina biformis* (Cobb, 1909) Goodey, 1932)	**burrowing nematode**	Widely distributed in tropical and subtropical regions around the world and present in glasshouses in Europe (Orton Williams & Siddiqi, 1973). It is restricted to Florida in the **USA**. Migratory endoparasite, causing development of cavities in root cortex. It can produce serious damage to maize, causing cortical lesions, root decay, and stunting of the plant. This nematode has a wide host range among crop and weed plants, but is most important on citrus and banana (Shurtleff, 1980). **Recorded** on maize (Qld), and widespread on a variety of plants (NSW, NT, Qld, SA, WA) **in Australia** (McLeod *et al*., 1994).
Rotylenchulus parvus (Williams, 1960) Sher, 1961 (synonym: *Helicotylenchus parvus* Williams, 1960)	reniform nematode	Sedentary semi-endoparasite. Immature females invade the roots, but only the anterior section penetrates the root tissue, the posterior part remaining in the soil and becoming obese (Luc *et al*., 1990). Widespread in eastern and southern Africa. Also recorded in Mauritius and California (**USA**). Hosts include cotton, maize, munga, papaya, sugarcane, sunhemp and tobacco. Common pest on maize (Heyns, 1976). **Recorded** on maize and a variety of other plants (Qld) **in Australia** (McLeod *et al*., 1994).
Tylenchorhynchus dubius (Butschli, 1873) Filipjev, 1936 (synonyms: *Tylenchus dubius* Bütschli, 1873; *Anguillulina dubia* (Bütschli, 1873) Goodey, 1932)	**stunt nematode**	One of the most commonly occurring plant-parasitic nematodes associated with crops in Europe. It is infrequently found in the **USA**. Also recorded in India. Browsing ectoparasite that feeds on epidermal cells and root hairs of growing roots. Characteristically found in sandy soils. Wide host range,

PATHOGEN	DISEASE[1]	COMMENTS
		including maize (Bridge, 1974). Not recorded on maize, but **one record** in SA on an unknown host **in Australia** (McLeod *et al*., 1994).
Xiphinema americanum Cobb, 1913 (synonym: *Tylencholaimus americanus* (Cobb, 1913) Micoletzky, 1922)	**dagger nematode**	Common and widely distributed in agricultural and forest soils in **USA**. Also recorded in Australia, British Honduras, Chile, India, Mexico, New Zealand, Pakistan, Poland and Sri Lanka (Siddiqi, 1973b). Ectoparasite, causing reduction of feeder roots, root decay, stunting and chlorosis. Although pathogenicity has been demonstrated on only a few crops, such as alfalfa and red clover, this nematode is considered to be an important pest. Wide host range, including maize (Shurtleff, 1980). Not recorded on maize, but **widespread** on a variety of plants (NSW, NT, Qld, SA, WA), **in Australia** (McLeod *et al*., 1994).
Xiphinema mediterraneum Lima	**dagger nematode**	An ectoparasite which feeds by inserting its style into roots. **Not recorded in Australia**.

1 Standardised common names shown in bold according to 'Common Names for Plant Diseases 1994. Committee on Standardization of Common Names for Plant Diseases of the American Phytopathological Society 1978-1993'.

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PATHOGEN	DISEASE[1]	COMMENTS
Phytoplasmas		
Maize bushy stunt phytoplasma	Maize bush stunt; Mesa central strain of corn stunt; achaparramiento	The disease occurs in southern **USA**, Peru and Colombia (Nault, 1983), but serious losses have not been reported. It develops at higher altitudes than corn stunt (Nault, 1983). Maize and teosinte are the only hosts (Nault, 1980). *Dalbulus* spp. of leafhopper are the only known vectors (Madden & Nault, 1983). **Not recorded on maize in Australia**.
Spiroplasma kunkelii Whitcomb *et al.*	**Corn stunt; achapparramiento; maize stunt; Mesa Central or Rio Grande maize stunt**	This is an important disease in lowlands of tropical central and south America (Nault, 1983). It has been reported in the **USA** (Texas, Louisiana, California, and Florida), but only as a minor disease (Bradefute *et al.*, 1981). Spreads in El Salvador, Mexico, Venezuela, Peru and Jamaica (McGee, 1994). Strains occur in Florida (Chen & Tsai, 1982) and California (Kloepper *et al.*, 1982). In newly infested areas, yield losses of 25-100% may occur. Maize and its wild teosinte relatives are the only known hosts of corn stunt (Chen & Tsai, 1982). **Not recorded on maize in Australia**.

1 Standardised common names shown in bold according to 'Common Names for Plant Diseases 1994. Committee on Standardization of Common Names for Plant Diseases of the American Phytopathological Society 1978-1993'.

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PATHOGEN	DISEASE	COMMENTS
Viruses		
Barley yellow dwarf luteovirus (BSMV)	barley yellow dwarf	Reported on maize from **USA** and Europe (Osler *et al*., 1985). It is a major pathogen of cereals and is distributed worldwide. The disease is of no importance on maize in the USA, but infected maize may be important as a virus reservoir for other crops (Brown *et al*., 1984). No report of being seed-borne or of transmission by seed. Transmission occurs by aphids in a persistent manner. In eastern Washington, the virus overwinters in cereals and oversummers in maize (Brown *et al*., 1984). Not recorded on maize, but **recorded** on wide range of grasses (NSW, Qld, SA, Tas., Vic., WA) **in Australia** (Buchen-Osmand *et al*., 1988). Found in the south-east of Queensland; coastal New South Wales; in all districts of Victoria; Tasmania (only the serotypes PAV and RPV); South Australia; and in Western Australia (Buchen-Osmand *et al*., 1988).
Brome mosaic bromovirus (BMV) (synonyms: Weidelgrasmosaikvirus; ryegrass streak virus; trespengrasmosaikvirus)	brome mosaic	Spreads in Eurasian region (eastern) **Australia**, South Africa, and the **USA** (Brunt *et al*., 1996), but reported on maize only in the USA (Ford *et al*., 1970). No report of being seed-borne, or of transmission by seed. Under laboratory conditions, nematodes of *Xiphinema* genus transmitted the virus (Brunt *et al*., 1996). Attempts to transmit the virus with aphids and mites have been unsuccessful (Brunt *et al*., 1996).
Cereal chlorotic mottle nucleorhabdovirus (CCMV)	cereal chlorotic mottle	Spreads in **Australia** (Greber, 1979) and Morocco (Brunt *et al*., 1996). *Avena sativa*, *Digitaria ciliaris*, *Dinebra retroflexa*, *Echinochloa colona*, *Hordeum vulgare*, *Setaria verticillata*, *Triticum aestivum* and *Zea mays* are the natural hosts of this virus (Brunt *et al*., 1996). CCMV causes fine chlorotic striations on leaves, stunting and tassel sterility in susceptible maize. Leafhoppers (*Cicadulina bimaculata*) spread the virus into maize from grass hosts, e.g. *Digitaria ciliaris* and *Echinochloa colona*. Incidence normally is about 1% in late season crops. However, this may be as high as 50% if fields are infested with susceptible grasses (Greber, 1979). Epidemics in maize are usually associated with high populations of *C. bimaculata* during hot summer weather (Persley, 1991). No report of being seed-borne or of transmission by seed. The virus is spread by the insect vectors *Nesoclutha pallida*, *Cicadula bimaculata* and *Cicadulina bipunctata* subsp. *bipunctella* (Brunt *et al*., 1996). **Recorded** on maize (NSW) **in Australia**.

PATHOGEN	DISEASE	COMMENTS
Chloris striate mosaic mastrevirus (CSMV) (synonym: Australian wheat striate mosaic virus)	striate mosaic	**Spreads in Australia** (Brunt *et al*., 1996). Natural host range confined to grasses including *Chloris gayana*, *Ixophorus unisetus* and *Dactylis glomerata* and the cereals *Triticum* spp., *Avena sativa*, *Hordeum vulgare* and *Zea mays* (Grylls, 1963; Greber, 1977). Transmitted persistently by the leafhopper *Nesoclutha pallida* (Grylls, 1963). No information on transmission through seed (Francki & Hatta, 1980). No information on crop losses caused by this virus.
Cucumber mosaic cucumovirus (CMV)	cucumber mosaic	The virus is distributed **worldwide**, but has only been reported on maize in the **USA**, and is a minor disease. No report of being seed-borne or of transmission by seed. Transmission occurs non-persistently by several aphid species. Not recorded on maize, but **recorded** on a wide range of other plants (NSW, Qld, SA, Tas., Vic., WA) **in Australia** (Buchen-Osmand *et al*., 1988).
Cynodon chlorotic streak nucleorhabdovirus (CCSV)	Cynodon chlorotic streak	Spreads in France, Iran, Jordon, Morocco, Spain, and Tunisia (Brunt *et al*., 1996). No information is available on incidence or losses (Lockhard *et al*., 1985). No report of being seed-borne or of transmission by seed. Transmitted by the planthopper, *Toya propinqua*. *Cynodon dactylon* and *Zea mays* are the natural hosts of this virus (Brunt *et al*., 1996). **Not recorded in Australia**.
Guinea grass mosaic potyvirus (GGMV) (Strains: GGMV-Strain B from maize; GGMV-Strain D from pearl millet; Brachiaria strain (Brunt *et al*., 1996))	Guinea grass mosaic	Spreads in Brazil, Colombia and Ivory Coast (Brunt *et al*., 1996). No information is available on incidence or losses (Lamy *et al*., 1979). *Panicum maximum*, *Pennisetum americanum* and *Zea mays* are the natural hosts of this virus (Brunt *et al*., 1996). No report of being seed-borne or of transmission by seed. Transmitted persistently by *Hysteroneura setariae* and *Rhopalosiphum maidis*; Aphididae (Brunt *et al*., 1996). **Not recorded in Australia**.
High Plains virus	High Plains disorder	The disease has been reported from the **USA** (Texas, western Kansas, northeastern Colorado and central Idaho, Nebraska and Utah) (Brown *et al*, 1994; Jardine *et al*., 1994; Jensen & Leslie, 1994). The virus was first found in wheat and maize plants from Texas and Idaho, and in 1994 the disease was observed in Kansas and Colorado. By the end of 1995, HPV had been confirmed in maize and wheat samples from nearly 100 counties in an area extending from the Texas panhandle to eastern Nebraska, to central South Dakota, to western Idaho and back through Colorado to eastern New Mexico and Texas (Jensen *et al*., 1996). Since then, it has been found more frequently over a much wider area, probably due to greater awareness and surveillance (Marcon *et al*., 1997). Yield losses to 75% have been reported from USA

PATHOGEN	DISEASE	COMMENTS
		(Jensen *et al*., 1996). Systemic spread of the virus appears to be important in the severity of the disease and potential crop yield loss. Seed transmission of the virus has been demonstrated in sweetcorn (Forster *et al*., 1996). The vector of this virus is the wheat curl mite, *Aceria tosichella* (Seifers *et al*., 1997). Hosts include barley, maize, oat, rye and wheat, as well as the grasses *Bromus secalinus*, *Setaria glauca* and *Setaria viridis* (Seifers *et al*., 1998). Importation of the disease through seed poses a serious economic threat to both the maize and wheat industries in Australia. HPV is a devastating virus in susceptible maize genotypes. **Not recorded in Australia**.
Johnsongrass mosaic potyvirus (JGMV) (synonym: maize dwarf mosaic virus - strain O; sugarcane mosaic virus - Australian Johnson grass virus; maize dwarf mosaic – Kansas I strain)	Johnson grass mosaic	First reported in Johnson grass and maize from Australia (Brunt *et al.*, 1996). **Spreads in Australia and the USA** (Brunt *et al*., 1996). Natural hosts are Johnson grass, maize and a number of grasses (Brunt *et al*., 1996). Transmitted in a non-persistent manner by *Aphis craccivora*, *A. gossypii* and *Rhopalosiphum maidis*. Not transmitted by seed (Brunt *et al*., 1996). This virus has a restricted distribution in Victoria and the Northern Territory (Persley, 1991).
Maize chlorotic dwarf waikavirus (MCDV) (synonym: Ohio corn stunt agent)	maize chlorotic dwarf	First reported in maize from Ohio, **USA** (Brunt *et al.*, 1996). Spreads in southern USA. Johnsongrass and maize are the natural hosts of this virus (Brunt *et al.*, 1996). The virus is transmitted semi-persistently by *Graminella nigrifrons*, *G. sonora* and *Exitianus exitiosus*. Not seed-borne. **Not recorded in Australia**.
Maize chlorotic mottle machlomovirus (MCMV)	maize chlorotic mottle	First reported in maize from Peru (Brunt *et al.*, 1996). Spreads in Argentina, Mexico, Peru and the **USA** (Kansas, Nebraska and Hawaii) (Brunt *et al.*, 1996). Maize is the natural host. Transmitted in a non-persistent manner by *Diabrotica* spp. and thrips, but the vectors are not known to move the virus over long distance (Jensen, 1985). Seed to seedling transmission at low level (Jensen *et al.*, 1991). Seed transmission makes MCMV a threat to the maize industry in Australia. **Not recorded in Australia**.
Maize dwarf mosaic potyvirus (MDMV), (synonym: MDMV-A; MDMV-D; MDMV-E; MDMV-F)	maize dwarf mosaic	First reported in maize in Ohio, USA (Brunt *et al.*, 1996). Spreads in China, South Africa and **USA** (Brunt *et al.*, 1996). The important natural hosts are *Zea mays*, *Sorghum bicolor* and *S. halepense*. The virus is ***seed-borne*** and seed transmitted (Mikel *et al.*, 1984). The disease is important in the USA where yield losses have been reported (Gregory & Ayers, 1982). MDMV is spread in maize crops by transient winged (alate) aphids (Vangessel, 1993). Alate

PATHOGEN	DISEASE	COMMENTS
		behaviour, consisting of many short flights with frequent probing, has been related to dispersal rather than to host finding. Strong correlations have been demonstrated between aphid numbers in traps and the incidence of MDMV (Vangessel, 1993). **Not recorded in Australia**.
Maize eyespot virus	maize eye spot	First reported in maize from Ivory Coast. Maize is the only natural host. Spreads in the Ivory coast (Brunt *et al*., 1996). **Not recorded in Australia**.
Maize gooseneck stripe virus	maize gooseneck stripe	Reported once from Kenya and Tanzania. No information is available on incidence or losses (Kulkarni, 1973). No report of being seed-borne or transmission by seed. Transmitted by the planthopper, *Peregrinus maidis*. **Not recorded in Australia**.
Maize Iranian mosaic nucleorhabdovirus	maize Iranian mosaic	First reported in maize from Shiraz, Iran (Brunt *et al*., 1996). Spreads in Iran. Natural hosts include *Echinochloa* spp., *Sorghum sudanense* and *Zea mays* (Brunt *et al*., 1996). Transmission occurs persistently by *Unkanodes tanasijevici* and *Laodelphax striatellus*. Not transmitted by seeds (Brunt *et al*., 1996). **Not recorded in Australia**.
Maize line virus	maize line	First reported in maize (in complex with maize stripe tenuivirus) from Tanzania (Brunt *et al*., 1996). Maize is the natural host of this virus. Spreads in Kenya and Tanzania (Brunt *et al*., 1996). No information is available on incidence or losses (Kulkarni, 1973). No report of being seed-borne, or of transmission by seed. Transmitted persistently by the planthopper, *Peregrinus maidis* (Brunt *et al*., 1996). **Not recorded in Australia**.
Maize mosaic nucleorhabdovirus (MMV) (synonym: virus del enanismo rayado maiz, maize stripe Indian virus, sorghum chlorosis virus, *Zea mays* virus; Brazilian maize mosaic virus; Corn chlorotic vein banding virus)	maize mosaic; corn chlorotic vein banding; enanismo rayado; corn stripe; sweet corn mosaic	First reported in maize from Colombia (Brunt *et al*., 1996). *Pennisetum*, *Sorghum* and *Zea mays* are the natural hosts of this virus. Spreads in Colombia, Costa Rica, Fiji, India, Mauritius, Mexico, Peru, Spain, Tanzania, Carabin Islands and the **USA** (Brunt *et al*., 1996). Transmitted persistently by the planthopper, *Peregrinus maidis* (Brunt *et al*., 1996). The disease causes severe losses in the tropics and subtropics. When grown continuously in wet areas, entire fields may be dwarfed with no harvestable ears (Brewbaker, 1979). It has been reported in the USA several times between 1974-1983, but has not become a significant problem (Bradfute & Tsai, 1983). This virus is reported on maize (NSW, NT, Qld, Tas., Vic., WA) in Australia (Büchen-Osmond *et al*., 1988), but is not listed as occurring in Australia by Greber (1983). Persley (pers. com.) suggests that confusion over symptoms caused by maize mosaic

PATHOGEN	DISEASE	COMMENTS
		nucleorhabdovirus and maize stripe tenuivirus could be responsible for this situation, and advises that further clarification is necessary before this virus is listed for Australia.
Maize mottle/chlorotic stunt virus (synonym: maize mottle virus)	maize mottle/chlorotic stunt	First reported in maize from Tanzania (Brunt *et al.*, 1996). Spreads in Nigeria, Rwanda, Sao Tome and Principe, Tanzania, Togo, Zambia, and Zimbabwe (Brunt *et al.*, 1996). Maize is the natural host of this virus. Transmitted persistently by *Cicadulina mbila*, *C. zeae*, *C. storeyi* and *C. triangula* (Brunt *et al.*, 1996). **Not recorded in Australia**.
Maize raya gruesa virus	maize raya gruesa	This is part of a complex of virus diseases in Colombia, including maize stripe, and maize rayado fino, that cause yield losses up to 50% (Varon de Agudelo *et al*., 1983). No report of being seed-borne, or transmission by seed. Transmitted persistently by *Perigrinus maidis*. **Not recorded in Australia**.
Maize rayado fino marafivirus (MRFV) (synonym: maize rayado Colombian strain, Brazilian corn streak strain)	maize rayado fino; maize Colombian stripe, Brazilian corn streak, fine striping disease	First reported in maize from El Salvador (Brunt *et al.*, 1996). Initially described as a strain of corn stunt. Spreads in Argentine, Brazil, Colombia, Costa Rica, Mexico, Peru, Venezuela and southern **USA**. *Zea mays* and teosinte are the natural hosts of this virus (Brunt *et al.*, 1996). No report of being seed-borne or of transmission by seed. Transmitted persistently by *Dalbulus maidis*. This is a major problem in central America with yield losses up to 40-50% (Toler *et al*. 1985). It was first reported in the USA in Florida and Texas (Bradfute *et al*. 1980), where it is considered potentially important because of the susceptibility of north American maize germplasm. The pathogen is not seed-borne, but it can be detected serologically in the vectors (Gordon *et al*. 1985). Transmission occurs persistently by *Dalbulus maidis* and four planthoppers (Toler *et al*. 1985). Three strains have been reported (Toler *et al.* 1985). **Not recorded in Australia**.
Maize rough dwarf fijivirus (MRDV) Strains: cereal tillering disease strain (CTD); mal de Rio Curato (MR 4). (synonym: virus del nanismo ruvido del mais)	maize rough dwarf	First reported in maize from Israel (Brunt *et al.*, 1996). Spreads in Argentina, former Czechoslovakia, France, Israel, Italy, Norway, Spain, Sweden and the former Yugoslavia (Brunt *et al.*, 1996). It has also been reported from Iran (Izadpanah *et al*., 1983) and China (Yang & Ma, 1983). This virus became important in Europe and Israel after the introduction of US hybrids (Milne & Lovisolo, 1977). Severe losses occurred in Argentina (Milne *et al*., 1983). Not seed-borne or seed transmissible. Transmitted persistently by *Delphacodes propinqua*, *Dicranotropis hamata*, *Laodelphax striatellus*, *Javasella pellucida* and *Sogatella vibix*. Natural hosts of this virus include Avena, Hordeum,

