Plant Health AUSTRALIA

RICEGROWERS' ASSOCIATION OF AUSTRALIA INC

Contingency Plan

Rice blast

Anamorph: *Pyricularia grisea* (Cooke) Sacc.
Synonym: *P. oryzae* Cavara
Teleomorph: *Magnaporthe grisea* (Herbert) Barr (T.T. Herbert) Yaegashi & Udagawa

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Background

Rice blast, caused by *Magnaporthe grisea*, is generally considered the most important disease of rice worldwide because of its extensive distribution and destructiveness under favourable conditions. Infection of rice plants occurs from airborne conidia and symptoms appear as lesions or spots. South-eastern Australia is the only rice-growing area in the world free of this disease. This disease remains the single biggest threat to the Australian rice industry. Even though disease modelling research in Australia has shown that the pathogen could initiate multiple disease cycles if introduced, the exact behaviour of the disease will not be known until it occurs.

Host range

M. grisea can infect and produce lesions on the following part of the rice plant: leaf (leaf blast), leaf collar (collar blast), culm, culm nodes, panicle neck node (neck rot) and panicle (panicle blast). The fungus can infect rice plants at any growth stage.

Although rice (*Oryza sativa*) is its main host, *M. grisea* can survive on the following plants: *Agropyron repens, Agrostis palustris, A. tenuis, Alopecurus pratensis, Andropogon sp., Anthoxanthum odoratum, Arundo donax, Avena byzantina, A. sterilis, A. sativa, Brachiaria mutica, Bromus catharticus, B. inermis, B. sitchensis, Canna indica, Chikushichloa aquatica, Costus speciosus, Curcuma aromatica, Cynodon dactylon, Cyperus rotundus, C. compressus, Dactylis glomerata, Digitaria sanguinalis, Echinochloa crus-galli, Eleusine indica, Eragrostis sp., Eremochloa ophiuroides, Eriochloa villosa, Festuca altaica, F. arundinacea, F. elatior, F. rubra, Fluminea sp., Glyceria leptolepis, Hierochloe odorata, Holcus lanatus, Hordeum vulgare, Hystrix patula, Leersia hexandra, L. japonica, L. oryzoides, Lolium italicum, L. multiflorum, L. perenne, Muhlenbergia sp., Musa sapientum, Oplismenus undulatifolius, Panicum miliaceum, P. ramosum, P. repens, Pennisetum typhoides, Phalaris arundinacea, P. canariensis, Phleum pratense, Poa annua, P. trivialis, Saccharum officinarum, Secale cereale, Setaria italica, S. viridis, Sorghum vulgare, Stenotaphrum secundatum, Triticum aestivum, Zea mays, Zingiber mioga, Z. officinale* and *Zizania latifolia.*

The role of these hosts in the rice blast disease cycle has been subject to controversy. Research indicate that although *M. grisea* can infect a wide range of plant hosts, some strains are very species, and even sometimes cultivar, specific (Valent and Chumley 1991; Borromeo et al. 1993).

Gouch and Kohn (2002) described a new species for the strains of *Magnoporthe* from *Oryza sativa, Eragrostris curvula, Eleusine coracana, Lolium perenne* and *Setaria* spp. According to these authors, the correct name of the isolates associated with these plants is *M. oryzae* where *M. grisea* should be used for the isolates associated with *Digitaria* spp.

Biology

Identification/Symptoms

Rice blast can infect most of the rice plant with the exception of the roots. Symptoms can be either lesions or spots. Lesions/spots shape, colour and size vary depending on varietal resistance, environmental conditions and the age of the lesions (Ou 1985).

LEAF BLAST

Initial lesions/spots are white to gray-green with darker borders. Older lesions are white-grey, surrounded with a red-brown margin and are diamond shaped (wide centre and pointed toward either end). Lesion size is commonly 1-1.5 cm long and 0.3-0.5 cm wide (Figure 1). Under favourable conditions, lesions can coalesce and kill the entire leaf.

