

**INDUSTRY BIOSECURITY PLAN
FOR THE GRAINS INDUSTRY**

Threat Specific Contingency Plan

Bacterial leaf streak

Xanthomonas translucens pv. *translucens*

Xanthomonas translucens pv. *undulosa*

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Plant Health Australia

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1	Purpose and background of this Contingency Plan.....	4
2	Australian Grains Industry	4
3	Eradication or containment decision matrix	4
4	Pest information/status	5
4.1	Pest details	5
4.1.1	General information.....	5
4.1.2	Life cycle	6
4.2	Affected hosts	7
4.2.1	Host range.....	7
4.2.2	Geographic distribution	7
4.2.3	Symptoms	8
4.3	Entry, establishment and spread	10
4.3.1	Entry potential	10
4.3.2	Establishment potential	10
4.3.3	Spread potential	10
4.3.4	Economic impact.....	10
4.3.5	Environmental impact.....	10
4.3.6	Overall risk	11
4.4	Diagnostic information	11
4.4.1	Diagnostic protocol.....	11
5	Pest management.....	12
5.1	Response checklist.....	12
5.2	Delimiting survey and epidemiology study	12
5.2.1	Sampling method	12
5.2.2	Epidemiological study	13
5.2.3	Models of spread potential	14
5.2.4	Pest Free Area (PFA) guidelines	14
5.3	Availability of control methods	15
5.3.1	General procedures for control	15
5.3.2	Control if small areas are affected	15
5.3.3	Control if large areas are affected.....	15
5.3.4	Cultural control	15
5.3.5	Host plant resistance.....	16
5.3.6	Chemical control.....	16

5.3.7	Mechanical control	16
5.3.8	Biological control	16
6	Course of action – eradication methods.....	16
6.1	Destruction strategy	17
6.1.1	Destruction protocols	17
6.1.2	Decontamination protocols.....	17
6.1.3	Priorities	18
6.1.4	Plants, by-products and waste processing	18
6.1.5	Disposal issues	18
6.2	Quarantine and movement controls	18
6.2.1	Quarantine priorities	18
6.2.2	Movement control for people, plant material and machinery	18
6.3	Zoning	19
6.3.1	Destruction Zone	19
6.3.2	Quarantine Zone	19
6.3.3	Buffer Zone.....	20
6.3.4	Restricted Area.....	20
6.3.5	Control Area	20
6.4	Decontamination and farm clean up.....	20
6.4.1	Decontamination procedures	20
6.4.2	Decontamination if pest is identified in small or large areas.....	21
6.4.3	General safety precautions	21
6.5	Surveillance and tracing	21
6.5.1	Surveillance.....	21
6.5.2	Survey regions	21
6.5.3	Post-eradication surveillance	22
7	References	23
7.1	Websites	25
8	Appendices	25
8.1	Appendix 1. Standard diagnostic protocols	25
8.2	Appendix 2. Resources and facilities.....	26
8.3	Appendix 3. Market access impacts	26

1 Purpose and background of this Contingency Plan

This Contingency Plan provides background information on the pest biology and available control measures for bacterial leaf streak (*Xanthomonas translucens* pv. *translucens* and *X. translucens* pv. *undulosa*). During the development of this plan both *X. translucens* pv. *translucens* and *X. translucens* pv. *undulosa* were found to be present in Australia (Murray and Brennan, 2009) and it is therefore unlikely an eradication response plan would be required, however, collation of information in this document ensures knowledge of the status of this pest in Australia is captured.

This document provides assistance with decision making should a new strain be detected, the pest is found in a new area or widespread damage caused by the pest is observed.

2 Australian Grains Industry

The Australian Grains Industry is primarily situated in a narrow crescent running through the mainland states, known as the grain belt. This area stretches in a curve from central Queensland, through New South Wales, Victoria and southern South Australia. In Western Australia, the grain belt covers the south-west corner of the state.

The grains industry is the largest plant industry and grain crops are grown in all states and territories. The gross value of grains and oilseeds in 2006/07 was \$5.3 billion, compared to the five year average for gross value of grains and oilseeds from 2002/03 – 2006/07 of \$7.4 billion per annum (ABS data). The grains industry consists of 25 leviable crops; however, Bacterial leaf streak is predominantly a threat to wheat, barley and triticale crops. Of these crops, wheat is the most important in terms of area cropped and economic value, with an average of nearly 19 million tonnes per year grown over 12.4 million hectares (ABS data for five year average to 2008). The average annual production of barley is approximately 7.1 million tonnes and the average annual area sown to barley is 4.3 million hectares (ABS data for five year average to 2008).