PATHOGEN	DISEASE	COMMENTS
		Triticum, millet, and Zea (Brunt *et al.*, 1996). **Not recorded in Australia**.
Maize sterile stunt rhabdovirus	maize sterile stunt	This disease only occurs in **Australia** (NSW, Qld). Maize sterile stunt virus affects only a limited number of maize lines with B37 and related genotypes being particularly susceptible (Persley, 1991). Symptoms include severe stunting, sterility, purple colouration and top necrosis. The virus and vector are common in grass hosts such as *Echinochloa colona* (Persley, 1991). Incidence can be 100% with complete economic loss (Greber, 1982). Hordeum, Triticum, Triticale and *Zea mays* are the natural hosts of this virus (Greber, 1982). The virus is transmitted by planthopper, *Sogatella longifurcifera* (Persley, 1991). The disease is of minor importance in commercial crops as highly susceptible material is identified in screening trials (Persley, 1991) .
Maize streak dwarf nucleorhabdovirus	maize streak dwarf	First reported in maize from China (Brunt *et al.*, 1996). Spreads in the Gansu Province of China (Brunt *et al.*, 1996). Maize is the natural host of this virus. Transmitted persistently by *Laodelphax striatellus* (Brunt *et al.*, 1996). **Not recorded in Australia**.
Maize streak monogeminivirus (MSV) (synonym: bajra streak virus; cereal African streak virus; maize streak A virus)	maize streak	First reported in maize from South Africa. Spreads in Africa, India, Madagascar and Yemen (Brunt *et al.*, 1996). This is a major disease throughout Africa and yield losses up to 100% have been reported (van Rensburg, 1981). Four strains have been reported: maize strain, *Panicum maximum* strain, sugarcane strain and *Digitaria setigera* strain. No report of being seed-borne or transmission by seed. Transmission occurs persistently by leafhoppers in the *Cicadulina* genus (Rose, 1978). **Not recorded in Australia**.
Maize stripe tenuivirus (MSpV) (synonyms: maize chlorotic stripe virus; maize hoja blanca virus; sorghum chlorosis virus)	maize stripe; maize hoja blanca, hoja blanca del maiz; Tsai's disease	First reported in maize from Florida, **USA** (Brunt *et al.*, 1996). MSpV causes broad chlorotic stipes on leaves and bending of the apical growth. This is an important disease in Venezuela (Lastra & Carballo, 1984) and is a localised problem in Florida in the USA (Gingery *et al.*, 1979). This disease is common on maize and sweetcorn **in Australia** in coastal regions of northern New South Wales and Queensland, but the incidence in crops is usually low (Persley, 1991). Seed infection does not occur, but the pathogen can be detected in plant tissues serologically (Falk & Tsai, 1982). Transmitted by the planthopper, *Perigrinus maidis* (Gingery *et al.*, 1979). *Sorghum bicolor* and *Zea mays* are the natural hosts of this virus (Brunt *et al.*, 1996).
Maize vein enation virus	maize vein enation	This disease was reported in India in 1976. Transmitted persistently by

PATHOGEN	DISEASE	COMMENTS
		Cicadulina mbila (Ahlawat & Raychaudhuri, 1976). **Not recorded in Australia**.
Maize white line mosaic satellivirus	maize white line mosaic	First reported in maize from the **USA** (Brunt *et al.*, 1996). Spreads in the USA (Ohio) and France (Brunt *et al.*, 1996). Maize is the natural host. Found only in complex with maize white line mosaic virus. Transmission probably in soil (Brunt *et al.*, 1996). **Not recorded in Australia**.
Maize white line mosaic virus (MWLMV) (synonyms: maize dwarf ringspot virus)	maize white line mosaic	First reported in maize from Vermont, **USA** (Gotlieb & Liese, 1980). Spreads in France, Italy and the USA. The virus has been detected in seeds (Louie *et al.*, 1982), but there is no evidence that transmission occurs by seeds. The virus is not transmitted by pollen or contact between plants. *Digitaria sanguinalis*, *Panicum dichotomiflorum*, *Setaria faberi* and *Setaria viridis* and *Zea mays* are the natural hosts. The virus is soil-transmitted (Grau *et al.*, 1981). Roots from infected plants can serve as an inoculum source (Louie, 1986). The disease has been found in four states of the USA and distribution is limited within these states. Yield losses of 10% have been reported (Gotlieb & Liese, 1980). Symptomless infection may underestimate incidence in the USA (Louie *et al.*, 1983). **Not recorded in Australia**.
Maize yellow stripe tenuivirus (synonyms: maize yellow stripe virus; maize fine stripe virus; maize chlorotic stunt virus)	maize yellow stripe	First reported in maize from Giza, Egypt (Brunt *et al.*, 1996). Spreads in Egypt. Maize, sorghum, wheat and barley are the natural hosts. Transmitted persistently by *Cicadulina chinai*. Not transmitted by contact between plants (Brunt *et al.*, 1996). **Not recorded in Australia**.
Rice black-streaked dwarf fijivirus (RBSDV) (synonyms: rice black streak virus)	rice black-streaked dwarf	First reported in rice from Japan (Brunt *et al.*, 1996). Spreads in China, Japan and Korea (Brunt *et al.*, 1996) This disease occurs in Japan (McGee, 1994). Hordeum, Secale, Triticum, Oryza and *Zea mays* are the natural hosts of this virus (Brunt *et al.*, 1996). Transmitted persistently by *Laodelphax striatellus*; *Unkanodes sapporona* and *U. albifiscia* (Brunt *et al.*, 1996). **Not recorded in Australia**.
Rice stripe tenuivirus	rice stripe	First reported in rice from Japan (Brunt *et al.*, 1996). Spreads in the eastern Asian region: China, Japan, Taiwan and the former USSR (Brunt *et al.*, 1996). This disease occurs in Japan and is unimportant on maize (McGee, 1994). Avena, Hordeum, Triticum, Oryza and *Zea mays* are the natural hosts of this virus (Brunt *et al.*, 1996). The virus is not seed-transmissible. Transmitted

PATHOGEN	DISEASE	COMMENTS
		persistently by *Laodelphax striatellus*; *Terthron albovittatum; Unkanodes sapporona* and *U. albifiscia* (Brunt *et al*., 1996). **Not recorded in Australia**.
Sugarcane Fiji disease fijivirus	Fiji disease	Spreads in the Philippines, New Guinea, Java and **Australia**. Found, but with no evidence of spread in the USA (Brunt *et al*., 1996). This is primarily a disease of sugarcane, maize acts as a reservoir of inoculum between crops. No report of being seed-borne or transmission by seed. Transmission occurs persistently by two *Perkinsiella* species. Not recorded on maize, but **recorded** on Saccharum (NSW, Qld), **in Australia** (Buchen-Osmand *et al*., 1988). Found in commercial cane crops in NSW and Queensland (Buchen-Osmand *et al*., 1988).
Sugarcane mosaic potyvirus (SCMV) (synonyms: grass mosaic virus; maize dwarf mosaic virus strain B; sorghum red stripe virus)	Sugarcane mosaic	Probably distributed **worldwide** (Brunt *et al*., 1996). **Spreads in Australia** (Brunt *et al*., 1996). Natural hosts are *Saccharum* spp., *Sorghum bicolor*, *S. halepense*, *Panicum* spp., *Eleusine* spp., *Setaria* spp., *Tripsacum dactyloides* and *Zea mays* (Brunt *et al*., 1996; Seifers *et al*., 1993). Transmitted non-persistently by *Dactynotus ambrosiae*, *Hysteroneura setariae*, *Rhopalosiphum maidis* and *Toxoptera graminum* and a number of other aphid species (Teakle & Grylls, 1973). Transmission through seed not reported for sugarcane, sorghum or certain grasses. However, maize dwarf mosaic virus strain B was transmitted to a small proportion of maize seedlings.
Wheat streak mosaic rymovirus (WSMV)	Wheat streak mosaic	First reported in wheat from the USA (Brunt *et al*., 1996). Spreads in Canada, Jordan, Romania, and the USA (Brunt *et al*., 1996). Maize, wheat and several grasses are the natural hosts. WSMV is ***seed-borne*** and transmitted naturally at a low level (Hill *et al*., 1974). The virus is also transmitted by the wheat curl mite *Eriphoyes tulipae* (Nault *et al*., 1967). After overwintering on winter wheat the mites leave this crop as it matures and are blown by the wind to spring wheat, barley and maize. WSMV causes severe mosaic of winter wheat and is a minor pathogen of sweetcorn, although severe outbreaks have been reported from Idaho (Finley, 1957). Infected maize provides an oversummering host for wheat in midwest USA (Gardner, 1981). MCMV is part of viral complex associated with lethal necrosis (Uyemoto, 1983). It can also cause the aberrant ratio mutation effect (Brakke & Samson, 1981). Importation of the disease through seed poses a threat to both the maize and wheat industries in Australia. WSMV is an important disease of winter wheat. Maize is seldom seriously affected, but may play a role in harbouring both the virus and its mite

PATHOGEN	DISEASE	COMMENTS
		vector. **Not recorded in Australia**.
Wheat striate virus (WStMV) (synonym: American wheat striate virus (AWst.M.))	Wheat striate	The disease has been reported on maize in South Dakota (Gardner *et al.*, 1981). Hosts includes maize, wheat and other cereals (Slykhuis, 1963). The pathogen is not seed-transmissible. Transmitted persistently by two species of planthopper (Jones *et al.*, 1981). **Not recorded in Australia**.

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Preliminary assessment of the risk of maize pathogens entering Australia on bulk grain imports from the USA

<u>Appendix 2</u>: Preliminary assessment of the risk of maize pathogens entering Australia on bulk grain imports from the USA

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	**Australia**	**Seed-borne**	**Soil-borne**	**Trash-borne**	**Vector**		
BACTERIA									
Clavibacter michiganensis subsp. ***nebraskensis*** (Vidaver & Mandel) Davis *et al*. 1984	Goss's bacterial wilt and blight	+	-	+		+	-	+	A
Pantoea stewartii subsp. ***stewartii*** (Smith) Mergaert *et al*. 1993	Stewart's bacterial wilt	+	-	+	-	+	+	+	A
Erwinia dissolvens (Rosen) Burkholder 1948	bacterial stalk rot	+	-	-	-	+	-	-	B
Pseudomonas syringae pv. ***lapsa*** (Ark) Young *et al*. 1978	bacterial stalk rot	+	-	+	+	+	-	±	B
Bacillus subtilis (Ehrenberg) Cohn	kernel rot; blight	+	+						D
Burkholderia andropogonis (Smith) Gillis *et al*. 1995	bacterial stripe	+	+						D
Erwinia carotovora subsp. ***carotovora*** (Jones) Bergey *et al*.1923	bacterial stalk and top rot	+	+						D
Erwinia chrysanthemi pv. ***zeae*** (Sabet) Victoria *et al*. 1975	bacterial stalk and top rot	+	+						D
Erwinia herbicola (Lohnis) Dye 1964	halo blight of corn	+	+	+	-	+	-	+	D
Pseudomonas sp.	yellow leaf blotch	-	-						D
Pseudomonas syringae pv. ***syringae*** van Hall 1902	holcus bacterial spot	+	+						D
Pseudomonas syringae pv. ***coronafaciens*** (Elliott) Young *et al*. 1978	chocolate spot	+	±						D
Xanthomonas vasicola pv. ***holcicola*** (Elliott) Vauterin *et al*. 1995	bacterial leaf spot	+	+						D
Acidovorax avenae subsp. ***avenae*** (Manns) Willems *et al*. 1992	bacterial leaf blight	+	+	+	-	+	-	+	E

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
FUNGI									
Cercospora zeae-maydis Tehon & Daniels	gray leaf spot	+	-	-	-	+	-	+	A
Peronosclerospora sorghi (Weston & Uppal) Shaw	sorghum downy mildew	+	-	+	+	+	-	+	A
Phymatotrichopsis omnivora (Duggar) Hennebert	root rot	+	-	-	+	+		+++	A
Sclerospora graminicola (Sacc.) Schröt.	Graminicola downy mildew; green ear	+	-			+		±	A
Ustilaginoidea virens (Cooke) Takah.	false smut	+	-	+				+	A
Absidia corymbifera (Cohan) Sacc. & Trott.		+	-	-	+			±	B
Absidia repens Tiegh		+	-		+			±	B
Acrodictys erecta (Ellis & Everh.) Ellis		+	-					±	B
Ascochyta ischaemi Sacc.	yellow leaf blight	+	-	-	-	+		±	B
Ascochyta maydis Stout.	Ascochyta leaf blight	+	-	-	-	+		-	B
Ascochyta tritici Hori & Enjoji		+	-	-	-	+		±	B
Aspergillus caespitosus Raper & Thom		+	-	+		-		±	B
Fusarium sacchari (Butler) Gams		+	-	±	+	+		±	B
Gonatobotrys zeae Futrell & Bain	Gonatobotrys seed rot	+	-	+				±	B
Graphium penicillioides Corda	leaf spot	+	-	-	-	+		±	B
Hansenula anomala (Hans.) Syd. & Syd.		+	-	-	+	+		±	B
Helminthosporium ahmadii Ellis		+	-	±	-	+		±	B
Leptosphaeria macrospora (Fuckel) Thuem.	leaf spot	+	-			+		±	B
Leptosphaeria variisepta Stout	Leptosphaeria leaf spot	+	-			+		+ (Nepal)	B
Leptothyrium zeae Stout	leaf spot	+	-			+		-	B

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Ligniera junci (Schwartz) Maire & Tison		+	-		+	+		±	B
Macrosporium maculatum Cooke & Ellis in Sumstein, nom. nud.		+	-			+		-	B
Massarina arundinacea (Sowerby:Fr.) Leuchtmann		+	-			+		±	B
Microascus cinereus (Emile-Weil & Gaudin) Curzi		+	-	±	+	+		±	B
Microascus cirrosus Curzi		+	-	±	+	+		±	B
Microascus longirostris Zukal		+	-	±	+			±	B
Mucor heimalis Wehmer		+	-		+			-	B
Mucor mucedo Mich. Ex Saint-Amans		+	-		+			-	B
Mycosphaerella zeae (Sacc.) Woronow	leaf blight	+	-	±		+		±	B
Myrothecium gramineum Lib.	shuck rot	+	-		+	+			B
Phoma americana Morgan-Jones & White	root rot	+	-		+	+		±	B
Phoma zeicola Ellis & Evrh.	root rot	+	-		+	+		±	B
Phyllosticta maydis Arny & Nelson	yellow leaf blight	+	-			+		-	B
Phyllosticta zeae Stout	Phyllosticta leaf spot	+	-			+		-	B
Physopella pallescens (Arth.) Cummins & Ramachar	leaf rust	+	-	-	+	+		-	B
Pithomyces maydicus (Sacc.) Ellis	ear rot	+	-			+			B
Pythium acanthium Drechs.	root rot	+	-		+			±	B
Pythium adhaerens Sparrow	root rot	+	-		+			±	B
Pythium angustatum Sparrow	root rot	+	-		+			±	B
Pythium pulchrum Minden	root rot	+	-		+			±	B
Pythium sylvaticum Campbell & Hendrix	seed rot	±	-		+			±	B
Rhizopus microsporus Tiegh.	Rhizopus ear rot	+	-	+				±	B
Rhizopus microsporus Tiegh. Var. ***rhizopodiformis*** (Cohn) Schipper	Rhizopus ear rot	+	-	+				±	B

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Rhopographus zeae Pat.	stalk rot	+	-			+		±	B
Septoria zeae Stout	leaf spot	+	-			+		±	B
Septoria zeina Stout	leaf spot	+	-			+		±	B
Sterile white basidiomycete *(SWB)*	SWB root rot	+	-					±	B
Wolfiporia cocos (Wolf) Ryvarden & Gilbertson	wood rot	+	-			+		±	B
Acremoniella verrucosa Tognini	leaf	-	+						D
Acremonium strictum Gams	black bundle	+	+						D
Acremonium zeae Gams & Sumner	Acremonium stalk rot	+	+						D
Actinomucor elegans (Eidam) Benjamin & Hesseltine		+	+						D
Alternaria alternata (Fr.:Fr.) Keissl.	Alternaria leaf blight	+	+						D
Alternaria longissima Deighton & MacGarvie	stalk rot	+	+						D
Ascochyta zeicola Ellis & Everh.	Ascochyta leaf spot	+	±						D
Aspergillus alliaceus Thom & Church		+	±						D
Aspergillus candidus Link		+	±						D
Aspergillus carbonarius (Bainier) Thom		+	±						D
Aspergillus clavatus Desmaz.		+	±						D
Aspergillus equitis Samson & Gams		+	±			-		±	D
Aspergillus flavipes (Bainier & Sartory) Thom & Church		+	±						D
Aspergillus flavus Likn:Fr.		+	+						D
Aspergillus fumigatus Fresen.		+	±						D
Aspergillus glaucus Link:Fr.	Aspergillus ear rot; yellow mould	+	+						D
Aspergillus hollandicus Samson & Gams		+	±						D
Aspergillus nidulellus Samson & Gams		+	±						D

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Aspergillus niger Tiegh.	Aspergillus ear rot; black mould	+	+						D
Aspergillus ochraceus Wilh.		+	±						D
Aspergillus parasiticus Speare		+	±						D
Aspergillus reptans Samson & Gams		+	±						D
Aspergillus restrictus Sm.		+	±						D
Aspergillus sydowii (Bainier & Startory) Thom & Church		+	±						D
Aspergillus ustus (Bainier) Thom & Raper		+	±						D
Aspergillus versicolor (Vuill.) Tiraboschi		+	±						D
Aspergillus wentii Wehmer		+	±						D
Aureobasidium pullulans (de Bary) Arnaud	brown spot	+	±						D
Bipolaris australiensis (Ellis) Tsuda & Ueyama	leaf spot	+	+						D
Bipolaris bicolor (Mitra) Shoemaker	leaf spot	-	+						D
Bipolaris cynodontis (Marig.) Shoemaker	leaf spot	+	+						D
Bipolaris hawaiiensis (Ellis) Uchida & Aragaki	Helminthosporium leaf spot	+	+						D
Bipolaris sacchari (Butler) Shoemaker		+	+						D
Bipolaris setariae (Sawada) Shoemaker	spot blotch	+	+						D
Bipolaris sorghicola (Lefebvre & Sherwin) Alcorn		+	+						D
Bipolaris sorokiniana (Sacc.) Shoemaker	Helminthosporium root rot	+	+						D
Bipolaris urochloae (Putterill) Shoemaker	leaf spot	+	+						D
Bipolaris victoriae (Meehan &		+	+						D

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Murphy) Shoemaker									
Blakeslea trispora Thaxt.		+	+						D
Botryosphaeria festucae (Lib.) Arx & Mueller	ear rot	+	±						D
Botryosphaeria quercuum (Schwein.) Sacc.	ear rot	+	±						D
Botrytis cineria Pers.: Fr.	Botrytis stalk rot	+	+						D
Candida krusei (Castellani) Berkhout		+	±						D
Cephalosporium maydis Samra *et al*.,	late wilt; slow wilt	-	-						D
Ceratocystis paradoxa (Dade) Moreau	leaf spot	+	+						D
Cercospora sorghi Ellis & Evrh.	gray leaf spot	+	±						D
Chaetomium funicola Cooke		+	±						D
Chaetomium globosum Kunze:Fr.		+	±						D
Chaetomium indicum Corda		+	±						D
Chrysonilia sitophilia (Mont.) Arx		+	±						D
Cladosporium cladosporioides (Fresen.) De Vries	Cladosporium rot	+	+						D
Cladosporium herbarum (Pers.:Fr.) Link	cob mould	+	+						D
Cladosporium macrocarpum Preuss	cob mould	+	+						D
Cladosporium tenuissimum Cooke		+	±						D
Claviceps gigantea Fuentes *et al.*	horse’s tooth; ergot	-	-						D
Coniothyrium scirpi Trail	leaf spot	+	±						D
Corynascus sepedonium (Emmons) Arx		+	±						D
Curvularia brachyspora Boedijn	leaf spot	±	+						D
Curvularia clavata P.C.Jain	leaf spot	+	±						D
Curvularia eragrostidis (Henn.) Meyer	Curvularia leaf spot	+	±						D
Curvularia geniculata (Tracy & Earle) Boedijn	Curvularia leaf spot	+	±						D
Curvularia gudauskasii (Morgan-Jones & Karr)	leaf spot	+	±						D