Figure 1. *Leaf blast symptoms (photos: left, D.E Groth, right, R.D. Cartwright)*

COLLAR ROT

Lesion is located the junction of the leaf blade and leaf sheath and can kill the entire leaf (Figure 2).

Figure 2. *Collar rot symptoms (photos D.E. Groth)*

NECK ROT

Symptoms (rotten neck) appear at the base of the panicle (Figure 3). Such attack often results with the killing of the entire panicle. Infected panicles appear white and are partly or completely unfilled (Figure 4). The whitehead symptoms can easily be confused with a stem borer attack which also results in a white and dead panicle.

Figure 3. *Neck rot symptoms (photos: left, D.E Groth, right, R.D. Cartwright)*

Figure 4. *'White heads' caused by neck rot (photo: R.D Cartwright)*

PANICLE BLAST

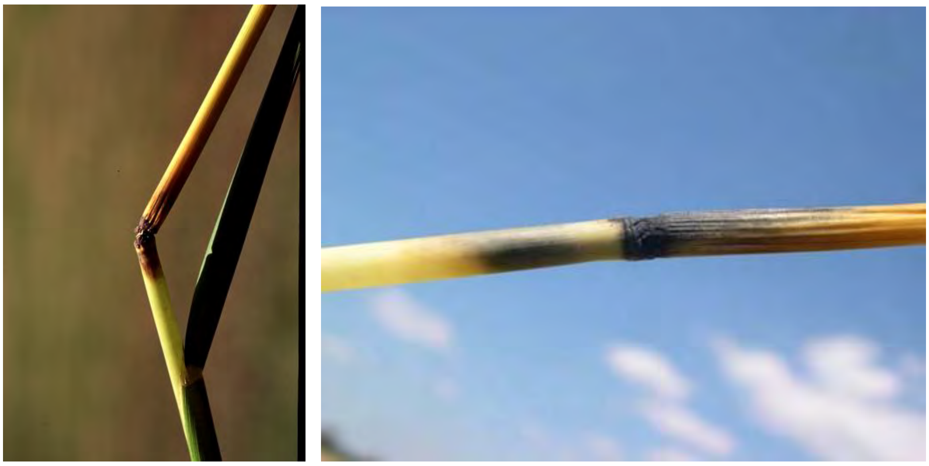
Panicle appears brown or back (Figure 5).

Figure 5. *Panicle blast symptoms (photo: D. E. Groth)*

NODE INFECTION

Infected nodes appear black-brown and dry and often occur in a banded pattern. This kind of infection often causes the culm to break, resulting with the death of the rice plant (Figure 6).

Figure 6. *Node infection symptoms (photos: left, D.E Groth, right, R.D. Cartwright)*



In California, the most common symptoms present dark lesions on the panicle neck node and on the flag leaf collar. Infected plants often display white, partly or completely unfilled panicles. Given the climatic conditions prevailing in south-eastern Australia, in the event of a rice blast outbreak, symptoms would be expected to be similar to those reported in California.

Disease cycle

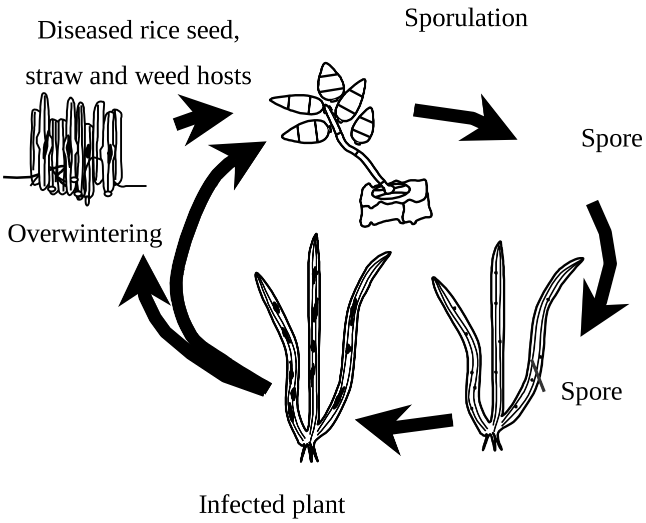
Rice blast is a polycyclic disease depending on favourable weather conditions. The pathogen survives winter as mycelium or conidia on diseased rice stubble, seed or in living plants. Under temperate growing climate, the primary inoculum (conidia) is thought to mainly originate from overwintered rice straw and infected rice seeds. Conidia are transported by wind/water and infect rice plants after landing on them. A few days later, condiophores are produced and release new airborne conidia (Figure 7).

Dispersal

WIND DISPERSAL

Spores are usually distributed within the rice-growing areas by air currents but the maximum distance that conidia can travel remains a controversial issue. The pathogen *M. grisea* has already been reported in New South Wales infecting several weeds but the potential pathogenicity of these isolates on rice is unknown. The role of plant hosts, such as weeds, in the rice blast disease cycle remains subject to controversy (Borromeo et al. 1993). This controversy is mainly explained by the genetic diversity of the fungus, the hosts and the variation in experimental conditions. Research demonstrated that although *M. grisea* can infect a wide range of plant hosts, some strains are very species, and even sometimes cultivar, specific (Valent and Chumley 1991; Borromeo et al. 1993). Even if Australian strains were unable to infect rice, virulent strains from overseas might be accidentally introduced to Australia.

Figure 7. *Disease cycle of rice blast*



TRANSPORT OF INFECTED PLANT MATERIAL (INCLUDING RICE SEEDS)

Under dry conditions at room temperature, conidia are able to survive for more than a year and mycelium for almost three years (Ou 1985). Due to its lengthy survival, importation or transport by travellers of contaminated seed, weeds or souvenirs made of rice straw could introduce rice blast to the rice-growing regions of south-eastern Australia.

TRAVELLERS

A study published in 1992 estimated the potential number of conidia of *M. grisea* introduced to Australia on the clothes of international travellers to be 240 000 million for 1988 alone (Phillips et al. 1992). Rice blast has been recorded in the Northern Territory (Stahl 1955; Heaton 1964); therefore, domestic travellers could also involuntarily introduce conidia to the rice-growing regions.

Surveillance

General surveillance

Rice-growers/agronomists/extension personnel need to be educated about the threat that rice blast represents to their industry and should also be encouraged to increase their vigilance for inspecting their crops for unusual symptoms or pests. The extension booklet “maintaining disease-free crops” (Cother and Lanoiselet 2002) was sent to every rice grower in NSW. Comprehensive information about current rice diseases and exotic rice diseases has also been incorporated in the CSIRO software MaNage Rice. Many rice growers are already using this free software. Any unusual symptoms observed by growers/agronomists/extension personnel should be immediately reported to an experienced and trained plant pathologist for formal identification. Alternatively, the Exotic Plant Pest Hotline can be contacted on 1800 084 881.

Targeted surveillance

Strict quarantine vigilance on the rice blast pathogen and other exotic pathogens must be maintained to protect the Australian rice industry. Barrier quarantine is in place in Australia both at the national and state level to prevent the introduction of exotic pests into Australia. The Australian Commonwealth *Quarantine Act 1908* requires an Australian Quarantine Inspection Service (AQIS) permit to import any parts of *Oryza* plants or plant parts and prohibits the importation of unmilled rice. The NSW *Plant Diseases Act 1924* prohibits the importation of rice plant parts, and machinery or packaging that has contacted rice plant parts into the rice quarantine area of NSW without the permission of the Chief of Division of Plant Industries of NSW Agriculture. Second hand agricultural machinery, including headers, are regularly imported from overseas and despite strict Australian quarantine regulation, it cannot be excluded that infected rice trash present in agricultural machinery/headers may have passed through quarantine inspection undetected. The 1996 rice blast outbreak in California (Greer et al. 1997) illustrates that the isolation of one rice-growing region from other rice-growing areas of the world does not guarantee continued freedom from exotic diseases threat. The quarantine vigilance should be maintained in order to protect the Australian rice industry from rice blast and other diseases.