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Curvularia inaequalis (Shear) Boedijn	Curvularia leaf spot	+	±						D
Curvularia intermedia Boedijn	Curvularia leaf spot	+	±						D
Curvularia lunata (Wakk.) Boedijn	Curvularia leaf spot	+	+						D
Curvularia pallescens Boedijn	Curvularia leaf spot; leaf spot of maize; corn leaf spot	+	±						D
Curvularia senegalensis (Speg.) Subramanian	Curvularia leaf spot	+	±						D
Curvularia tuberculata P.C.Jain	leaf spot	+	±						D
Cyathus stercoreus (Schw.) de Toni in Sacc.	bird's nest fungus	-	+						D
Dendrophoma zeae Tehon		+	±						D
Diaporthe phaseolorum (Cooke & Ellis) Sacc.	seedling blight	+	±						D
Dictyochaeta fertilis (Hughes & Kendrick) Holubova-Jechova	root rot	+	±						D
Didymella exitialis (Morini) Mueller	Didymella leaf spot	-	-						D
Diplodia maydis (Berk.) Sacc.	Diplodia ear and stalk rot	+	+						D
Doratomyces stemonitis (Per.:Fr.) Morton & Sm.	ear rot	+	±						D
Epicoccum nigrum Link	red kernel; red kernel disease	+	+						D
Exserohilum longirostratum (Subram.) Sivanesan	stalk rot	-	+						D
Exserohilum monoceras (Drechs.) Leonard & Suggs	leaf blotch	±	+						D
Exserohilum pedicellatum (Henry) Leonard & Suggs	Helminthosporium root rot	+	+						D
Exserohilum prolatum Leonard & Suggs	Exserohilum leaf spot	+	+						D
Exserohilum rostratum (Drechs.) Leonard & Suggs	Helminthosporium leaf disease	+	+						D

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Fusarium acuminatum Ellis & Everh.	root and stem rot	+	+						D
Fusarium avenaceum (Fr.: Fr.) Sacc.	stalk and root rot	+	±						D
Fusarium chlamydosporum Wollenweb. & Reinking		±	+						D
Fusarium crookwellense Burgess *et al*.	stem rot	±	+						D
Fusarium culmorum (Wm. G. Sm.) Sacc.	stalk rot	+	+						D
Fusarium episphaeria (Tode) Snyder & Hans.	stalk rot	+	±						D
Fusarium equiseti (Corda) Sacc.	stalk rot	+	+						D
Fusarium graminearum Schwabe	Gibberella stalk rot; red ear rot; pink ear rot	+	+						D
Fusarium merismoides Corda	stalk rot	+	±						D
Fusarium moniliforme Sheld.	Fusarium ear and stalk rot; Fusarium kernel rot	+	+						D
Fusarium oxysporum Schlechtend.:Fr.	root rot	+	+						D
Fusarium pallidoroseum (Cooke) Sacc.	root rot	+	+						D
Fusarium poae (Peck) Wollenweb.	white cob rot; silver top	+	±						D
Fusarium proliferatum (Matsushima) Nirenberg	root rot	+	±						D
Fusarium roseum Link: Fr.	root rot	+	±						D
Fusarium solani (Mart.) Sacc.	stalk rot	+	±						D
Fusarium subglutinans (Wollenweb. & Reinking) Nelson *et al*.	Fusarium stalk and ear rot	+	+						D
Fusarium tricinctum (Corda) Sacc	root rot	+	±						D
Gaeumannomyces graminis (Sacc.) Arx & Olivier	root rot	+	+						D
Geotrichum candidum Link	stalk rot	±	+						D
Glomerella tucumanensis (Speg.) Arx & Mueller		+	±						D

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		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Gonatobotrys simplex Corda	Gonatobotrys seed rot	+	±						D
Harzia acremonioides (Harz) Costantin		+	±						D
Hyalothyridium maydis	round blotch	-	-						D
Lasiodiplodia theobromae (Pat) Griffon & Maubl.	black kernel rot	+	±						D
Leptosphaerulina trifolii (Rostr.) Petr.		+	±						D
Macrophomina phaseolina (Tassi) Goidanich	charcoal rot	+	+						D
Marasmius graminum (Lib.) Berk.	seedling and foor rot	+	+						D
Marasmius sacchari Wakk.	Marasmius root and stalk rot	+	+						D
Mariannaea elegans (Corda) Samson	stalk rot	+	±						D
Microdochium bolleyi (Sprague) De Hoog & Hermanides-Nijhof	Microdochium root rot	+	±						D
Microdochium nivale (Fr.) Samuels & Hallett	Microdochium root rot	+	±						D
Mucor circinelloides Teigh.		+	±						D
Mucor fragilis Bainier	seedling rot	+	±						D
Mucor plumbeus Bonord.		+	±						D
Mucor racemosus Fresen.		+	±						D
Myrothecium cinctum (Corda) Sacc.	root rot	+	±						D
Myrothecium verrucaria (Albertini & Schwein.) Ditmar.:Fr.	root rot	+	±						D
Nigrospora oryzae (Berk. & Broome) Petch	Nigrospora ear rot	+	+						D
Nigrospora sacchari (Speg.) Mason		-	+						D
Nigrospora sphaerica (Sacc.) Mason	stalk rot	+	+						D
Olpitrichum macrosporum (Farl.) Sumstine		±	+						D
Paraphaeosphaeria michotii (Westend.) Eriksson	leaf spot	+	±						D

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		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Penicillium aurantiogriseum Dierckx		+	±						D
Penicillium brevicompactum Dierckx		+	±						D
Penicillium canescens Sopp		+	±						D
Penicillium chrysogenum Thom		+	±						D
Penicillium citrinum Thom		+	±						D
Penicillium crustosum Thom		+	±						D
Penicillium funiculosum Thom		+	+						D
Penicillium minioluteum Dierckx	seed rot	-	+						D
Perichaena vermicularis (Schwein.) Rostr.		+	±						D
Periconia circinata (Mangin) Sacc.	root rot	+	±						D
Periconia macrospinosa Lefebvre & Johnson in Lefebvre *et al*.		±	+						D
Peronosclerospora heteropogoni Sirdhana *et al*.	Rajasthan downy mildew	-	-						D
Peronosclerospora maydis (Racib.) Shaw	Java downy mildew	-	+						D
Peronosclerospora philippinensis (Weston) Shaw	Philippine downy mildew	-	-						D
Peronosclerospora sacchari (Miyake) Shaw	sugarcane downy mildew	-	- (eradicated)						D
Peronosclerospora spontanea (Weston) Shaw	spontaneum downy mildew	-	-						D
Phaeocytostroma ambiguum (Mont.) Petr. in Petr. & Syd.	Phaeocytosporella stalk infection	+	+						D
Phaeosphaeria eustoma (Fuckel) Holm	Phaeosphaeria leaf spot	+	±						D
Phaeosphaeria herpotricha (De Not) Holm	Phaeosphaeria leaf spot	+	+						D
Phaeosphaeria maydis (Henn.) Rane, Payak & Renfro	Phaeosphaeria leaf spot	-	+						D
Phaeotrichoconis crotalariae (Salam & Rao) Subram.		±	+						D

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		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Phoma terrestris Hans.	pink root; stalk rot	+	±						D
Phomopsis sp.	Phomopsis seed rot	+	+						D
Phycomyces nitens Kunze		+	±						D
Phyllachora maydis Maubl.	tar spot	-	-						D
Physarum pusillum (Berk. & Curtis) List.	slime mould	+	±						D
Physoderma maydis (Miyabe) Miyabe	brown spot of maize	+	+						D
Physopella zeae (Mains) Cummins & Ramachar	tropical rust	-	-						D
Phytophthora cactorum (Lebert & Cohn) Schroet.	root rot	+	+						D
Phytophthora drechsleri Tucker	root rot	+	±						D
Phytophthora nicotianae Breda de Haan var. ***parasitica*** (Dastur) Waterhouse	root rot	+	±						D
Pleurophragmium verruculosum Tiwari		-	+						D
Puccinia polysora Underw.	southern rust	+	+						D
Puccinia sorghi Schwein.	common maize rust	+	+						D
Pyrenochaeta indica Viswanathan	black root rot	-	+						D
Pyricularia grisea (Cooke) Sacc.	white leaf spot	+	+						D
Pyronema omphalodes (Bull.:Fr.) Fuckel		+	±						D
Pythium aphanidermatum (Edson) Fitzp.	Pythium stalk rot	+	±						D
Pythium arrhenomanes Drechs.	root rot	+	±						D
Pythium graminicola Subramanian	root rot	+	±						D
Pythium irregulare Buisman	seedling blight, damping off	+	±						D
Pythium myriotylum Drechs.	root rot	+	+						D
Pythium paroecandrum Drechs.	root rot	+	±						D
Pythium rostratum Butler	root rot	+	±						D

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		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Pythium splendens Braun	root rot	+	+						D
Pythium ultimum Trow	root rot	+	±						D
Pythium zeae	Pythium leaf spot	-	-						D
Ramulispora sorghi (Ellis & Everh.) Olive & Lefebvre in Olive *et al*.	brown leaf spot	±	+						D
Rhizoctonia solani Kühn	Rhizoctonia root rot	+	+						D
Rhizoctonia solani Kühn f.sp. ***sasakii*** Shirai	banded leaf and sheath spot	-	-						D
Rhizoctonia zeae Voorhees	sclerotial rot	+	+						D
Rhizopus arrhizus Fischer	Rhizopus ear rot	+	±						D
Rhizopus stolonifer (Ehrenb.:Fr.) Vuill.	Rhizopus ear rot	+	+						D
Sclerophthora macrospora (Sacc.) Thirumalachar *et al*.	crazy top	+	+						D
Sclerophthora rayssiae Kenneth *et al*. var. ***zeae*** Payak & Renfro	brown stripe downy mildew	-	-						D
Sclerotinia sclerotiorum (Lib) de Bary	Sclerotinia stalk rot	+	±						D
Sclerotium rolfsii Sacc.	Sclerotium ear rot	+	+						D
Scopulariopsis brevicaulis (Sacc.) Bainier	ear rot	+	±						D
Scopulariopsis brumptii Salvanet-Duval	ear rot	+	±						D
Septoria maydis	Septoria leaf blotch	-	-						D
Septoria zeicola Stout	leaf spot	+	+						D
Stenocarpella macrospora (Earle) Sutton	Diplodia ear and stalk rot	+	+						D
Stenocarpella maydis (Berk.) Sutton	Diplodia ear and stalk rot	+	+						D
Stictis stellata Schwein.		+	±						D
Syncephalastrum racemosum Cohn ex Schroet		+	±						D
Trichoderma koningii Oudem.		+	±						D

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Trichoderma viride Pers.:Fr.	Trichoderma ear rot	+	±						D
Trichothecium roseum (Pers.:Fr.) Link	pink mould	+	±						D
Verticillium tenerum (Pers.:Fr.) Link		+	±						D
Aspergillus chevalieri (Mangin) Thom & Church var. ***intermedius***		+	-					±	E
Aspergillus echinulatus (Delacr.) Thom & Church		+	-		-	-		±	E
Aspergillus elegans Gasp.		+	-		-	-		±	E
Aspergillus mangini Thom & Raper		+	-			-		±	E
Aspergillus rubrobrunneus Samson & Gams		+	-					±	E
Aspergillus stellifer Samson & Gams		+	-					±	E
Aspergillus sulphureus (Fresen.) Wehmer		+	-					±	E
Aspergillus tamarii Kita		+	-					±	E
Aspergillus unguis (Emile-Weil & Gaudin) Thom & Raper		+	-					±	E
Aureobasidium zeae (Narita & Hiratsuka) Dingley	eye spot; brown spot	+	-					±	E
Basidiobotrys pallida (Berk. & Curtis) Hughes		+	-					±	E
Bipolaris maydis (Nisikado & Miyake) Shoemaker	southern leaf blight	+	+	+	-	+		+	E
Bipolaris zeicola (Stout) Shoemaker	northern leaf spot	+	+	+	-	+	-	+	E
Botryosphaeria disrupta (Berk. & Curtis) Arx & Mueller	ear rot	+	-					±	E
Botryosphaeria rhodina (Cooke) Arx	ear rot	+	-					±	E
Botryosphaeria zeae (Stout) Arx & Mueller	gray ear rot	+	-					-	E
Byssochlamys nivea Westling		+	-					±	E
Candida albicans (Robin) Berkhout		+	-					±	E

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Candida guilliermondii (Castellani) Langeron & Guerra		+	-					±	E
Candida intermedia (Cif. & Ashford) Langeron & Guerra		+	-					±	E
Candida parapsilosis (Ashford) Langeron & Talice		+	-					±	E
Candida pseudotropicalis (Castellani) Basgal		+	-					±	E
Chaetomium bostrychodes Zopf		+	-					±	E
Chaetomium brasiliense Batista & Pontual		+	-					±	E
Chaetomium dolichptrichum Ames		+	-					±	E
Chaetomium murorum Corda		+	-					±	E
Chaetomium torulosum Bainier		+	-					±	E
Ciccinella muscae (Sorokin) Berl. & DE Toni		+	-					±	E
Cladosporium zeae Peck		+	-					±	E
Colletotrichum cereale Manns in Selby & Manns		+	-			-		±	E
Colletotrichum graminicola (Ces.) Wils.	anthracnose	+	+	+	-	+		+	E
Cryptococcus laurentii (Kuff.) Skinner		+	-					±	E
Dictyochora gambellii Fairm.		+	-					±	E
Didymium iridis (Ditmar) Fr.		+	-					±	E
Didymosphaeria graminicola Ellis & Everh.		+	-					±	E
Exserohilum turcicum (Pass.) Leonard & Suggs	northern leaf blight	+	+	+	-	+	-	+	E
Fusisporium cerealis Cooke		+	-					-	E
Gibberella cyanogena (Desmaz.) Sacc.	root rot	+	±						E
Gibberella pulicaris (Fr.:Fr.) Sacc.	root rot	+	±						E
Glabrocyphella ellisiana Cooke		+	-					-	E

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	**Australia**	**Seed-borne**	**Soil-borne**	**Trash-borne**	**Vector**		
Gloeocercospora sorghi Bain & Edgerton ex Deighton	zonate leaf spot	+	-				-		E
Illosporium pallidum Cooke		+	-					-	E
Isariopsis subulata Ellis & Everh.		+	-					-	E
Lecanidion atratum (Hedw.) Rabenh.		+	±						E
Leptosphaeria maydis Stout	leaf spot	+	-					-	E
Lophiosphaera zeicola Ellis & Everh.		+	-						E
Lophiostoma arundinis (Pers.:Fr.) Ces. & De Not)		+	-					±	E
***Marasmiellus* sp.**	Borde blanco	-	-						E
Melanospora zamiae Corda		+	-					±	E
Microascus desmosporus (Lechmere) Curzi		+	-					±	E
Monascus purpureus Went	silage mold	+	-						E
Monascus ruber Diegh.	silage mold	+	-						E
Olpitrichum tenellum (Berk. & Curtis) Holubova-Jechova		+	-						E
Ophiliosphaerella herpotricha (Fr.:Fr.) Walker		+	-						E
Penicillium clarviforne Bainier		+	-						E
Penicillium expansum Link	Penicillium ear rot	+	-						E
Penicillium felludanum Biourge		+	-						E
Penicillium glabrum (Wehmer) Westling		+	-						E
Penicillium granulatum Bainier		+	-						E
Penicillium grisefulvum Dierckx		+	-						E
Penicillium herquei Bainier & Sartory		+	-						E
Penicillium implicatum Biourge		+	-						E
Penicillium janthinellum Biourge		+	-						E
Penicillium oxalicum Currie & Thom		+	-						E
Penicillium puberulum Bainier		+	-						E
Penicillium purpurogenum Stoll		+	-						E

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		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Penicillium roquefortii Thom		+	-						E
Penicillium rugulosum Thom		+	-						E
Penicillium sclerotiorum Van Beyma		+	-						E
Penicillium thomii Maire		+	-						E
Penicillium variabile Sopp		+	-						E
Penicillium verrucosum Dierckx		+	-						E
Penicillium viridicatum Westling		+	-						E
Penicillium waksmanii Zaleski		+	-						E
Perisporium zeae Berk. & Curtis		+	-						E
Physalospora abdita (Berk. & Curtis) Stevens in Voorhees		+	-					±	E
Pithoascus intermedius (Emmons & Dodge) Arx		+	-						E
Pithoascus schumachrei (Hans.) Arx		+	-						E
Pleospora straminis Sacc. & Speg.		+	-						E
Podospora minor Ellis & Everh.		+	-						E
Polyschema olivacea (Ellis & Everh.) Ellis		+	-						E
Sphaerella paulula Cooke		+	-					±	E
Sporidesmium folliculatum (Corda) Mason & Hughes		+	-					±	E
Sporisorium holci-sorghi (Rivolta) Vanky	head smut	+	+	+	+	-	-	+	E
Stachybotrys zeae Morgan-Jones & Karr		+	-					±	E
Stauronema cruciferum (Ellis) Syd *et al*.		+	-					?	E
Stictis radiata Pers.:Fr.		+	-					±	E
Talaromyces luteus (Zukal) Benjamin		+	-					±	E
Talaromyces stipitatus (Thom) Benjamin		+	-					±	E
Thamnidium elegans Link:Fr		+	-					±	E

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Tritirachium oryzae (Vincens) De Hoog		+	-					-	E
Tubeufia cylindrothecia (Seaver) Höhn		+	-					±	E
Typhula phacorrhiza (Reichard:Fr.) Fr.	snow mould	+	-					±	E
Ulocladium lanuginosum (Harz.) Simmons		+	-					±	E
Ustilago zeae (Beckm.) Unger	boil smut	+	c						E
NEMATODES									
Dolichodorus heterocephalus Cobb, 1914	awl nematode	+	-		+			+	A
Heterodera zeae Koshy *et al*. 1970	corn cyst nematode	+	-		+	+		+	A
Hoplolaimus columbus Sher 1963	lance nematode	+	-		+			+	A
Longidorus breviannulatus Norton & Hoffman 1975	needle nematode	+	-		+			+	A
Pratylenchus scribneri Steiner, 1943	root lesion nematode	+	-		+	+		+	A
Hoplolaimus galeatus (Cobb) Thorne 1935	lance nematode	+	-		+			±	B
Meloidogyne chitwoodi Golden *et al*. 1980	root-knot nematode	+	-		+				B
Paratrichodorus christiei (Allen) Siddiqi 1974	stubby-root nematode	+	-		+			±	B
Quinisulcius acutus (Allen) Siddiqi 1974	stubby-root nematode	+	-		+	+			B
Belonolaimus longicaudatus Rau 1958	sting nematode	+	±						D
Criconema mutabile (Taylor) Raski & Luc	ring nematode	+	+						D

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Ditylenchus dipsaci (Kuhn) Flipjev 1936	bulb and stem nematode	+	±						D
Filenchus exiguus (de Man) Ebsary		+	+						D
Filenchus filiformis (Butschli) Ebsary		-	+						D
Gracilacus mutabilis (Colbran) Raski 1962		-	+						D
Helicotylenchus dihystera (Cobb) Sher 1961	spiral nematode	+	+						D
Helicotylenchus multicinctus (Cobb) Golden 1956	spiral nematode	+	+						D
Helicotylenchus pseudorobustus (Steiner) Golden 1956	spiral nematode	+	±						D
Heterodera avenae Wollenweber 1924	cereal cyst nematode	+	±						D
Macroposthonia ornata (Raski) de Grisse & Loof, 1965	ring nematode	+	+						D
Meloidogyne arenaria (Neal) Chitwood 1949	root-knot nematode	+	±						D
Meloidogyne incognita (Kofold & White) Chitwood 1949	root-knot nematode	+	+						D
Meloidogyne javanica (Treub) Chitwood 1949	root-knot nematode	+	+						D
Nacobbus dorsalis Thorne & Allen		+	-						D
Neopsilenchus magnidens (Thorne) Thorne & Malek		-	+						D
Paratrichodorus lobatus (Colbran) Siddique 1974	stubby root nematode	-	+						D
Paratrichodorus minor (Colbran) Siddiqi 1974	stubby-root nematode	-	+						D
Pratylenchus brachyurus (Godfrey) Filipjev & Schuurmans Stekhoven 1941	root lesion nematode	+	+						D
Pratylenchus crenatus Loof	root lesion nematode	+	±						D
Pratylenchus hexincisus Taylor &	root lesion nematode	+	±						D