Passengers arriving from overseas, especially if they have visited a farm while overseas, need to be monitored very closely by AQIS. Growers returning from an overseas „rice study tour‟ need to be aware of the risk of bringing back rice blast spores attached to their clothes or footwear. In such case, their clothes and footwear need to be washed/cleaned before coming back to Australia.

Exotic pest survey method

RICE PLANTS - Rice blast can infect rice plants very early in the season and therefore if monitoring is conducted, it should be conducted throughout the rice-growing season. Leaf blast symptoms are usually the first symptoms to appear. In the event of a rice blast outbreak in south-eastern Australia, the most common symptoms are likely to be found on the neck nodes and on flag leaf collars.

RICE GRAIN/BULK - The test is carried out on a working sample of 400 seeds. Grain should be sampled to give a representative sample of a bulk consignment (1-2 kg minimum is required).

Diagnostic and laboratories

Samples presenting symptoms should be placed into paper bags and taken/send to the Plant Pathologist as soon as possible. It is recommended to collect samples presenting young, middle stage and mature lesions/symptoms to maximise the chances of a positive identification by the Plant Pathologist. Plastic bags are not recommended, especially during the hot Australian summer as they tend to trigger favourable conditions for the growth of saprophytes. After collection, the samples should be placed into a closed container such as a cardbox to protect the samples from physical damage and dusty conditions. Placing the container into a cooler box is then highly recommended especially if long distances driving is required to take the samples to the Plant Pathologists. If sending the samples by mail, express mail should be used and (they) should not be sent at the end of the week to prevent samples staying in hot conditions over the week end.

The following researchers should be consulted for diagnosis of suspected rice blast:

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Management/control options/R&D

Rice blast arrived in California in 1996. Preventive measures aimed at reducing the incidence of the disease were rapidly introduced by Californian authorities. From 1996 to 1998, rice growers were allowed to burn limited acreages of infected rice fields to try to prevent the spread of the disease, by reducing the amount of inoculum. Then, in 1997, the Californian Department of Pesticide Regulation temporarily granted the registration of the fungicide Quadris®[1] (active ingredient: azoxystrobin) for the control of rice blast. Fungicide field trials have since show that azoxystrobin could be used to reduce the incidence of neck blast and improve yield (Greer and Webster 2001). When used, Quadris® is applied twice, costing $US30-35/acre/application. Gem® (trifloxystrobin) is another fungicide used to

[1] In Australia, azoxystrobin is commercialised as Amistar®

control rice blast in the USA. Gem®[2] has more activity against blast but is not as long lasting as Quadris® , which can give control for 2-3 weeks.

Research and development

Rice blast has been the subject of much research. Research mainly focuses on host resistance, breeding strategies, epidemiology, integrated disease management, population studies, genetics and molecular biology.

Given the ancestral relationship between a lot of the NSW germ plasm and that of Californian cultivars, it is expected that our germ plasm will be susceptible to the blast pathogen. In 2003, eight Australian cultivars (Kyeema, Langi, Jarrah, Illabong, Namaga, Opus, Paragon) were tested in a rice blast nursery at Biggs (California) by Dr Jeff Oster to establish their susceptibility to the disease. As suspected, all of them were susceptible to the Californian race IG-1.

In 1999, a RIRDC project (AGR-7A) was initiated to obtain enough data (azoxystrobin residues) to support an emergency registration of azoxystrobin (commercial name Amistar®) for rice blast control in rice. This project contributed to the preparedness of the Australian Rice Industry in the even of a rice blast outbreak.