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		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Jenkins 1957									
Pratylenchus neglectus (Rensch) Filipjev & Schuurmans Stekhoven 1941	root lesion nematode	+	±						D
Pratylenchus penetrans (Cobb) Chitwood & Oteifa 1952	root lesion nematode	+	+						D
Pratylenchus thornei Sher & Allen 1953	root lesion nematode	+	±						D
Pratylenchus zeae Graham 1951	root lesion nematode	+	+						D
Punctodera chalcoensis Stone *et al*. 1976	cyst nematode	-	-						D
Radopholus similis (Cobb) Thorne 1949	burrowing nematode	+	+						D
Rotylenchulus parvus (Williams) Sher 1961	reniform nematode	+	+						D
Tylenchorhynchus dubius (Butschli) Filipjev 1936	stunt nematode	+	±						D
Xiphinema americanum Cobb 1913	dagger nematode	+	±						D
Xiphinema mediterraneam Lima	dagger nematode	-	-						E
PHYTOPLASMAS									
Spiroplasma kunkelii Whitcomb *et al*	corn stunt	+	-						E
Maize bushy stunt phytoplasma	maize bush stunt	+	-						E
VIRUSES									
High Plains virus	High Plains disorder	+	-	+				+	A
Maize chlorotic mottle	maize chlorotic mottle	+	-	+			+	+	A

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machlomovirus (MCMV)									
Maize dwarf mosaic potyvirus (MDMV)	maize dwarf mosaic	+	-	+			+	+	A
Wheat streak mosaic rymovirus (WSMV)	wheat streak mosaic	+	-	+			+	+	A
Barley yellow dwarf luteovirus (BSMV)	barley yellow dwarf	+	+						D
Brome mosaic bromovirus (BMV)	brome mosaic	+	+						D
Cereal chlorotic mottle (?) nucleorhabdovirus (CCMV)	cereal chlorotic mottle	-	+						D
Chloris striate mosaic monogeminivirus (CSMV)	striate mosaic	**-**	**+**						D
Cucumber mosaic cucumovirus (CMV)	cucumber mosaic	+	+						D
Cynodon chlorotic streak nucleorhabdovirus (CCSV)	Cynodon chlorotic streak	-	-						D
Guinea grass mosaic potyvirus (GGMV)	Guinea grass mosaic	-	-						D
Johnsongrass mosaic potyvirus (JGMV)	Johnson grass mosaic	+	+						D
Maize eyespot virus	maize eye spot	-	-						D
Maize gooseneck stripe virus	maize gooseneck stripe	-	-						D
Maize Iranian mosaic nucleorhabdovirus	maize Iranian mosaic	-	-						D
Maize line virus	maize line	-	-						D
Maize mottle/chlorotic stunt virus	maize mottle/ chlorotic stunt	-	-						D
Maize raya gruesa virus	maize raya gruesa	-	-						D
Maize rough dwarf fijivirus (MRDV)	maize rough dwarf	-	-						D
Maize sterile stunt rhabdovirus	maize sterile stunt	-	+						D
Maize streak dwarf nucleorhabdovirus	maize streak dwarf	-	-						D

PATHOGEN	DISEASE	Status in[T]		Pathway[TT]				Economic Importance[TTT]	Risk Category[TTTT]
		USA	Australia	Seed-borne	Soil-borne	Trash-borne	Vector		
Maize streak monogeminivirus (MSV)	maize streak	-	-						D
Maize vein enation virus	maize vein enation	-	-						D
Maize yellow stripe tenuivirus	maize yellow stripe	-	-						D
Rice black-streaked dwarf fijivirus (RBSDV)	rice black-streaked dwarf	-	-						D
Rice stripe tenuivirus	rice stripe	-	-						D
Sugarcane Fiji disease fijivirus	Fiji disease	-	+						D
Sugarcane mosaic potyvirus (SCMV)	sugarcane mosaic	-	+						D
Wheat striate virus (WStMV)	wheat striate	+	-	-	-	-	+	±	D
Maize bushy stunt phytoplasma	maize bush stunt;	+	-				+	±	E
Maize chlorotic dwarf waikavirus (MCDV)	maize chlorotic dwarf	+	-				+	?	E
Maize mosaic nucleorhabdovirus (MMV)	maize mosaic	+	-	-	-	-	+		E
Maize rayado fino marafivirus (MRFV)	maize rayado fino	+	-				+	+	E
Maize stripe tenuivirus (MSpV)	maize stripe	+	-				+	±	E
Maize white line mosaic satellivirus	maize white line mosaic	+	-		+			±	E
Maize white line mosaic virus (MWLMV)	maize white line mosaic	+	-	±	+		-	+	E

Preliminary Assessment of the Risk of Maize Pathogens entering Australia on Bulk Grain Imports from the USA

T: + = present on maize; - = not present on maize; ± = present on other host(s); c = under official control

TT: + = present in pathway; - = not present in pathway, blank = not known if in pathway

TTT: + = likely to cause economic damage; - = unlikely to cause economic damage; ± = equivocal

TTTT: **Risk Categories**

A Present in USA, in pathway, not present in Australia or officially controlled in Australia, and capable of significant economic damage

B As for A except lower economic damage

C Present in USA, in pathway, present in Australia but with equivocal evidence for exotic pathogenic strains capable of economic damage

D Present in Australia and not officially controlled, or not in pathway, or not in USA

E Insufficient information for judgement

PART 1

Data Sheets on Ten High Risk Pathogens

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CONTENTS

Peronosclerospora sorghi

Species: *Peronosclerospora sorghi* (Weston & Uppal) Shaw;
Oomycetes; Peronosporales.

Synonym(s): *Sclerospora sorghi* Weston & Uppal; *Sclerospora graminicola* var. *andropogonis-sorghi* Kulkarni; *Sclerospora andropogonis-sorghi* (Kulk.) Mundkur; *Sclerospora andropogonis-vulgaris* (Kulk.) Mundkur.

Common name(s): Sorghum downy mildew.

Host(s): *Andropogon sorghi, Heteropogon contortus, Panicum glaucum, P. typheron, Sorghum bicolor, S. bicolor* subsp. *arundinaceum, S. bicolor* var. *technicum, S. caffrorum, S. halepense, S. nitidum*, *Sorghum* X *almum*, *Sorghum* X *drummondii, Zea diploperennis, Z. mexicana, and Z. mays*.

Part of plant affected: Leaves, stems, inflorescence and seeds.

Distribution:
Asia: Bangladesh, China, India, Iran, Israel, Japan, Nepal, Pakistan, Philippines, Thailand and Yemen (CMI, 1988; Jeger *et al.*, 1998; SBML, 1999).
Africa: Benin, Botswana, Burundi, Egypt, Ethiopia, Ghana, Kenya, Malawi, Mauritiana, Mozambique, Nigeria, Rwanda, Somalia, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe (CMI, 1988; Jeger *et al.*, 1998).
North America: Mexico and USA (Alabama, Alaska, Arkansas, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New Mexico, Oklahoma, Tennessee and Texas (Bonde, 1982; CMI, 1988; Farr *et al.* 1989; EPPO 1998; Jeger *et al*, 1998).
Central America and Caribbean: El Salvador, Guatemala, Honduras, Nicaragua, Panama and Puerto Rico (CMI, 1988; EPPO 1998; Jeger *et al*, 1998).
South America: Argentina, Bolivia, Brazil, Colombia, Uruguay and Venezuela (CMI, 1988; EPPO 1998; Jeger *et al*, 1998).

On maize this fungus has been reported from India, Kenya, Nepal, South Africa, Thailand, Uganda, Venezuela, Zimbabwe (SBML, 1999) and USA (Alabama, Alaska, Arkansas, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Missouri, Nebraska, New Mexico, Oklahoma, Tennessee and Texas) (Bonde, 1982; Farr *et al.* 1989).

Biology: There are two types of symptom produced by *Peronosclerospora sorghi* in both sorghum and maize; systemic infection which occurs by oospores or conidia during the first four weeks of germination of the seed; and local lesions resulting from conidial infection of older plants, which may also give rise to systemic infection (Schuh *et al*., 1986).

Systemic infection in maize seedlings is characterised by chlorosis that normally appears after seedling emergence. The first leaf is invariably free from infection; this may be caused by the first leaf outgrowing the pathogen, which requires time to invade the root and stem tissue, or the existence of a passive defence mechanism in the first leaf which prevents entry of the fungus. If no infection is observed within 2 weeks, the second leaf escapes infection while the younger leaves may subsequently develop symptoms.

Infected maize plants are sometimes stunted and occasionally have white-striped leaves and abnormal seed set. Leaf chlorosis always includes the base of the blade, with the transverse margin usually being sharply defined between the diseased and healthy tissue. This symptom appears further up the blade in successively formed leaves (half-leaf symptom). The leaves of infected plants tend to be narrower and more erect than those on healthy plants. In maize, most systemically infected plants are sterile, but occasionally some will set seed.

Peronosclerospora sorghi produces oospores in infected host tissue. Oospores are produced less frequently and abundantly on maize than on sorghum, and appear in both hosts only in systemically infected plants (Bigeriwa *et al*., 1998). Oospore populations in soil of 8-95 per gram have been reported following sorghum crops (Pratt *et al*., 1978). Oospores are thought to survive for at least three years under a variety of conditions (Frederiksen, 1980), and can be dispersed by wind. Oospores germinate in soil by germ tubes that infect underground parts of susceptible seedlings, which then become systemically infected. No infection by oospores occurs if seedlings emerge in cool soils below 20°C. In arid areas, oospores initiate infection of seedlings, whereas in areas where a perennial host such as Johnson grass is present, infection can be initiated from conidia (Bigeriwa *et al*., 1998).

Conidia are produced from systemically infected plants at temperatures between 17 and 29°C, with an optimum temperature of 24 to 26°C, depending on the geographic isolate. Conidial germination requires a saturated atmosphere, and moderate temperatures of 15 to 25°C, depending on the isolate. High levels of systemic infection can occur between 11 and 32 °C, with a wet period of 4 hours or longer. Conidia lose their viability after 3 to 4 hours, and probably only play a role in short distance spread of the fungus.

The fungus can infect corn seed, being confined in mature seeds to the pericarp and pedicel. Jones *et al.* (1972) found that seed transmission of the disease occurs when infected seeds at the soft dough stage are planted in sterile soil, but is prevented by reducing the moisture content to 9% and by storage for 40 days prior to planting. These results should be treated with caution, since the findings are based on a total of only 75 seeds per treatment. When 400 seeds harvested from systemically infected maize plants were planted in sterile soil in a greenhouse, 256 plants showed systemic infection at and after the fifth leaf stage (Rao *et al*., 1984). This suggests that the presence of oospores within the seed resulted in the transmission of the fungus, regardless of seed moisture content (Rao *et al*., 1984).

Worldwide, there appears to be at least two strains of *S. sorghi*; the sorghum-maize strain and the maize-strain (Jeger *et al*., 1998). The sorghum-maize strain infects both sorghum and maize, and is present in southern India (Karnataka, Maharashtra and Tamil Nadu), Israel, Mexico, the USA, Central South America and in some regions of Africa (Frederiksen & Renfro, 1977). The maize strain is present in northwestern India (Rajasthan) and Thailand (Bonde, 1982). Yao *et al.*, (1991) found that the RFLP banding patterns of the maize pathotype of *P. sorghi* from Thailand were completely different to the banding patterns of *P. sorghi* isolates from Africa and America; and more similar to those of *P. maydis*.

Entry potential: The fungus is seed-borne, either as mycelium in immature seeds, or oospores in the pericarp and pedicel of the seed, so the entry potential is high. While there is evidence that seed transmission can be prevented by reducing the moisture content of the seed to 9% and by storage for 40 days prior to planting, other experiments suggest that the presence of oospores within the seed results in the transmission of the fungus, regardless of seed moisture content (Rao *et al*., 1984). The fungus could also be introduced in bulk maize shipments as oospores in trash and soil.

Establishment potential: The establishment potential of the pathogen is high, as environmental conditions favourable for its growth occur in many of the maize growing areas of Australia. Oospores in or on seed, trash or soil are the likely primary inoculum. These spores require soil temperatures above 20°C for germination, and these temperatures occur in Australia in summer when maize crops are grown. Suitable temperatures for conidial production and germination also occur during this period. The close proximity of maize and sorghum crops to many of the feed lots where the imported maize would be used in Australia increases the risk of establishment should spillage of grain, trash or soil occur. The wide distribution of Johnson grass in northern Australia, especially along roadways, also provides a perennial source of susceptible host material.

Spread potential: The spread potential of the pathogen is high, as oospores can be spread long distances by wind, in seed and crop residues, and in soil on farm machinery. Conidia can also spread the disease locally within crops.

Economic importance: Sorghum downy mildew is a serious disease of both maize and sorghum in the tropics and subtropics, and is the most widely distributed of the major downy mildew diseases of these crops. Severe outbreaks have occurred in India, Israel, Mexico, Thailand, Texas and Venezuela. In Nigeria, grain yield losses in maize from this disease range from 10 to 90%. In Texas, the disease incidence can be 30% or higher given favourable environmental conditions.

Estimated risk: The quarantine risk presented by this fungus is high, given the presence of oospores in seed, maize trash and soil, the longevity of these spores, the suitability of the climate in Australia for disease development, the wide distribution of susceptible hosts, and the economic importance of this disease.

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Maize dwarf mosaic potyvirus (MDMV)

Species: Maize dwarf mosaic potyvirus (MDMV).

Synonym(s): MDMV-A; MDMV-D; MDMV-E; MDMV-F.

Common name(s): Maize dwarf mosaic (MDM).

Host(s): *Sorghum bicolor, S. halepense* and *Zea mays* (Ford *et al.*, 1989).

Part of plant affected: Whole plant.

Distribution: China, South Africa and the USA (Brunt *et al.*, 1996). Reported from North Carolina (Vangessel & Coble, 1993), Ohio (Janson & Ellett, 1963), Texas (Horn, 1996) and Georgia (Baird & Lee, 1999) in the USA.

Biology: Early symptoms are shortening of the upper inter-nodes and finely stippled light and dark green mottles or mosaics on the youngest leaves. Symptoms persist as plants mature. Infected maize plants are stunted, and may be barren or show poor seed set.

The virus is seed transmitted in dent maize at frequencies from 0.007% to 0.4% (Mikel *et al.*, 1984). MDMV seed transmission rate may be as high as 15% in susceptible cultivars (Personal communication from Prof. Donald T. Gordon, Ohio State University, Ohio, USA to Dr. Sharan Singh). MDMV is transmitted in a non-persistent manner by many species of aphids, and is spread in maize crops by transient winged (alate) aphids (Vangessel, 1993). A strong correlation has been demonstrated between aphid numbers in traps and the incidence of MDMV (Vangessel, 1993).

Recent investigations of the taxonomy of aphid-borne potyviruses infecting species of Poaceae have shown that virus isolates previously included as strains of sugarcane mosaic virus comprise four distinct potyviruses: maize dwarf mosaic potyvirus; Johnson grass mosaic potyvirus; sugarcane mosaic potyvirus; and sorghum mosaic potyvirus. The corn leaf aphid (*Rhopalosiphum maidis*) plays an important role in spread of the virus from Johnson grass to maize.

Entry potential: The virus is seed-borne, therefore, entry risk is high.

Establishment potential: MDMV is seed transmitted in dent corn at up to 0.4%, so the risk of establishment is high. In addition to maize, the virus infects *Sorghum bicolor* and *S. halepense*. The presence of these hosts would favour establishment. Maize is grown in Australia at temperatures (< 16 °C) which favour infection.

Spread potential: Infected seeds are an important source of spread of MDMV. It is spread by many species of aphids.

Economic importance: The disease is important in the USA where yield losses have been reported (Gregory & Ayers, 1982). MDMV is part of the complex of viruses causing corn lethal necrosis (Uyemoto *et al*., 1981).

Estimated risk: Very high. The virus infects sorghum as well as maize. Johnson grass can act as a reservoir for the virus.

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High Plains virus (HPV)

Species: High Plains virus (HPV).

Synonym(s): None.

Common name(s): High plains disorder.

Host(s): *Zea mays* and *Triticum aestivum.*

Part of plant affected: Whole plant.

Distribution: Spreads in the USA High Plains and Rocky Mountain regions from eastern Nebraska to western Idaho, and from Montana and South Dakota to the Texas Panhandle. The virus has also been found in sweetcorn in Florida (Jardine *et al*., 1994; Jensen & Lane, 1994; Jensen, 1996; Mahmood *et al*., 1998).

Biology: HPV is a newly discovered viral disease of sweetcorn in USA. The disease, identified in the summer of 1993 in several High Plains states, produces interveinal chlorotic lesions, which are often most severe on lower leaves and leaf tips. Rapid systemic spread of the virus results in plant stunting and death (Marcon *et al*., 1997).

> **Entry potential:** The virus has been detected in seeds, therefore, entry risk is very high.
>
> **Establishment potential:** As the pathogen is seed-borne and has been shown to be seed-transmissible in maize, the establishment risk is very high. The virus also infects wheat, and the abundance of this host would favour establishment.
>
> **Spread potential:** The virus is transmitted by *Aceria tosichella*, which also transmits wheat streak mosaic virus (Marcon *et al*., 1997). As this vector is not present in Australia, spread potential is very low.

Economic importance: The virus was first recorded in USA on wheat and maize plants from Texas and Idaho, and in 1994 the disease was observed in Kansas and Colorado. By the end of 1995, HPV had been confirmed in maize and wheat samples from nearly 100 counties in an area extending from the Texas panhandle to eastern Nebraska, to central South Dakota, western Idaho, and back through Colorado to eastern New Mexico and Texas (Jensen *et al*., 1996). Since then, it has been found more frequently over a much wider area, probably due to greater awareness and surveillance (Marcon *et al.,* 1997). Yield losses in maize to 75% have been reported from the USA (Jensen *et al*., 1996).

Estimated risk: This virus constitutes a high phytosanitary risk because it is economically important, not present in Australia, seed borne, and seed transmissable. Importation of this virus in seed is not only a threat to the maize industry, but is also a threat to the wheat industry in Australia.

Key references:

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Wheat streak mosaic rymovirus (WSMV)

Species: Wheat streak mosaic rymovirus (WSMV).

Synonym(s): None.

Common name(s): Wheat streak mosaic (WSM).

Host(s): Natural - *Echinochloa* spp., *Panicum* spp., *Setaria* spp., *Triticum aestivum* and *Zea mays* (some cultivars only) (Brunt *et al.,* 1996).

Part of plant affected: Whole plant.

Distribution: Spreads in Canada, Jordan, Romania, and the USA (Brunt *et al.*, 1996). Reported from Arkansas (Anon, 1999), Colorado (Brown *et al*., 1994), Idaho (Finley, 1957), Iowa (Hill *et al*., 1974), Kansas (Niblett & Claflin, 1978), Kentucky (Townsend *et al*., 1996), Nebraska (Mahmood *et al*., 1998), South Dakota (Gardner, 1981) and the Central Great Plains (Wiese, 1987).

Biology: Symptoms consist of small oval to elliptical spots on the tips of older leaves, often accompanied by general chlorosis. Very susceptible lines may have poorly developed ears with little or no seed set. General yellowing and severe stunting of the plant may occur. WSMV is transmitted by mechanical inoculations but is not transmitted by contact between plants.

> **Entry potential:** The most likely means of entry is via vegetative material, seeds, or through the vector. The virus has been detected in seeds (Hill *et al.*, 1974), therefore, entry risk is very high.
>
> **Establishment potential:** WSMV is seed transmitted, therefore establishment risk is very high. It has been reported to be naturally seed transmitted at low levels of incidence (Hill *et al*., 1974). In addition to maize, the virus infects wheat. The presence of this host would favour establishment.
>
> **Spread potential:** The virus is transmitted by seed and by the wheat curl mite (*Aceria tulipae*, synonym: *Eriophyes tulipae*) (Nault *et al*., 1967). The mites overwinter on winter wheat then leave the crop as it matures and are blown by the wind to spring wheat, barley and corn. As this mite has not been recorded in Australia, spread potential risk is low.

Economic importance: WSMV causes severe mosaic of winter wheat. It is a minor pathogen of sweetcorn, although severe outbreaks have been reported from Idaho, USA (Finley, 1957). Infected corn provides an oversummering host for wheat in midwest USA (Gardner, 1981). MSMV is part of a viral complex associated with lethal necrosis. The complex can also cause the aberrant ratio mutation effect (Brakke & Samson, 1981).

Estimated risk: Very high. Importation of the disease through seed is certainly a threat, not only to maize, but also to the wheat industry in Australia.

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Sclerospora graminicola

Species: *Sclerospora graminicola,* (Sacc.) J. Schröt.;
Oomycetes; Peronosporales; Peronosporaceae.

Synonym(s): *Peronospora graminicola* Sacc.

Common name(s): Graminicola downy mildew; green ear disease.

Host(s): *Agrostis alba, Chaetochloa* spp., *Echinochloa crus-galli, Sorghum* spp., *Setaria italica, Euchlaena* spp., *Panicum miliaceum, Pennisetum glaucum, Saccharum officinarum, Zea mays* and *Zea mexicana* (Frederiksen & Renfro, 1977).

Part of plant affected: Leaves, stems, roots and inflorescence.

Distribution: Widespread on all continents except Australia (Farr *et al.*, 1989).
Asia: Bhutan, China, India, Iran, Israel, Japan, Kazakhstan, Korea, Pakistan Taiwan and Yemen (Jeger *et al.*, 1998; SBML, 1999).
Africa: Burkina Faso, Chad, Egypt, Ethiopia, Gambia, Ghana, Ivory Coast, Kenya, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe (Jeger *et al.*, 1998; SBML, 1999).
Europe: Bulgaria, Caucasus, Czechoslovakia, France, Hungary, Italy, Netherlands, Poland, Romania, Spain, Switzerland and Yugoslavia,(Jeger *et al.*, 1998; SBML, 1999).
Central America/Caribbean: Puerto Rico (Jeger *et al.*, 1998; SBML, 1999).
North America: Canada, Mexico, USA (Florida, Hawaii, Iowa, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Mexico, New York, North Dakota, Oklahoma, South Dakota, Texas, Virginia, Washington and Wisconsin) (Jeger *et al.*, 1998; SBML, 1999).
Oceania: Fiji (SBML, 1999).
South America: Argentina (Jegger *et al*., 1998).

The pathogen has been found in maize only in the USA (Iowa, Oklahoma and Wisconsin), and South Africa (SBML, 1999).

Biology: *Sclerospora graminicola* causes grey blotching and mottling of leaves, with white downy growth development on discoloured areas. Stunting and chlorotic streaks or stripes are common symptoms. This pathogen has been infrequently reported on maize, however it causes ‘green ear disease’, a major disease of millets and foxtail grasses. There is considerable variation in the symptoms, which almost always develop as a result of systemic infection. Symptoms vary according to host and ambient conditions. Under field conditions systemic infection has been observed as early as 6 days after sowing. Systemic symptoms generally appear on the second leaf, and once these appear, all the subsequent leaves and panicles also develop symptoms (Singh & King, 1988). The disease can also appear on the first leaf under conditions of severe disease development.

Leaf symptoms begin as chlorosis at the base of the leaf lamina, and this chlorosis increases in area on successive leaves. 'Half-leaf' symptoms, characterised by the diseased basal portion of the leaf and non-diseased areas towards the tip, occur in pearl millet genotypes. Under conditions of high humidity and moderate temperature, the infected chlorotic leaf area supports a massive amount of asexual sporulation. This generally occurs on the abaxial surface of the leaves, giving them a downy appearance.

If infection begins early, plants are severely stunted and chlorotic, and may die. If infection is delayed, dwarfing may occur, or some shoots may escape the disease. Severely infected plants are generally stunted and do not produce panicles. The name 'green ear' stems from the appearance of green panicles due to transformation of floral parts into leafy structures, which can be total or partial. This is sometimes referred to as virescence. These leafy structures can also be chlorotic, and sometimes support sporulation. In certain cases, green ear is the only manifestation of the disease.

Primary infection occurs from oospores in the soil. In India, oospores may survive in soil for at least three years. Some remain viable after passage through the alimentary canal in cattle. The mode of germination is still uncertain. Light rains favour disease development and spread. Heavy dews and moderate night temperatures are optimal for production of sporangia. Secondary spread to other hosts is by windborne sporangia. Temperatures of 24-32°C for two days after sowing are conducive to heavy infection. The optimal temperature for sporangial formation and germination is 17°C with the maximum at 34°C.

Oospores may also be seed-borne. Transmission of *S. graminicola* from seed to seedling was obtained from mycelium and a 2-year-old *Pennisetum glaucum* seed sample contaminated with oospores. Seedlings were grown out in peat-soil in a growth chamber. Diseased seedlings developed from seed which had been naturally infected or contaminated by mycelium, from seed with oospores on the surface and from seeds artificially inoculated with oospores (Shetty *et al*., 1980).

Oospores can be transported to new areas by measures other than seed. They can be spread by the strong winds and frequent localised whirlwinds characteristic of the hot dry seasons in the tropics, which can move dust and soil particles considerable distances. They can also be spread in farmyard manure, by cattle walking through infested fields, and on implements during routine farming activities.

Pathogenic variability in *S. graminicola* has been reported (King *et al*., 1989). Two mating types have been identified and are considered to be necessary for the production of oospores, illustrating the heterothallic nature of the pathogen (Michelmore *et al*., 1982). Mating types produced by collections of the pathogen from South Africa are compatible with those produced by collections of the pathogen from West Africa (Idris & Ball, 1984).

Entry potential: The fungus is seed-borne on pearl millet, but not on maize (Shetty *et al*., 1980), therefore, it could enter Australia as oospores in soil or maize trashl.

Establishment potential: Environmental conditions favourable for the growth of the pathogen are experienced in many of the maize growing areas throughout Australia. The establishment potential of the pathogen is estimated to be high.

Spread potential: Oospores can spread the pathogen into disease free areas, either in maize trash or soil in maize grain, or on the seed of other grasses. Once established, wind and rain spread the pathogen locally.

Economic importance: This is a minor disease of maize but is a major disease of pearl millet (Bonde, 1982). Some observations indicate 27% loss in pearl millet due to *S. graminicola* from 1962 to 1964 in Rajasthan, India (Mathur & Dalela, 1971). According to reports from Africa, there was 10% loss in Nigeria (King & Webster, 1970), and 0-50% in other West African countries (Nene & Singh, 1976).

Estimated risk: *Sclerospora graminicola* is an important pathogen of millets. If introduced, it will pose a threat to both the maize and millet industries in Australia.

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Phymatotrichopsis omnivora

Species: *Phymatotrichopsis omnivora* (Duggar) Hennebert; Hypomycetes; Aphyllophorales.

Synonym(s): *Phymatotrichum omnivorum* Duggar; *Ozonium omnivorum* Shear.

Common name(s): Phymatotrichum root rot; Texas root rot; Maladie du Texas du cotonnier; Wurzelfaeule der Baumwolle; Purdricion texana.

Hosts: *Gossypium herbaceum, G. hirsutum* and *G. barbadense* are the major crop hosts of this fungus. The fungus can attack more than 2000 species of dicotyledons (Farr *et al*., 1989). This fungus has been reported on maize from Texas (USA) only.

Part of plant affected: Roots, plant.

Distribution: Confined mostly to the calcareous clay soils of the south-western USA (Arizona, Arkansas, California, Louisiana, Nevada, New Mexico, Oklahoma, Texas and Utah) and northern Mexico. Also reported from Brazil and Venezuela (Farr *et al*., 1989).

Biology: No information is available on the biology of *Phymatotrichopsis omnivora* on maize. On cotton, the infection of the root system early in the season does not cause above ground symptoms (Rush *et al*., 1984). Symptoms only become conspicuous during summer, as a sudden wilting of the plant, with or without prior chlorosis of the leaves. The foliage droops, turns brown and may remain hanging on branches for a few days before dropping off to leave a bare, dead stalk. At this stage, the roots are dead and their surface is covered with a network of tawny-yellow fungal strands. If there is abundant water, brown to black wart-like sclerotia on the surface roots are also seen. The cortex of the dead roots is soft and readily peels off. The conidial stage develops on the ground, near the margin of the zone of dying plants in the form of cushion-like, creamy yellowish masses. These spore mats are not often found in cotton fields. Dead plants occur in localised areas that expand in warm, moist conditions. In severe cases, entire fields are covered with dead plants.

The disease occurs most commonly on heavy calcareous soils. The primary inoculum source is sclerotia, or strands surviving on roots of host plants. High winter temperatures favour survival (Wheeler & Hine, 1972). The fungus spreads as fine mycelial strands, which traverse the soil and infect other roots. Strands do not survive for one year on roots of killed cotton plants remaining in the soil, and strands buried 25 cm deep in the rhizosphere of cotton plants in the field did not survive for more than 3 months. Thus, strands only overwinter on live cotton roots. Sclerotia, however, can survive in an inactive state for 10 years or more. Sclerotia and strands can tolerate high levels of CO_2. After heavy summer rain, large tawny mycelial mats may form on the soil surface, on which conidia are borne. These spores germinate with difficulty or not at all, and probably play no part in the dissemination of the fungus. Root rot in cotton is favoured by temperatures over 22°C and relatively high soil moisture levels (Rush *et al*., 1984).

Entry potential: The fungus is not seed-borne, but could enter Australia as sclerotia on root debris or in contaminated soil.

Establishment potential: The risk of establishment in Australia is difficult to estimate. In the US and Mexico, the fungus is confined mostly to calcareous clay soils. Soils of this type occur over large areas of semi arid and arid Australia. The occurrence of suitable soils, the longevity of sclerotia, and the wide host range of the fungus, suggest there is a moderate risk of this fungus becoming established in Australia.

Spread potential: Under natural conditions, as a soil-borne pathogen, *Phymatotrichopsis omnivora* has low dispersal potential. It persists at certain locations where soil conditions are favourable, and does not very readily spread. It is most likely to be transported by humans, with soil or on roots of infected plants. Sclerotia and infected roots of host plants are the main source of introduction and spread of this fungus into disease free areas.

Economic importance: The fungus is most serious on cotton, where it kills plants before maturity, reduces yield and quality by killing partly developed bolls, and reduces lint quality in plants which survive until harvest. Yield losses of 2% in Texas (USA) have been reported, which amounts to an annual loss exceeding US$25 million (Watkins, 1981). On sunflowers, the fungus alone delays seed germination, and this combined with late planting may result in significant losses (Orellana, 1973). In general, there is relatively little information on hosts other than cotton in the research literature, perhaps because cotton is the main crop grown on the calcareous clay soils where the fungus occurs.

Estimated risk: High. Texas root rot is generally considered one of the most destructive plant diseases known. It occurs most commonly on heavy calcareous soils, which occur over large areas of semi arid and arid Australia. If introduced, it will pose a serious threat to the cotton industry in Australia; and to native vegetation given its wide host range.

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Maize chlorotic mottle machlomovirus

Species: Maize chlorotic mottle machlomovirus (MCMV).

Synonym(s): None.

Common name(s): Maize chlorotic mottle (MCM).

Host(s): Natural - *Zea mays* (Brunt *et al.*, 1996).

Part of plant affected: Whole plant.

Distribution:
Western Hemisphere: Argentina, Mexico, Peru and USA (Hawaii, Kansas and Nebraska,) (Brunt *et al.*, 1996).

MCMV has been reported in several countries throughout the Western Hemisphere including Argentina, Mexico, Peru and the USA. MCMV is probably also present but not yet reported in other Western Hemisphere countries. Its vector, *Diabrotica* spp., are strictly New World species; thus MCMV has the potential to be present and become established in any maize-growing region within the Western Hemisphere.

In Nebraska and Kansas (USA), MCMV was initially restricted to the Republican River valley which borders these two states (Uyemoto, 1983). In Kauai, Hawaii the virus is present in winter nursery maize breeding plots (Jiang *et al.*, 1992). It is important to note that MCMV and maize mottle chlorotic stunt virus, which is endemic to tropical Africa, are two distinct and unrelated viruses (Thottappilly *et al.*, 1993). The two taxonomically, morphologically and geographically distinct viruses should not be confused because of their similar names.

Biology: For field-grown maize infected with MCMV, growth is stunted with the formation of short internodes. Leaf symptoms begin as chlorotic stripes running parallel to the veins which later coalesce to produce elongated chlorotic blotches, finally resulting in leaf necrosis and epinasty. In severe infections of particularly susceptible lines, leaf necrosis can result in plant death. A general observation is that the younger the maize plant is when MCMV infects, the more severe the stunting and symptoms become. MCMV has been detected by serological methods in all parts of an infected maize plant, including leaf, stem, roots, cob, husk, silk, kernel, seed, anther and sheath tissues (Jiang *et al.*, 1992).

When MCMV co-infects maize with any potyvirus, a synergistic interaction occurs, causing a severe disease called corn lethal necrosis (CLN). In maize the most common potyviruses found in co-infections with MCMV is maize dwarf mosaic potyvirus (MDMV). Symptoms of corn lethal necrosis are much more severe than the additive symptoms of either MCMV or the potyvirus virus alone. The virus complex causes a severe systemic necrosis which culminates in death of the plant (Niblett & Claflin, 1978; Uyemoto *et al.*, 1980; Uyemoto *et al.*, 1981). The titre of MCMV in plants infected with both MCMV and a potyvirus is more than five times higher than in plants infected with MCMV alone (Goldberg & Brakke, 1987). Three strains or serotypes have been reported: Kansas serotypes 1 and 2, and the Peru serotype

(Uyemoto, 1980). MCMV is a mechanically transmissible virus like MDMV and wheat streak mosaic virus.

Bockelman *et al*. (1982) were unable to detect seed transmission of MCMV in several maize inbred and hybrid lines. Castillo and Hebert (1974) also did not observe seed transmission in a hybrid maize line. Jensen *et al*. (1991), however, found 17 MCMV infected seedlings grown out in a greenhouse from 42,000 maize seeds and Delgadillo-Sanchez *et al*. (1994) detected the virus in two of 12,910 sweetcorn plants and one of 12,020 white-grained dent maize plants after seed transmission. These studies clearly established that MCMV is seed transmitted at a low level.

The virus is easily transmitted mechanically in the laboratory. Extensive research has been conducted on how MCMV is transmitted and maintained in nature, particularly during maize-free periods. MCMV can be transmitted by the cereal leaf beetle (*Oulema melanopus*), the corn flea beetle (*Systena frontalis*) and *Chaetocnema pulicaria*, the southern corn rootworm (*Diabrotica undecimpunctata*), the northern corn rootworm (*D. longicornis*) and the western corn rootworm (*D. virgifera*) (Nault *et al*., 1978; Reyes & Castillo, 1988; Jensen, 1985). In Hawaii, MCMV has been shown to be transmitted by the thrip, *Frankliniella williamsi* (Jiang *et al*., 1992).

Entry potential: The most likely means of entry is via vegetative material or through the vector. The virus is seed-borne (Jensen *et al*., 1991), therefore entry risk is high. In a study that was performed to explain a sudden outbreak of MCMV in Hawaii, MCMV was identified by ELISA in 17 seedlings grown out in a greenhouse from 42,000 maize seeds harvested from symptomatic plants in commercial winter nurseries in Hawaii (Jensen *et al*., 1991). Seedborne infection was later confirmed in Hawaii-produced maize seed (Jiang *et al*., 1992) and in sweetcorn seed (Delgadillo-Sanchez *et al*., 1994). In earlier studies where seed transmission was not observed, only 800-2153 seedlings were assayed (Castillo & Hebert, 1974; Bockelman *et al*., 1982). It is generally concluded that the sample size in the studies where seed transmission was not observed was too small to detect the low level of MCMV seed transmission.

Establishment potential: The virus has been reported to be naturally seed transmitted at very low levels (Jensen *et al.*, 1991), therefore, establishment risk will be high. In Kansas and Nebraska (USA), MCMV infections re-occur in the same locations within maize fields year after year. This observation has led to the hypothesis that the virus is maintained in the soil from season to season (Uyemoto, 1983). There are conflicting reports as to whether MCMV can survive in maize residues during maize-free periods (Uyemoto, 1983; Montenegro & Castillo, 1996). The virus has been shown to over-winter in ploughed corn stubble. It is also hypothesised that the larval stages of the corn rootworms, that have been shown to successfully transmit the virus, are capable of harbouring infectious virus during the host-free periods (Uyemoto, 1983).

It is now thought that MCMV can be introduced into geographically distinct maize-growing regions by the introduction of an infected plant or by seed transmission. Once present, the virus can then persist in the region by infection in maize or by over-wintering in the larval stages of the vector when the maize host is not present.

Spread potential: Infected seeds are the main source of spread of this virus. The virus is transmissible by the cereal beetle, corn flea beetle and corn rootworm (Nault *et al.*, 1978).

Economic importance: In Peru, losses in floury and sweet maize varieties due to MCMV have been reported to average between 10 and 15%. In Kansas crop losses due to corn lethal necrosis have been estimated to be between 50 and 90% (Uyemoto *et al*., 1980; Niblett & Claflin, 1978) depending on the variety of maize and the year.

Estimated risk: Very high. Introduction of the disease through seed is a definite possibility. Seed transmission of MCMV is a threat to the maize industry in Australia.

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Cercospora zeae-maydis

Species: *Cercospora zeae-maydis* Tehon & Daniels; Hyphomycetes.

Synonym(s): None.

Common name(s): Gray leaf spot (GLS).

Host(s): *Zea mays* (Farr *et al*., 1989).

Part of plant affected: Leaf.

Distribution: USA (Delaware, Illinois, Kentucky, Maryland, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia and West Virginia), West Indies and South America (Farr *et al*., 1989; Saghai Maroof *et al*., 1993).

Biology: Lesions on maturing maize leaves are pale brown or gray to tan, long, narrow and rectangular; being characteristically restricted by the veins. The lesions may coalesce, killing the leaves. The disease is usually first noticed attacking the lower leaves. Extensive leaf blighting may occur until all the leaves are killed, finally resulting in stalk breakage and lodging. Total loss may occur if gray leaf spot infection occurs early and favourable environmental conditions exist following infection.

Gray leaf spot is a polycyclic disease that is sensitive to agronomic practices, such as conventional tillage, that reduce primary inoculum. The pathogen overwinters in corn debris, and it has been demonstrated that GLS is more severe in fields where conservation tillage is practised than in conventionally tilled fields.

Single spore isolates of *Cercospora-zeae maydis* from different regions of the USA differ in growth rates and production of the phytotoxin cercosporin. DNA finger printing has distinguished two groups that are significantly different from each other. The most prevalent group is distributed throughout corn production regions of the USA, while the other group is localised in the eastern third of the USA. Both are pathogenic on maize, and differences in virulence are not obvious. The isolates within each group are relatively uniform genetically. Thus, there is little potential for the emergence of races or pathotypes of the pathogen.

Entry potential: The fungus is not seed-borne, but could enter the country on infected vegetative material or trash.

Establishment potential: The pathogen over-winters on the debris of previously diseased corn plants remaining on the soil surface. In spring, conidia are produced and disseminated to corn plants by wind and rain splash. Conidia require several days of high relative humidity to successfully germinate and infect maize leaves. Several weeks may be needed for the development of mature lesions on leaves. Conidia for secondary spread are produced from two to four weeks after initial leaf infection. Tillage systems that leave sufficient diseased crop residue on the soil surface provide sufficient primary inoculum to produce severe levels of gray leaf spot (de Nazareno *et* *al*., 1993). Abundant moisture, suitable temperatures, host susceptibility and the presence of infested residues on the soil surface, are necessary for the pathogen to cause an epidemic.