In the event of a rice blast outbreak

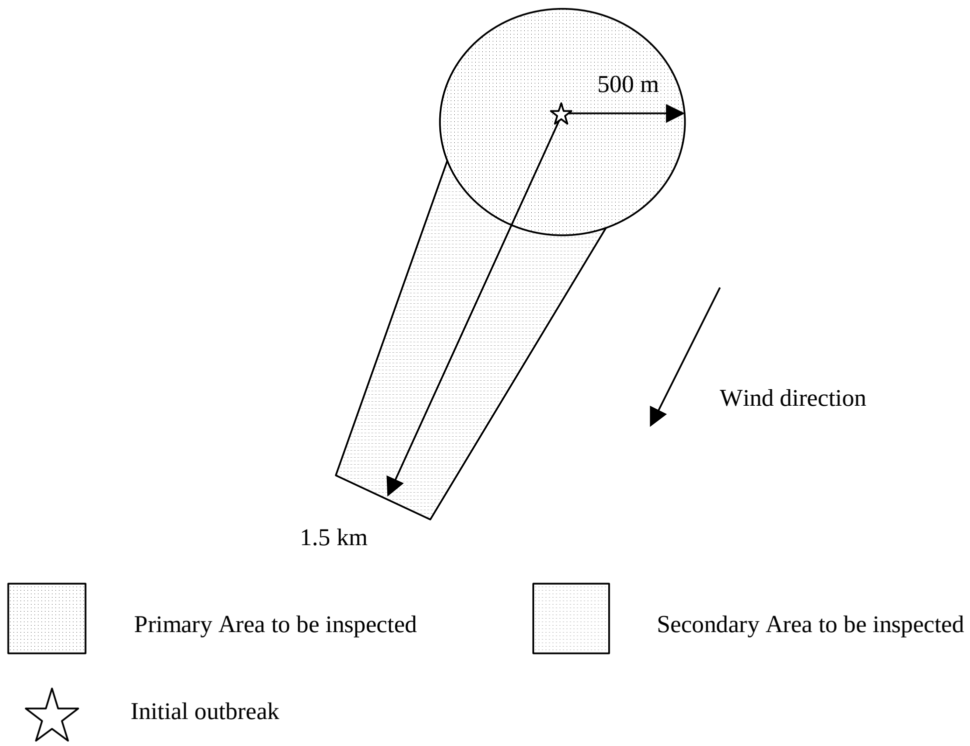
Defining the outbreak zone

A) EARLY DETECTION/NO SPORULATION OBSERVED

Following the first report of a suspect rice blast outbreak, crop inspection should start at soon as possible. The primary area to be inspected should cover a 500 m radius of the initial outbreak. Once the primary area has been inspected, if no other suspected symptoms have been found, the secondary area should be inspected (Figure 8). If rice blast symptoms are observed, a new primary area and a secondary area need to defined and surveyed. Additionally to this comprehensive initial survey, a substantial number of rice farms located within the whole rice-growing area should be randomly selected and surveyed for the presence of the disease.

[2] In Australia, trifloxystrobin is commercialised as Flint®

Figure 8. *Primary and secondary area to be inspected following a suspected outbreak of rice blast (early detection/no sporulation observed)*



B) LATE DETECTION/SPORULATION OBSERVED

The primary area to be inspected should cover a 1000 m radius of the initial outbreak. Once the primary area has been inspected, if no other suspected symptoms have been found, the secondary area (3 km long) should be inspected (Figure 9). If rice blast symptoms are observed, a new primary area and a secondary area need to defined and surveyed. Additionally to this comprehensive initial survey, a substantial number of rice farms located within the whole rice-growing area should be randomly selected and surveyed for the presence of the disease.

Case 1: Rice blast is found in one or few rice fields

Defining the Quarantine area

Once the infected area has been defined, a quarantine area needs to be set up:

- The infected rice bay and any other contiguous rice bays plus the banks of the rice bays and a dryland boundary area around the block 50 m wide (Figure 10).