Spread potential: The pathogen can survive up to one year on maize debris (de Nazareno *et al*., 1992), which can spread the pathogen into disease free areas. Conidia from lesions on residue are the primary inoculum source for initiating new infections (de Nazareno *et al*., 1993). Once the pathogen is established, secondary conidia produced from two to four weeks after initial leaf infection are disseminated locally by wind and rain.

Economic importance: Gray leaf spot is a severe foliar disease of maize, and is one of the major yield-limiting diseases of maize in the United States (Ringer & Grybauskas, 1995). Since the early 1970s, the prevalence and severity of GLS has increased markedly in the eastern United States from South Carolina to New York and west to Tennessee (Saghai Maroof *et al*., 1993). Losses due to reduced grain fill and lodging can be considerable in seasons favourable for disease development. Yield losses are estimated to be between 10 and 25% annually in areas where GLS is endemic, but they can be much higher (Saghai Maroof *et al*., 1993).

Estimated risk: This fungus represents a high quarantine risk to Australia in imported maize from the USA. Large quantities of trash could introduce this disease into Australia.

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Pantoea stewartii subsp. *stewartii*

Species: *Pantoea stewartii* subsp. *stewartii* (Smith) Mergaert *et al*. 1993;
Halobacteriales; Enterobacteriaceae.

Synonym(s): *Erwinia stewartii* (Smith) Dye 1963; *Aplanobacter stewartii* (Smith) McCulloch 1918*; Bacterium stewartii* (Smith) Smith 1905*; Bacillus stewartii* (Smith) Holland 1920; *Phytomonas stewartii* (Smith) Bergey *et al.* 1923; *Xanthomonas stewartii* (Smith) Dowson 1939.

Common name(s): Stewart's bacterial wilt; Stewart's wilt; Stewart's leaf blight; Stewart's disease; maize bacteriosis; maladie de stewarte, fletrissemnet bacterien.

Host(s): Natural - *Euchlaena mexicana*, *Tripsacum dactyloides* and *Zea mays*; by inoculation - *Coix lachryma-jobi, Setaria pumila* and *Zea perennis*.

Part of plant affected: Leaves, stems, inflorescence and seeds.

Distribution:
Asia: China, India, Malaysia, Thailand and Viet Nam (Pepper, 1967; Smith, *et al*., 1997)
Europe: Austria, Greece, Poland, Romania and Russia (Smith, *et al*., 1997).
North America: Canada, Mexico and USA (Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, Washington, West Virginia and Wisconsin) (Pepper, 1967; Smith *et al*., 1997).
Central America and Caribbean: Costa Rica and Puerto Rico (Smith *et al*., 1997).
South America: Brazil, Guyana and Peru (Smith *et al*., 1997).

Biology: Stewart's bacterial wilt is an important disease of maize, causing a severe early season wilt of susceptible sweetcorn and a late season leaf blight of susceptible sweetcorn and dent maize. Sweetcorn is more susceptible to this pathogen than dent maize, but there are some very susceptible dent maize inbred lines and hybrids (Shurtleff, 1980).

In sweetcorn, susceptible hybrids wilt rapidly and resemble plants with an inadequate water supply. Infected plants that do not die are stunted and may produce no ears. Diseased plants frequently show short to long irregular pale-green to yellowish streaks on the leaves. Seedlings of very susceptible dent maize hybrids and inbreds may wither and die. These symptoms are known as the leaf-blight or late infection stage, generally occurring after tassel emergence. The streaked areas, which die and become straw-coloured, originate from feeding wounds of *Chaetocnema pulicaria*. Entire leaves may die and dry up. Premature leaf death predisposes the weakened plant to stalk rot disease and reduced yields. Infected plants may produce premature, bleached and dead tassels. Cavities may form in the stalks of severely infected plants near the soil line. In such plants, bacteria spread throughout the vascular system, sometimes infecting the kernels. Bacterial exudate may ooze through stomata of the inner husks in cases of severe infection. The surface of the enveloped kernels may then be covered with bacterial slime. Mineral nutrition influences disease intensity, and high temperatures aggravate disease severity.

The bacterium overwinters in seed, soil and maize stalks, but the main means of overwintering in the USA is corn flea beetle, *Chaetocnema pulicaria*. This beetle migrates and can be carried over considerable distances in air currents. Once the bacteria have been acquired, the insect can carry and transmit them throughout its life (Smith *et al*., 1997). The intensity of the disease generally coincides with population levels of this vector. Mild winters favour insect build up and disease incidence the following spring (Forgey *et al.*, 1982). In the USA, disease severity can be forecast on the basis of the average temperatures during December, January and February, which are linked to the survival of *C. pulicaria* (Castor *et al.*, 1975). Other vectors include *Agriotes mancus* (wheat wireworm), *Chaetocnema denticulata, Delia platura* (onion maggot), *Diabrotica longicornis, Diabrotica undecimpunctata howarti* (twelve-spotted cucumber beetle), *Hylemya cilicrura* (seed corn maggot) and *Phyllophaga* sp. (May beetle) (Shurtleff, 1980; Smith *et al*., 1997), but only *Chaetocnema pulicaria* is known to be important in overwintering and spread of this bacterium in the USA (Munkvold *et al*., 1996).

Khan *et al*. (1996) found that plant to seed transmission of the pathogen is low in dent and sweetcorn inbred currently used as seed parents. This is probably due to the high level of resistance in the plants that prevent systemic infection. They found that *Pantoea stewartii* was only detected in seed produced from plants that were systemically infected, while the bacterium was not isolated from seed from hybrids or inbreds with nonsystemic infection..

Virulence of strains of *P. stewartii* has been studied extensively at the molecular level. Most virulent strains had 11-13 plasmids (Coplin *et al*., 1981). Pathogenicity genes from *P. stewartii* have been cloned and studied using complementation analysis. These genes are required for both water-soaked lesion formation and wilting on maize seedlings, but may not be required for the initial growth of the bacterium (Coplin *et al*., 1992).

Entry potential: The main means by which the bacterium would gain entry into the country is by infected seed. The pathogen is seed-borne (Lamka *et al.*, 1991), therefore, entry risk is high.

Establishment potential: Seed to seedling transmission rates are very low, therefore establishment risk is low. Block *et al*. (1992) recovered *P. stewartii* from only nine of 4,058 seedlings grown from seeds produced on diseased plants. In a subsequent trial, Block *et al*. (1994) observed only 29 infected seedlings grown from nearly 53,600 seeds of infected plants. Transmission of the bacterium from seed to seedlings has not been observed in several hundred seed lots certified for domestic and export use by the Illinois Crop Improvement Association, even though *P. stewartii* was detected in leaves of plants sampled from the fields in which the seed was produced (Khan *et al*., 1996).

Spread potential: Infected seeds, soil, manure and plant debris are the main sources of spread of the disease into disease free areas. In the USA, these means of spread are of little importance compared with spread by the beetle, *Chaetocnema pulicaria*. In the absence of this vector in Australia, it is likely that spread of this bacterium would be limited. Of the recorded vectors of *P. stewartii*, only the onion maggot, *Delia platura*, has been recorded in Australia. This vector is unlikely to be of significance, as only *Chaetocnema pulicaria* is known to be important in overwintering and spread of this bacterium (Munkvold *et al*., 1996). However, a number of leaf and flea beetles have been recorded on maize in Australia, and these require evaluation as potential vectors of *P. stewartii*. They include *Aulacophora hilaris* (pumpkin flea beetle), *Monolepta australis* (red shouldered leaf beetle), *Rhyparida dimidiata* (sugarcane leaf beetle) and *Rhyparida limbatipennis* (brown swarming leaf beetle) (Stout, 1982; Paton, 1988).

Economic importance: Severe losses were reported from Italy (Veneto region) prior to the 1950s, following the use of seed imported from the USA (Smith *et al*., 1997). The disease has not persisted in Italy to any significant extent, presumably because of the absence of an effective vector. Outbreaks of the disease in 1990 and 1992 caused substantial losses to the seed corn industry in Iowa. In 1995, the disease caused heavy losses in Illinios (Pataky *et al*., 1996). In general, *P. stewartii* is much more destructive on sweetcorn than on dent maize. Susceptibility and time of infection influence the extent of losses (Pataky & Eastburn, 1993). In sweetcorn hybrids inoculated in a nursery, the disease caused virtually no yield loss in resistant hybrids, but susceptible hybrids experienced losses of 40-100% when inoculated at the three- to five-leaf stage, 15-35% when inoculated at five to seven leaves, and 0% when inoculated at seven to nine leaves (Pataky & Eastburn, 1993). Khan *et al*. (1996) suggested that quarantine restrictions on the movement of seed produced on wilt resistant inbred lines are probably unnecessary as the bacteria do not become systemically distributed within these plants.

Estimated risk: The bacterium is indigenous to America and has been introduced to other parts of the world with maize seed. Severe losses occurred in Italy following the use of seed imported from the USA (Smith *et al*., 1997). The insect vectors only carry the disease locally and are unlikely to be carried on grain, so the principal pathway for international movement is in or on infected seeds. Maize is grown extensively in Australia, and environmental conditions are suitable for disease development. As the pathogen can cause significant yield losses, this bacterium represents a quarantine risk to Australia. This risk is difficult to quantify until local insects have been evaluated for their potential to vector the bacterium.

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Smith, I.M., McNamara, D.G., Scott, P.R., and Holderness, M. (1997). Quarantine Pests for Europe. University Press, Cambridge. 1425 pp.

Stout, O. (1982). Specific Survey of Agricultural Pests and Diseases in the South Pacific. Plant Quarantine Guidelines in the Pacific Region. UNDP / FAO.

Clavibacter michiganensis subsp. *nebraskensis*

Species: *Clavibacter michiganensis* subsp. *nebraskensis* (Vidaver & Mandel); Davis *et al*. 1984; Eubacteriales; Corynebacteriaceae.

Synonym(s): *Corynebacterium nebraskense* Vidaver & Mandel 1974; *Corynebacterium michiganense* pv. *nebraskense* (Vidaver & Mandel) Dye & Kemp 1977.

Common name(s): Goss's bacterial wilt and blight; Goss's wilt; Nebraska leaf freckles and wilt; leaf freckles and wilt.

Host(s): Natural - *Zea mays*; by inoculation - *Saccharum officinarum*, *Sorghum bicolor*, *S. sudanense*, *Tripsacum dactyloides* and *Zea mexicana* (Bradbury, 1991).

Part of plant affected: Whole plant.

Distribution: USA (Illinois, Iowa, Kansas and Nebraska) (Bradbury, 1991).

Biology: The initiation and development of this disease is affected by the type and cultivar of maize planted, the presence of inoculum, and favourable weather. Wind or hail injuries to plants provide avenues for invasion, and the bacterium survives readily in irrigation water. Infection may occur through leaves or via roots and stems. This disease has been called a "warm weather disease" because the symptoms do not appear until mid-season to late-season, when mean daily temperatures are relatively high (Smidt & Vidaver, 1986). The pathogen was recovered from field-grown maize plants and crop residues throughout 1982 and 1983 in Nebraska, USA. Pathogen levels in crop residues were highest just after harvest in October, and declined by 4-5 orders of magnitude over winter, spring and summer (Smidt & Vidaver, 1986).

Discrete lesions, containing water-soaked streaks, appear parallel to leaf veins. As the streaks enlarge, droplets of bacterial exudate may appear on the surface. Early infections may cause seedlings to wilt, wither or die. Later infection results in stunting, wilting or leaf blight, which consists of grey to light-green to yellow stripes (these stripes are occasionally red on certain hybrids or inbreds) with wavy or irregular margins which follow leaf veins. Discrete, water-soaked spots (freckles) along the veins are characteristic of the disease. These spots are dark-green to blackish in appearance and look like freckles when infected leaves turn brown. Eventually, the coalescence of stripes results in a leaf scorch, reminiscent of the effects of drought.

Systemically infected plants may have discoloured vascular bundles. A dry or water-soaked to slimy-brown rot of the roots and lower stalk may occur. Plants at any stage of development can become infected, wilt and die. In Iowa, seed infection in leaf-inoculated susceptible plants reached 4% (Biddle *et al*., 1985).

Populations of *C. michiganensis* subsp. *nebraskensis* on growing plants increased 3-4 orders of magnitude throughout the growing season. The pathogen was isolated from the surfaces of plants in early June before disease symptoms were observed, suggesting an epiphytic phase in the field. Inoculation of the leaves of a susceptible maize inbred (A632Ht) with increasing numbers of inoculations of a rifampicin-tolerant strain of *C. michiganensis* subsp. *nebraskensis* resulted in an increase in pathogen populations in seeds, ear shanks and stalks (Biddle *et al*., 1990). Rocheford *et al*. (1985) found that injury from wind or sand provided avenues for infection. Milder field symptoms observed in 1982 and 1983 appeared to be related to cooler mean daily temperature during late May and June, compared with symptoms observed in 1980 and 1981, when the disease was more severe (Smidt & Vidaver, 1986).

Studies conducted in a controlled environment showed that the optimum temperature for bacterial growth on maize plants was 27°C, with a doubling time of 3.5 hours. At lower temperatures, the growth rate dropped, until at 12°C the doubling time was >9 hours. At 38°C, the bacterium died. When inoculated plants were shifted from a temperature regime that favoured bacterial growth (32/25°C day/night) to one that retarded growth (40/20°C) the growth rate decreased rapidly. However, when inoculated plants were shifted from a restrictive temperature to a permissive one, bacterial growth increased and rapidly reached its maximum rate (Smidt & Vidaver, 1986).

Variation among 50 strains of *C. michiganensis* subsp. *nebraskensis*, isolated from popcorn residue and maize plants in Nebraska, was assessed on the basis of colony colour and morphology on solid media, bacteriocin production, pathogenicity and bacteriophage sensitivity. Seven major groups were identified by the first three criteria; these were further subdivided by bacteriophage sensitivity, making a total of 20 subgroups that identify a minimum of 20 individual strains (Suparyono & Pataky, 1989). A total of 85 strains of *C. michiganensis* subsp. *nebraskensis* were classified by bacteriocin and bacteriophage typing into eight groups (Vidaver *et al*., 1981).

Entry potential: The main means by which the bacterium would be to gain entry into Australia is by infected seed. *C. michiganensis* subsp. *nebraskensis* has been detected in seeds, both externally and internally, and may be found in the vicinity of the endosperm, scutellum and embryo (Biddle *et al.,* 1990). As the bacterium is seed-borne, entry risk is very high.

Establishment potential: The bacterium is seed-borne and seed to seedling transmission has been demonstrated, so the establishment risk is high. The transmission of *C. michiganensis* subsp. *nebraskensis* to seedlings occurred at the rate of 1.6% when seeds harvested from heavily infected plants were planted in sterilised soil (Rocheford *et al*., 1985). Biddle *et al*. (1990) demonstrated that transmission did not take place from naturally infected seeds in sterilised soil or in the field but did occur at the rate of 0.1-0.4% from seeds inoculated by vacuum filtration and planted in sterilised soil. Seed-borne inoculum is of minor concern in an area where the disease is already established, but infected seeds could introduce the pathogen into new areas (Biddle *et al*., 1990).

Spread potential: Seed transmission occurs at low rates and may spread the disease over large areas. Seed-borne inoculum, however, is thought to be of minor significance in the epidemiology of the pathogen in areas where it is present, as the transmission rate of seed appears to be low. Within fields, the main source of inoculum is plant debris, with the pathogen possibly being dispersed by wind and rain.

Economic importance: The pathogen is confined to the USA. The disease was first discovered in Nebraska in 1969 and has gradually spread across the USA corn-belt. Losses are generally minor, but may be severe in individual fields (Wysong *et al*., 1973).

Estimated risk: The pathogen is seed-borne and seed transmissible, therefore, estimated risk is high.

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PART 2

Data Sheets on Six Low Risk Pathogens

Professor John Irwin

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March 1999

CONTENTS

Dolichodorus heterocephalus

Species: *Dolichodorus heterocephalus* Cobb

Common name: Awl nematode

Hosts: *Zea mays* (infrequent), and *Apium graveolens* (Orton Williams 1974)

Part of plants affected: Roots, plant

Distribution: USA (south-eastern states), South Africa

Biology: *Dolichodorus* is an ectoparasitic nematode that frequents wet soils. Feeding populations of this nematode cause root lesions, rotting and overall plant stunting. There are few reports in the literature concerning its pathogenicity to maize (Shurtleff 1980). Damage is confined to limited areas, but relatively small populations can cause serious damage.

Economic importance: Because of its localised occurrence, this nematode causes overall minor losses.

Estimated risk: The quarantine risk posed by this nematode is low since it is not seed borne, could only be introduced in soil or trash, and it would be slow to establish.

References:

Orton Williams, K.H. 1974. *Dolichodorus heterocephalus.* CIH descriptions of plant parasitic nematodes. Set 4, No 56.

Shurtleff, M.C. 1980. Compendium of corn diseases. The American Phytopathological Society, Minnesota. 105 pp.

Heterodera zeae

Species: *Heterodera zeae* Koshy *et al.* 1970

Common name(s): Corn cyst nematode

Hosts: *Zea mays*

Part of plant affected: Roots, plant

Distribution: USA (Eisenbach *et al.* 1993), Thailand (Chinnasri *et al.* 1995), Pakistan (Maqbool 1981), India (Bajaj and Gupta 1994), Egypt (Kheir *et al.* 1989)

Biology: Eggs of *Heterodera* are not extruded into the soil, but are retained in the female nematode which forms a cyst. *Heterodera zeae* is an endoparasitic nematode, and induces formation of syncitia in host cells, with little root swelling. Females are saccate, while the males are vermiform. Pathogenic races of *H. zeae* have been reported (Bajaj and Gupta 1994).

The cyst nematode causes severe stunting of infected corn (Eisenbach *et al.* 1993), and is very widespread in India.

Economic importance: In the US, the corn cyst nematode has been reported from Maryland and Virginia (Eisenbach *et al.* 1993), where it causes localised serious losses. It is regarded as a serious economic disease of maize in India (Bajaj and Gupta 1994).

Estimated risk: The quarantine risk posed by *H. zeae* is low, since it is not seedborne and can only be transmitted in trash and soil.

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Hoplolaimus columbus

Species: *Hoplolaimus columbus* Sher

Common name: lance nematode, Columbia nematode

Hosts: This nematode has a wide host range (Fassuliotis 1976; Lewis and Smith 1976), including *Zea mays, Glycine max* and *Gossypium hirsutum..*

Part of plants affected: Roots and plant

Distribution: North America

Biology: The lance nematode is ecto-, simiendo-, and endoparasitic. It produces root lesions, resulting in chlorosis and moderate stunting of above ground parts. It causes serious losses in soybean and cotton in Georgia and South Carolina of the USA (Fassuliotis 1976). Eggs are laid in the soil; the nematode is not seed borne.

Economic importance: *Hoplolaimus columbus* is one of the most damaging species of *Hoplolaimus.* It is widespread in North America.

Estimated risk: It is considered that the quarantine risk posed by *Hoplolaimus columbus* is low, since it is not seed borne, and could only be imported as eggs in trash or soil. It would be slow to establish.

References:

Fassuliotis, G. 1976. *Hoplolaimus columbus*. CIH descriptions of plant-parasitic nematodes. Set 6, No 81.

Lewis, S.A. and Smith, F.H. 1976. Host plants, distribution, and ecological associations of *Hoplolaimus columbus.* Journal of Nematology 8: 264-270.

Pratylenchus scribneri

Species: *Pratylenchus scribneri* Steiner

Common name: Root lesion nematode

Hosts: This nematode has a wide host range, including *Zea mays, Saccharum* spp, *Sorghum* spp, *Malus* spp, *Prunus* spp, *Medicago sativa, Fragaria* spp, *Allium cepa, Vigna* spp, *Glycine max, Trifolium repens, Lycopersicon esculentum, Nicotiana tabacum*.

Part of plants affected: Roots, plant

Distribution: Africa, Bulgaria, Egypt, India, Israel, Japan, Mexico, Netherlands, Nigeria, Sweden, Turkey, USA.