Figure 9. *Primary and secondary area to be inspected following a suspected outbreak of rice blast (late detection/sporulation observed)*

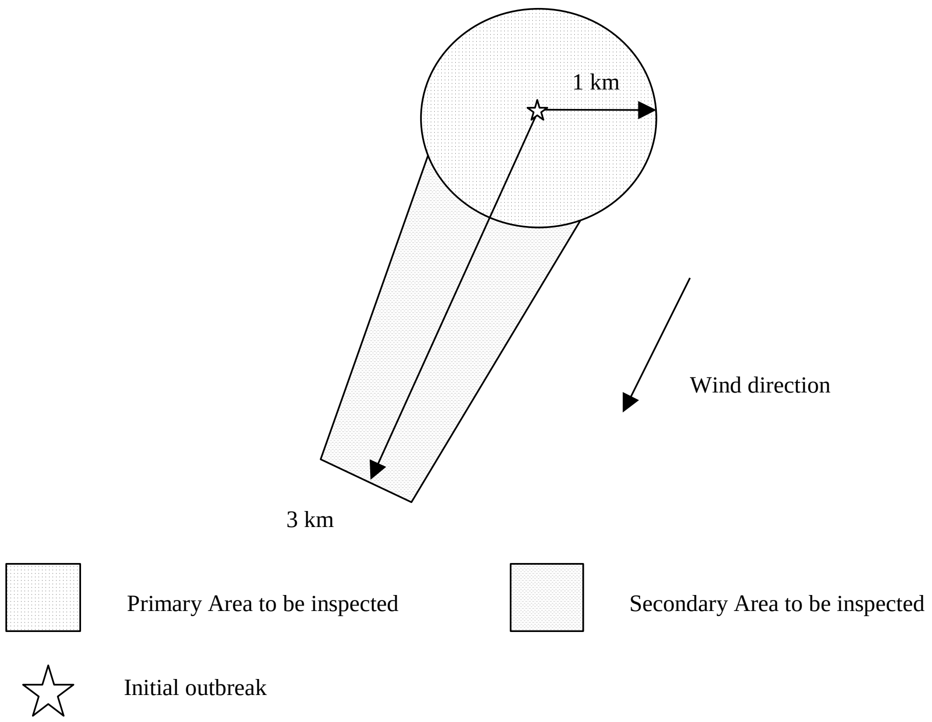
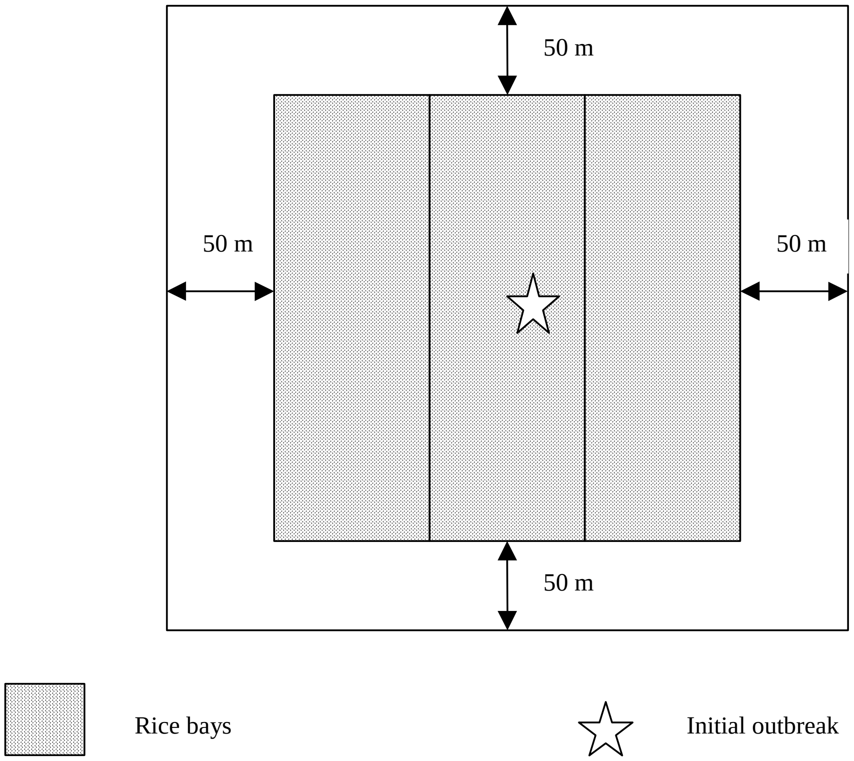