Biology: *Pratylenchus* is a migratory endoparasitic root-infecting nematode. The nematodes feed and reproduce in the root cortex. Corn is reported to be resistant to population densities of less than 500 per gram of dry root tissue. However, populations of several thousand per gram are possible, and it is at these levels that damage occurs. Symptoms on roots include poor root growth, necrotic root lesions, root decay and stunting (Loof 1985; Shurtleff 1980).

Economic importance: It is estimated that *P. scribneri* would cause most damage on sandy soils, and overall cause minor losses.

Estimated risk: *P. scribneri* is not seed borne, and could only be imported in soil or trash. It would be slow to establish, and overall it presents a low quarantine risk.

References:

Loof, P.A.A. 1985. *Pratylenchus scribneri*. CIH Descriptions of plant parasitic nematodes. Set 8. No 110.

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Longidorus breviannulatus

Species: *Longidorus breviannulatus* Norton & Hoffman

Common name: Needle nematode

Hosts: *Zea mays,* other grasses, *Apium graveolens, Solanum tuberosum, Vitis* spp, *Lactuca sativa*

Part of plants affected: Roots, plant

Distribution: *Longidorus* commonly occurs in temperate regions of the world. In the USA, it has been recorded on maize, in Delaware, Illinois and Iowa.

Biology: *Longidorus* is a long (4-8mm), ectoparasitic nematode. Symptoms of nematode feeding include stubby roots, thickened lateral roots, and severe chlorosis and stunting of the above ground parts. They only cause serious problems in sandy soils, and damage is often obvious soon after seedling emergence. This results in spare stands of severely stunted plants. Eggs are laid in the soil, and the nematode is not seed borne (Shurtleff 1980).

Economic importance: Where the nematode occurs, it can cause devastating disease. However, its occurrence is generally localised.

Estimated risk: It is considered that the quarantine risk posed by *Longidorus* is low, since it could only be imported as eggs in soil or trash, and it would be slow to establish.

Reference

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Ustilaginoidea virens

Species: *Ustilaginoidea virens* (Cooke) Takah.; Hyphomycetes

Synonym(s): *Ustilaginoidea oryzae* (Pat.) Brefeld.; *Tilletia oryzae* Patouillard; *Ustilago virens* Cooke; teleomorph: *Claviceps virens* (Cke.) Sakurai ex Nakata

Common name(s): False smut; green smut

Host(s): *Digitaria adscendens*, *Oryza* spp, *Panicum trypheron*, *Zea mays*

Part of plant affected: Kernals become infected with greenish fungal mass

Distribution: India, Burma, Philippines, Panama, Peru, USA (Louisiana)

Biology: *U. oryzae* has been reported as seed borne (Richardson 1979), although there is no evidence of seed transmission of the disease. The disease is characterised by the presence of sclerotia (galls) that replace the flowers on the tassel of maize. Superficially, the symptoms resemble a smut infection, thus the name "false smut", as the galls contain masses of greenish spores. Generally, only a few isolated flowers are replaced by the fungal galls, so the disease is of minor importance (Haskell and Diehl 1929; Sharma and Verma 1979).

Disease development is favoured by hot humid and wet weather conditions.

Economic importance: The disease is regarded as being of only minor importance anywhere in the world that it occurs (Sharma and Verma 1979).

Estimated risk: False smut is estimated to be a low risk quarantine pathogen. There is no evidence for seed transmission, and the fungus causes only minor losses.

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Richardson, M.J. 1979. An annotated list of seed-borne diseases. Commonwealth Agricultural Bureau, Slough, England. 320 pp.

Sharma, H.S.S. and Verma, R.N. 1979. False smut of maize in India. Plant Disease Reporter 63: 996-997.

POTENTIAL QUARANTINE PATHOGENS THAT MAY BE INTRODUCED INTO AUSTRALIA THROUGH SEEDS OF VARIOUS AGRICULTURAL PLANT SPECIES PRESENT AS CONTAMINANTS OF USA MAIZE GRAIN

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POTENTIAL QUARANTINE PATHOGENS THAT MAY BE INTRODUCED INTO AUSTRALIA THROUGH SEEDS OF VARIOUS AGRICULTURAL PLANT SPECIES PRESENT AS CONTAMINANTS OF USA MAIZE GRAIN (NB: THIS MAY NOT BE A COMPRENSIVE COVERAGE AT THIS STAGE)

PATHOGEN	DISEASE	CONTAMINANT
Bacteria		
Pseudomonas adzukicola Tanii & Baba 1979	stem rot	Adzuki bean
Pseudomonas syringae pv. ***panici*** (Elliott) Young, Dye & Wilkie 1978; (synonym: *Bacterium panici* Elliott 1923; *Phytobacterium panici* (Elliott) Hauduroy *et al.* 1953; *Phytomonas panici* (Elliott) Bergey *et al.* 1930; *Pseudomonas panici* (Elliott) Stapp 1928; *Xanthomonas panici* (Elliott) Savulescu 1947)	brown streak	French millet
Xanthomonas axonopodis pv. ***phaseoli*** (Smith) Vautrin *et al*., 1995 (synonym: *Xanthomonas campestris* pv. *Phaseoli* (Smith) Dye 1978; *Bascillus phaseoli* Smith 1897; *Bacterium phaseoli* (Smith) Smith 1905; *Phytomonas phaseoli* (Smith) Bergey *et al*. 1923; *Pseudomonas phaseoli* (Smith) Smith 1901; *Xanthomonas phaseoli* (Smith) Dawson 1939; *Phytomonas phaseoli* var. *fuscans* Burkholder 1930; *Bacterium phaseoli* var. *fuscans* (Burkhholder) Okabe 1933; *Pseudomonas phaseoli* var. *fuscans* (Burkholder) Stapp 1935; *Xanthomonas phaseoli* var. *fuscans* (Burkholder) Starr & Burkholder 1942; *Xanthomonas fuscans* (Burkholder) Burkholder 1959; *Xanthomonas phaseoli* var. *indica* Uppal *et al*. 1946)	bacterial blight	Phaseolus, lablab
Xanthomonas axonopodis pv. ***ricini*** (Yoshi & Takimoto) Vautrin *et al*., 1995 (synonym: *Xanthomonas campestris* pv. *ricini* (Yoshi & Takimoto) Dye 1978; *Bacterium ricini* Yoshi & Takimoto 1928; *Pseudomonas ricini* (Yoshi & Takimoto) Stapp 1935; *Xanthomonas ricini* Yoshi & Takimoto Dowson 1939; *Phytomonas ricinicola* (Elliott) Magrou 1937; *Pseudomonas ricinicola* (Elliott) Curzi 1934; *Xanthomonas ricinicola* (Elliott) Dowson 1939; *Xanthomonas anandensis* Desai & Shah 1963)	leaf blight	castor bean
Xanthomonas axonopodis pv. ***vignicola*** (Burkholder) Vautrine *et al*., 1995 (synonym: *Xanthomonas campestris* pv. *vignicola* (Burkholder) Dye 1978; *Xanthomonas campestris* f.sp. *vignicola* (Burkholder) Sabet *et al.* 1969; *X. phaseoli* f.sp. *vignicola* (Burkholder) Sabet 1959; *X. vignicola* Burkholder 1944)	bacterial blight	Vigna, Phaseolus
Xanthomonas oryzae pv. ***oryzae*** (Ishiyama) Swings *et al*., 1990 (synonym: *Xanthomonas campestris* pv. *oryzae* (Ishiyama) Dye 1978; *Pseudomonas oryzae* Ishiyama 1922; *Bacterium oryzae* (Ishiyama) Elliott 1930; *Phytomonas oryzae* (Ishiyama) Magrou 1937; *Xanthomonas oryzae* (Ishiyama) Dowson 1943)	bacterial blight	rice, other gramineae
Xanthomonas oryzae pv. ***oryzicola*** (Fang *et al*.) Swings *et al*., 1990 (synonym: *Xanthomonas campestris* pv. *oryzicola* (Fang *et al*.) Dye 1978; *Xanthomonas translucens* f.sp. *oryzicola*	leaf streak	rice

PATHOGEN	**DISEASE**	**CONTAMINANT**
(Fang *et al*.) Bradbury 1971; *Xanthomonas oryzicola* (*Fang et al*.) Faan & Wu 1957)		
Fungi		
Alternaria linicola Groves & Skolko	*Alternaria* blight	linseed
Alternaria padwickii (Ganguly) Ellis (synonym: *Trichoconis padwicki* Ganguly)	Stackburn, seedling blight and leaf spot	rice
Alternaria ricini (Yoshi) Hansf.	seedling blight, leaf blight, capsule mould	castor bean
Ascochyta sojaecola Abramov	leaf spot	soybean
Balansia oryzae-sativae Hashioka (anamorph, *Ephelis oryzae* Syd.)	udbatta disease	rice
Cercospora sojina Hara	frog-eye spot	soybean
Cochliobolus miyabeanus (Ito & Kuirbay-ashi) Drechs. ex Dastur (anamorph: *Drechslera oryzae* (Breda de Haan) Subram. & Jain; synonym: *Bipolaris oryzae* (Breda de Haan) Shoem.)	brown leaf spot	rice
Colletotrichum lindemuthianum (Sacc.& Magnus) Lams.-Scrib.	anthracnose	Phaseolus
Diaporthe phaseolorum var. ***caulivora*** Athow & Caldwell	stem canker	soybean
Fusarium oxysporum f.sp. ***lini*** (Bolley) Snyder & Hansen	Fusarium wilt	linseed
Fusarium oxysporum f.sp. ***phaseoli*** Kendr. & Snyder	Fusarium yellows, wilt	navy bean
Gibberella fujikuroi (Saw.) Wollenw. (anamorph, *Fusarium moniliforme* Sheldon)	Bakanae disease	rice
Hymenula cerealis Ell. & Ev.	stripe	barley, oats, wheat
Magnaporthe grisea (Hebert) Barr (anamorph, *Pyricularia grisea* (Cooke) Sacc.; *Pyricularia oryzae* Briosi & Cavara)	blast	rice
Melampsora lini (Ehrenb.) Desm.	linseed rust	linseed
Monographella albescens (Thüm.) Parkinson *et al*. (synonym: *Rhyncosporium oryzae* Hashioka & Yokogi; anamorph: *Gerlachia oryzae* (Hashioka & Yokogi) W. Gams)	leaf scald	rice
Mycosphaerella holci Tehon (anamorph: *Phoma sorghina* (Sacc.) Boerema *et al*.)	glume blight	rice
Mycosphaerella rabiei Kovachevskii (synonym: *Didymella rabiei* (Kovachevskii) Arx; anamorph: *Ascochyta rabiei* (Pass.) Labrousse)	*Ascochyta* blight	chickpea
Peronosclerospora maydis (Racib.) Shaw (synonym: *Sclerospora maydis* (Racib.) Butler.)	Java downy mildew	maize
Peronosclerospora philippinensis (Weston) Shaw (synonym: *Sclerospora philippinensis* (Weston) Holiday)	Philippine downy mildew	maize, sorghum, sugarcane
Peronosclerospora sacchari (Miyake) Shaw (synonym: *Sclerospora sacchari* Miyake).	Sugarcane downy mildew	maize, sorghum, sugarcane
Peronosclerospora sorghi (Weston & Uppal) Shaw (synonym: *Sclerospora sorghi* Weston & Uppal)	sorghum downy mildew	maize, sorghum
Phialophora gregata (Allington & D.W. Chamberlain) W. Gams (synonym: *Cephalosporium gregatum* Allington & D.W. Chamberlain)	brown stem rot	soybean

PATHOGEN	DISEASE	CONTAMINANT
Plasmopara halstedii (Farlow) Berl. & de Toni in Sacc. (synonym: *Peronospora halstedii* Farl.)	sunflower downy mildew	sunflower
Pleosphaerulina sojaecola Miura (anamorph, *Phyllosticta sojaecola* Massal.; *Phyllosticta glycinea* Tehon & Daniels)	Phyllosticta leaf spot and canker	soybean
Sclerophthora rayssiae var. ***zeae*** Payak & Renfro (synonym: *Sclerophthora rayssiae* var. *zeae*)	Brown stripe downy mildew of maize	maize
Sclerotinia ricini Godfrey	capsule mould	castor bean
Septoria glycines Hemmi	brown spot	soybean
Sporisorium cruentum (Kühn) Vanky (synonym: *Sphacelotheca cruenta* (Kühn) Potter; *Ustilago cruneta* Kühn; *Sphacelotheca chrysopogonis* Clinton; *Sphacelotheca holci* Jacks.)	loose kernel smut	sorghum
Sporisorium holci-sorghi (Rivolta) Vanky (synonym: *Sporisorium reilianum* (Kühn) McAlpine (synonym: *Sphacelotheca reiliana* (Kühn) Clinton; *Ustilago reiliana* Kühn)	head smut	sorghum
Sporisorium sorghi Link in Willd. (synonym: *Sphacelotheca sorghi* (Link) Clinton)	covered kernel smut of sorghum	sorghum
Tilletia controversa Kühn in Rabenh. (synonym: *Tilletia brevifaciens* Fisch.)	dwarf bunt	wheat
Tilletia indica Mitra (synonym: *Neovossia indica* (Mitra) Mund.	Karnal Bunt	wheat, triticale
Tolyposporium ehrenbergii (Kühn) Patouillard	long smut	sorghum
Ustilago avenae (Pers.) Rostr. (synonym: *Ustilago nigra* Tapke)	semiloose smut	barley, oats
Ustilago segetum (Pers.) Roussel var. ***hordei*** (Pers.) Rabenh. (synonym: *Ustilago hordei* (Pers.) Lagerh.)	Covered smut	barley, oats, rye, Agropyron
Ustilago tritici (Pers.) Rostr. (synonym: *Ustilago nuda* (Jenson) Rostr., nom.nud.)	loose smut	wheat, barley, rye, Agropyron
Verticillium albo-atrum Reinke & Berthier	lucerne wilt	lucerne
Nematodes		
Heterodera glycines Ichinohe 1952	soybean cyst nematode	soybean
Aphelenchoides besseyi Christie 1942	white tip	rice
Viruses		
Bean southern mosaic sobemovirus	southern bean mosaic	cowpea, navy bean
Broad bean mottle bromovirus	broad bean mottle	Vicia
Broad bean stain comovirus	broad bean stain	Vicia
Broad bean true mosaic comovirus	broad bean true mosaic	Vicia
Cowpea mild mottle carlavirus	cowpea mild mottle	cowpea, soybean
Cowpea mottle carmovirus	cowpea mottle	cowpea
Cowpea severe mosaic comovirus	cowpea severe mosaic	cowpea

PATHOGEN	DISEASE	CONTAMINANT
Pea early browning tobravirus	pea early browning	pea, Vicia
Pea seed-borne mosaic potyvirus	pea seed-borne mosaic	pea
Peanut clump furovirus	peanut clump	peanut, sorghum, millet
Peanut stripe potyvirus	peanut stripe	peanut
Peanut stunt cucumovirus	peanut stunt	peanut, Vicia, soybean

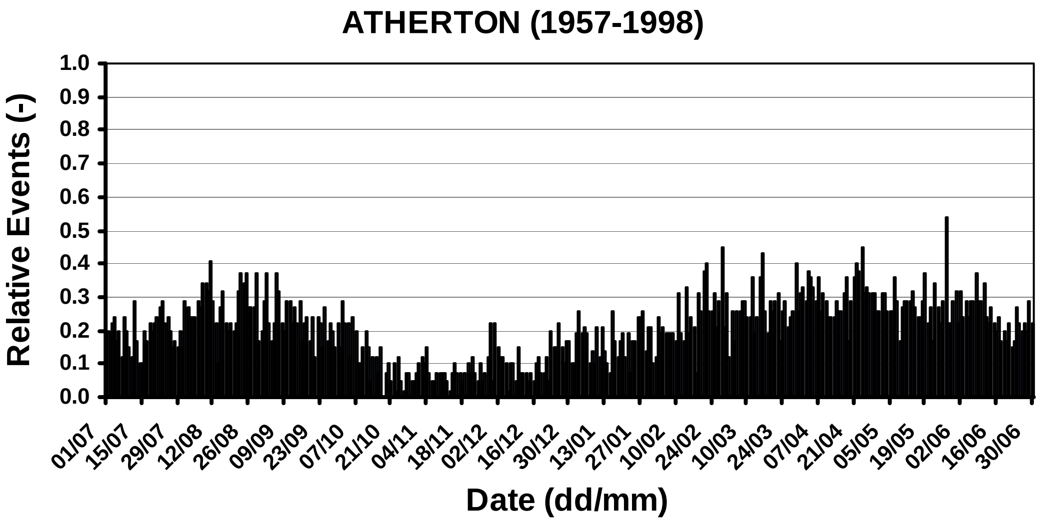
Probability of the occurrence of weather conditions favourable for development of downy mildew on maize and sorghum at locations in Australia

November 1998

The conditions necessary for development of downy mildew on maize and sorghum caused by *Peronosclerospora sorghi* are:

Process	Temperature	Humidity	Time
Sporulation	15–23°C	RH > 80%	5–6 hours in the dark
Germination	12–20°C (12–32°C)	Dew period	2 hours
Infection	10–33°C	Dew period	4 hours (2 hours)

Thus, downy mildew can develop when RH>80% for >10 hours at night or when RH = 100% for > 4 hours in the night, when temperature is 10–33°C in the night. The probability of the occurrence of such conditions suitable for the establishment and development of downy mildew at eleven Australian sites, ranging from Kununurra in northern Australia to Wagga Wagga in southern Australia. The data was simulated using the Silo Weather Data 1957-1998. The bars on the graphs indicate the probability that suitable climatic conditions for the disease to establish, will occur on a particular day of the year. For example at Dalby between 21 April and 05 May, conditions for disease establishment will occur in 4 or 5 out of 10 years.
From the data analysed for the limited number of sites, Monto was the most favourable site for development of downy mildew, with suitable conditions occurring frequently in spring and again from late summer to late autumn. Generally, frequent suitable conditions occurred at several Queensland sites, while conditions were less favourable in the Northern Territory and New South Wales.


ATHERTON (1957-1998)
Relative Events (-)
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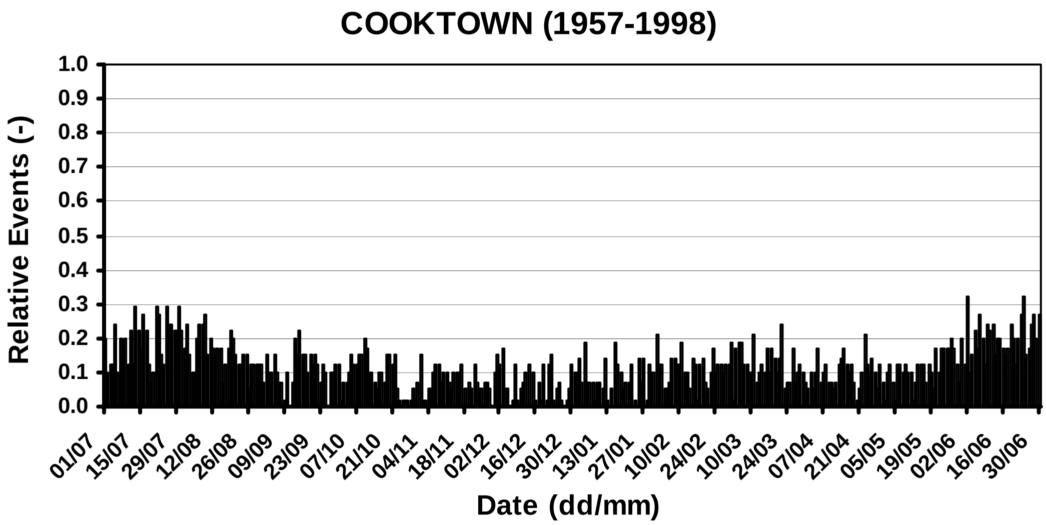
0.4
0.3
0.2
0.1
0.0
01/07 15/07 29/07 12/08 26/08 09/09 23/09 07/10 21/10 04/11 18/11 02/12 16/12 30/12 13/01 27/01 10/02 24/02 10/03 24/03 07/04 21/04 05/05 19/05 02/06 16/06 30/06
Date (dd/mm)


COOKTOWN (1957-1998)
Relative Events (-)
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0.6
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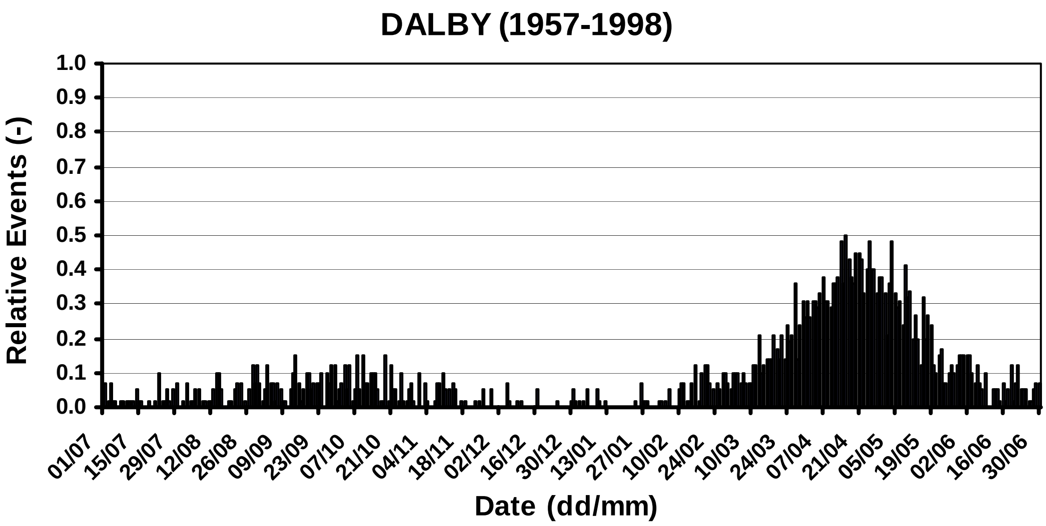
0.4
0.3
0.2
0.1
0.0
01/07 15/07 29/07 12/08 26/08 09/09 23/09 07/10 21/10 04/11 18/11 02/12 16/12 30/12 13/01 27/01 10/02 24/02 10/03 24/03 07/04 21/04 05/05 19/05 02/06 16/06 30/06
Date (dd/mm)


DALBY (1957-1998)
Relative Events (-)
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0.6
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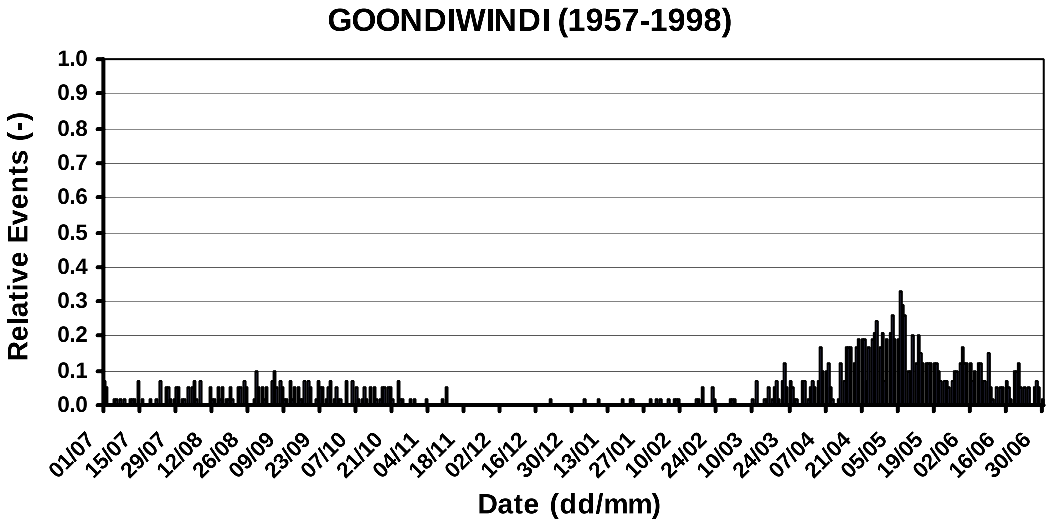
0.3
0.2
0.1
0.0
01/07 15/07 29/07 12/08 26/08 09/09 23/09 07/10 21/10 04/11 18/11 02/12 16/12 30/12 13/01 27/01 10/02 24/02 10/03 24/03 07/04 21/04 05/05 19/05 02/06 16/06 30/06
Date (dd/mm)


GOONDIWINDI (1957-1998)
Relative Events (-)
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0.8
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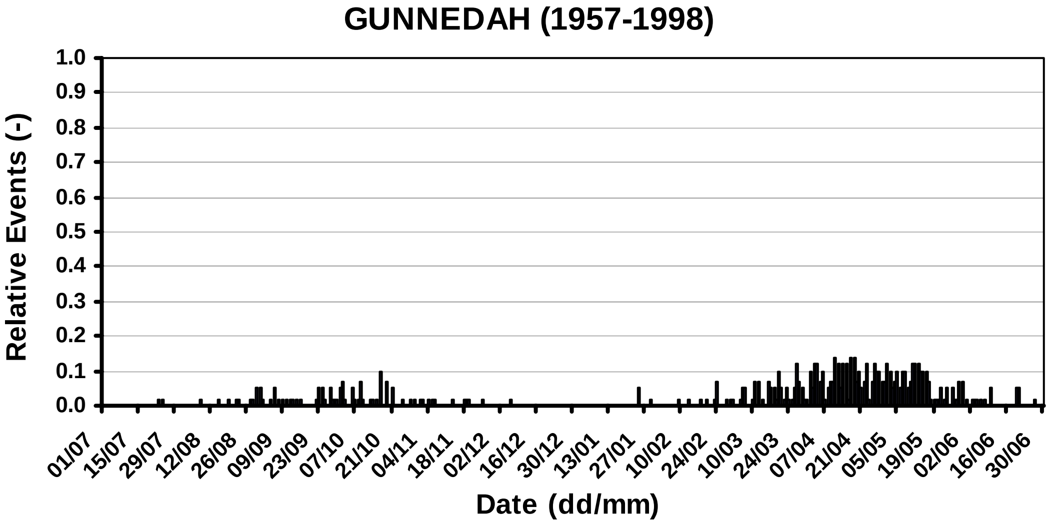
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01/07 15/07 29/07 12/08 26/08 09/09 23/09 07/10 21/10 04/11 18/11 02/12 16/12 30/12 13/01 27/01 10/02 24/02 10/03 24/03 07/04 21/04 05/05 19/05 02/06 16/06 30/06
Date (dd/mm)


GUNNEDAH (1957-1998)
Relative Events (-)
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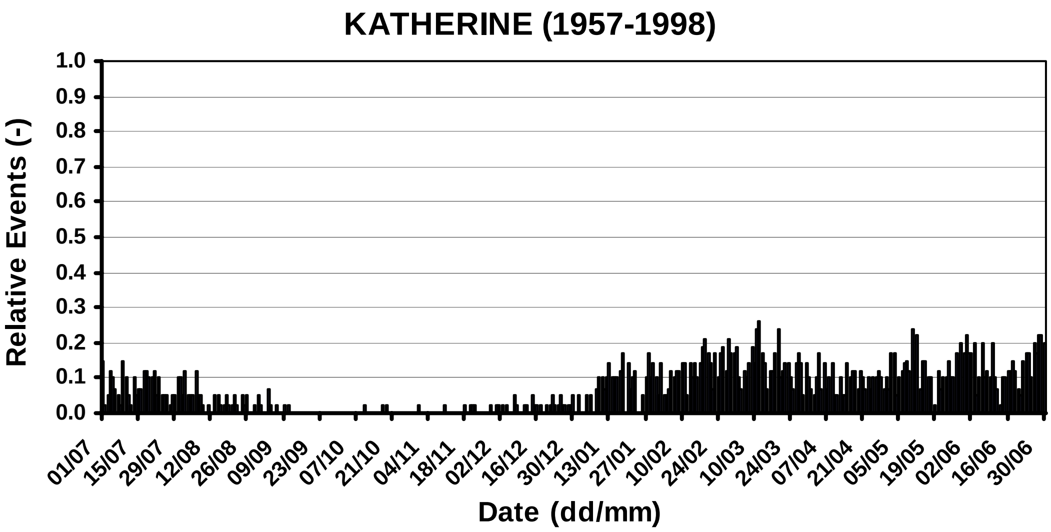
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01/07 15/07 29/07 12/08 26/08 09/09 23/09 07/10 21/10 04/11 18/11 02/12 16/12 30/12 13/01 27/01 10/02 24/02 10/03 24/03 07/04 21/04 05/05 19/05 02/06 16/06 30/06
Date (dd/mm)


KATHERINE (1957-1998)
Relative Events (-)
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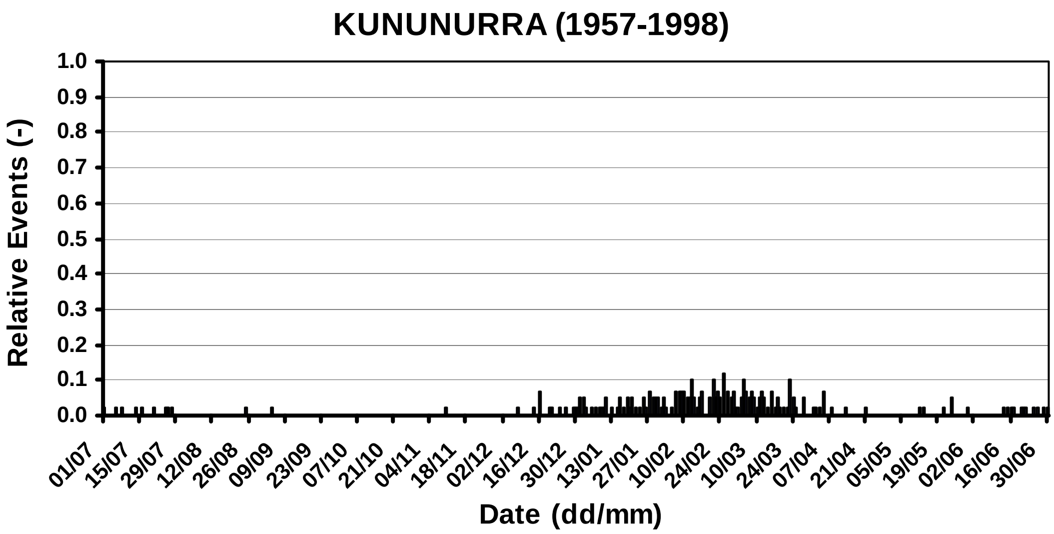
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01/07 15/07 29/07 12/08 26/08 09/09 23/09 07/10 21/10 04/11 18/11 02/12 16/12 30/12 13/01 27/01 10/02 24/02 10/03 24/03 07/04 21/04 05/05 19/05 02/06 16/06 30/06
Date (dd/mm)


KUNUNURRA (1957-1998)
Relative Events (-)
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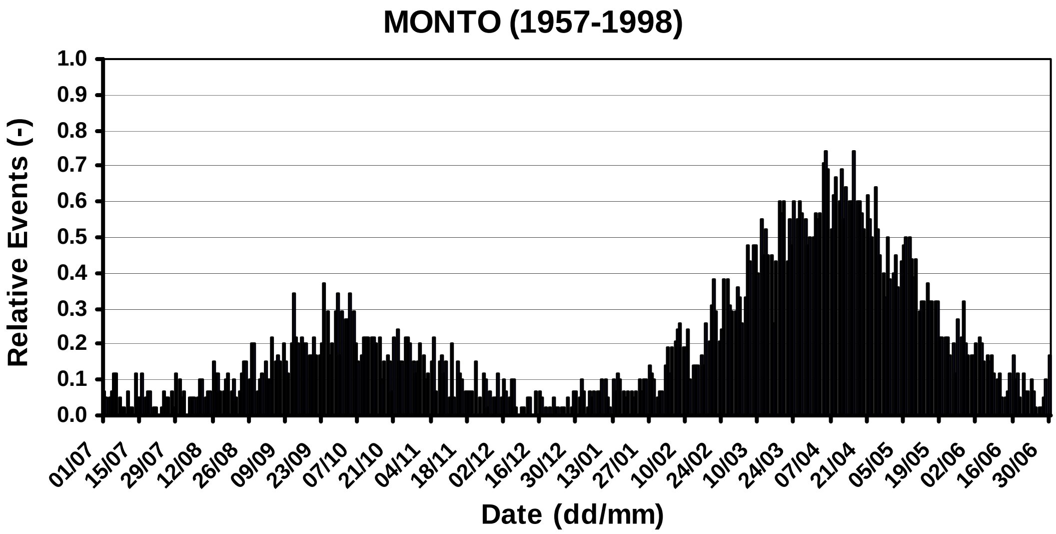
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01/07 15/07 29/07 12/08 26/08 09/09 23/09 07/10 21/10 04/11 18/11 02/12 16/12 30/12 13/01 27/01 10/02 24/02 10/03 24/03 07/04 21/04 05/05 19/05 02/06 16/06 30/06
Date (dd/mm)


MONTO (1957-1998)
Relative Events (-)
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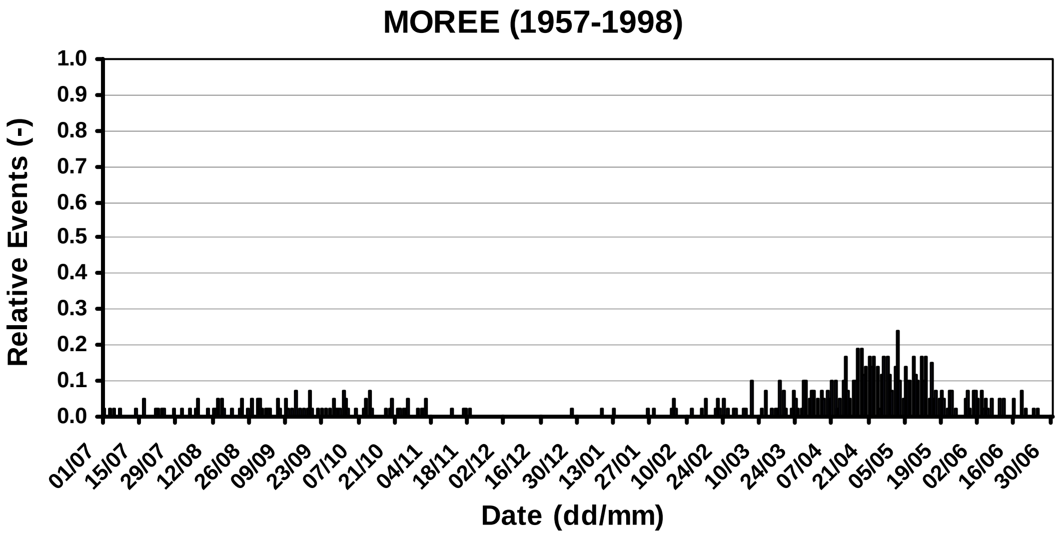
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01/07 15/07 29/07 12/08 26/08 09/09 23/09 07/10 21/10 04/11 18/11 02/12 16/12 30/12 13/01 27/01 10/02 24/02 10/03 24/03 07/04 21/04 05/05 19/05 02/06 16/06 30/06
Date (dd/mm)


MOREE (1957-1998)
Relative Events (-)
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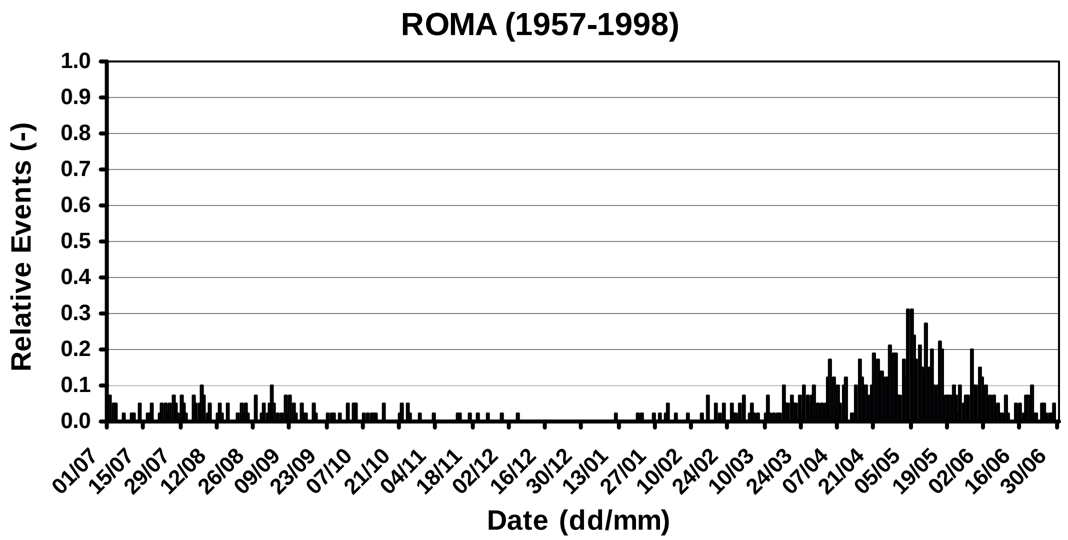
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01/07 15/07 29/07 12/08 26/08 09/09 23/09 07/10 21/10 04/11 18/11 02/12 16/12 30/12 13/01 27/01 10/02 24/02 10/03 24/03 07/04 21/04 05/05 19/05 02/06 16/06 30/06
Date (dd/mm)


ROMA (1957-1998)
Relative Events (-)
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0.3
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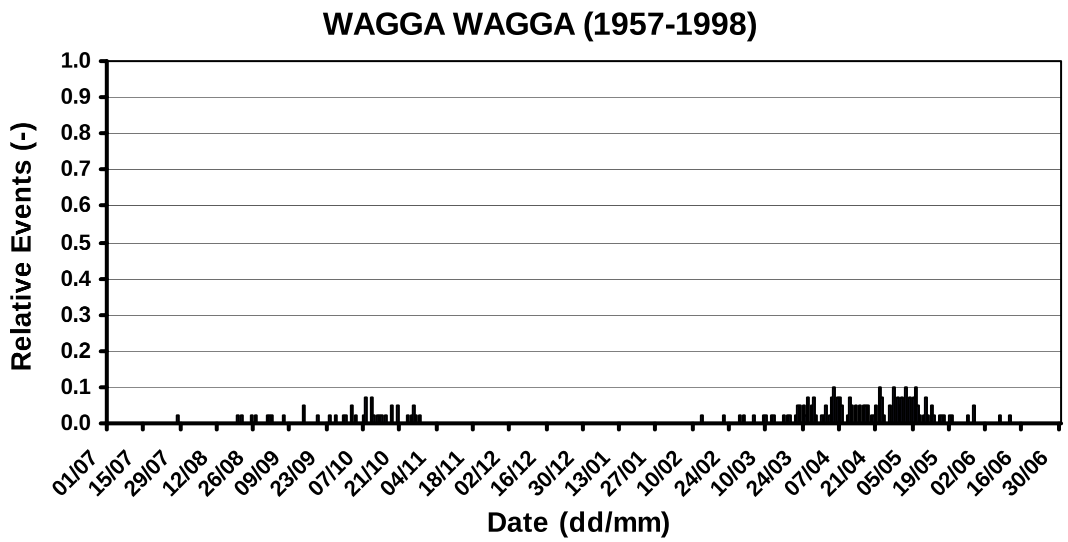
0.1
0.0
01/07 15/07 29/07 12/08 26/08 09/09 23/09 07/10 21/10 04/11 18/11 02/12 16/12 30/12 13/01 27/01 10/02 24/02 10/03 24/03 07/04 21/04 05/05 19/05 02/06 16/06 30/06
Date (dd/mm)


WAGGA WAGGA (1957-1998)
Relative Events (-)
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0.2
0.1
0.0
01/07 15/07 29/07 12/08 26/08 09/09 23/09 07/10 21/10 04/11 18/11 02/12 16/12 30/12 13/01 27/01 10/02 24/02 10/03 24/03 07/04 21/04 05/05 19/05 02/06 16/06 30/06
Date (dd/mm)