Figure 10. *Quarantine area around the initial rice blast outbreak*



Once rice blast has been confirmed, drainage of the area should be blocked in order to let the water evaporate completely. Entry into the diseased crop should be strictly monitored and kept to a minimum. Personnel entering the crop must wear disposable overalls which can be destroyed after use.

QUARANTINE AND CONTAINMENT

Once the infected area has been delimited, a quarantine zone should be established to prevent the dissemination of the disease. The quarantine area should extend for 100 m around the infected area. Movement of people, vehicle and farm machinery must be restricted to the minimum required for the monitoring of the situation and the eradication attempt.

Spores and infected rice debris can be accidentally transported by the vehicles/equipment/machinery used within the quarantine area. Therefore, any vehicle/equipment must be cleaned of any plant and soil debris before leaving the quarantine area, ideally with a 2% hypochlorite solution using a high pressure cleaner. Boots, overall and gloves used by the survey and control team must be disinfected using a 2% hypochlorite solution.

DESTRUCTION/ERADICATION

Ideally, the quarantine area should be sprayed with a herbicide containing the active ingredient paraquat. Gramoxone® contains 250 g/L of paraquat and should be used at the rate of 4-8 L/ha[3]. Roundup® (360 g/L of glyphosate) is not recommended in this case as the effect of this herbicide is too slow in such an emergency situation. The use of paraquat is strongly recommended as it has the advantage of being a plant desiccant. The whole quarantine area must then be burnt and no rice must be grown within the quarantine area for at least 3 years.

DOCUMENTATION TO ESTABLISH AREA FREEDOM

Rice should be grown at the end of the 3 years of quarantine period and the crop should be monitored during the entire rice-growing season. No rice blast symptom indicates disease freedom.

Case 2: Rice blast is found in many rice fields within a same rice-growing area (i.e: MIA)

This situation could arise if the initial disease outbreak was not detected for some time. At this stage the disease has to be contained within the affected area as eradication would not be an option unless the industry is prepared to stop growing rice in the whole area for at least 3 to 5 years.

The whole infected rice-growing area will be declared a Quarantine area (i.e MIA or CIA or MVDI or the Lachlan Valley).

CONTAINMENT

Everything needs to be done to contain the disease within the contaminated area and prevent it spreading to the other rice-growing areas:

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[3] In NSW, Gramoxone is registered for „right of way/firebreak" applications at the rate of 1.6 to 4 L/ha.

- rice grains originating form the infected area must be segregated and should not be delivered to a silo located outside the Quarantine area. The rice industry will have to put a segregation system into place.
- the SunRice pure rice seed production sites will have to be (re-)located in one of the disease free areas. These certified seed should always be used by rice-growers.
- movement of people, vehicles and rice farming equipment can potentially spread rice blast spores (especially in attached soil, mud and plant debris) and other pests and therefore must be managed. Harvesters and other farming equipment used to harvest rice within the Quarantine area should not leave the Quarantine area unless cleaned and fumigated. Farm vehicles should be clean of mud, soil and plant debris before leaving a contaminated farm.
- clothing, tool and footwear used on farms located within the infected should not leave the Quarantine area and should never be used on disease-free farms.
- within the Quarantine area, all rice stubbles should be burnt to reduce the amount of inoculum.

Case 3: Rice blast smut is found widespread in all rice-growing areas

Eradication will not be an option and the industry (like the Californian) will have to live with the disease. Rice blast will need to be managed by cultural practices, chemical control (fungicides) and the use of resistant cultivars.

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