Due to Australia's relatively small population and domestic demand, export markets are essential for the viability of Australian grain farms. Australia currently exports around 60% of its grain with wheat and barley accounting for 62% and 19%, respectively, of total grain exports. With this reliance on exports, maintaining our current plant health status through appropriate biosecurity measures is of utmost importance in retaining access to these markets.

3 Eradication or containment decision matrix

The decision to eradicate should be based on the potential economic impact of host damage resulting from Bacterial leaf streak (*Xanthomonas translucens*), the cost of eradication and on technical feasibility. Eradication costs must factor in long term surveys to prove the success of the eradication program.

As *X. translucens* is present in Australia, no specific eradication matrix has been developed.

4 Pest information/status

4.1 Pest details

Scientific name	Synonyms	Common names
<i>Xanthomonas translucens</i> pv. <i>translucens</i>	<i>Xanthomonas campestris</i> pv. <i>translucens</i> , <i>Bacterium translucens</i> , <i>Phytomonas translucens</i> , <i>Xanthomonas translucens</i>	Bacterial leaf streak, black chaff, Xanthomonas streak
<i>Xanthomonas translucens</i> pv. <i>undulosa</i>	<i>Xanthomonas translucens</i>	Bacterial leaf streak, black chaff, Xanthomonas streak

4.1.1 General information

Taxonomic position – Phylum: Proteobacteria; Class: Gammaproteobacteria; Order: Xanthomonadales; Family: Xanthomonadaceae

Bacterial leaf streak, caused by the pathogen *Xanthomonas translucens* pv. *translucens*, was first discovered in barley (*Hordeum vulgare*) (Jones *et al.*, 1917) and later in wheat (*Triticum aestivum*) (Smith *et al.*, 1919). This pathogen causes disease mainly in wheat, but can infect a number of other *Poaceae* species, such as barley, triticale and rye. *X. translucens* has adapted to grow as an epiphyte on wheat (Azaad and Schaad, 1988), and this growth habit is probably a prerequisite for infection (Leben, 1965). The pathogen can cause sporadic but widespread damage in wheat crops overseas, particularly under moist conditions (Azaad and Schaad 1988).

Different names have been proposed, depending on the host plant, for the closely related cereal streak pathogens also often grouped together under the name 'translucens group'. The taxonomy of this group of bacteria and the phytopathological relevance of the classification has been recently revisited in detail and clarified (Vauterin *et al.*, 1995; Bragard *et al.*, 1997). The name *X. translucens* pv. *undulosa* is usually the name used to refer to the pathogen that causes BLS on wheat.

Infected wheat plants show two distinct symptoms: leaf lesions and 'black chaff'. Leaf streak begins as water-soaked lesions on the extremities or mid vein of leaves. Under moist conditions, these streaks elongate rapidly following the parallel venation of the leaf and result in chlorotic or necrotic leaves (Cunfer, 1987). In dry conditions the exudates solidify into yellowish granules which are easily detachable on the surface of leaves. The partial or complete darkening of the glumes and peduncles by this pathogen is known as 'black chaff'. Symptom severity of the leaves and black chaff are independent (Tillman *et al.*, 1996): even cultivars that are tolerant to leaf symptoms may show darkening of the peduncle in affected plants. Yield reductions from bacterial leaf streak are usually minor (<10%) but under sprinkler irrigation yield losses of up to 40% have been reported (Forster and Schaad, 1988).

Both *X. translucens* pv. *translucens* and *X. translucens* pv. *undulosa* have been recorded in the eastern grain growing regions in Australia. Despite their presence, yield losses in wheat and barley from this disease are rarely reported and their potential for causing economic losses is rated as very low (Murray and Brennan, 2009; 2010).

4.1.2 Life cycle

The *X. translucens* bacteria primarily survives between susceptible crop plant hosts in infected seed, but can also survive at low levels on plant debris, volunteer cereals and wild hosts (without symptoms necessarily showing on the wild host plants). Free bacteria cannot survive more than 14 days in air-dried soil (Cunfer, 1988). Survival on plant debris is also short and unlikely to persist through the hot, Australian summer temperatures (Milus and Mirlohi 1995). Therefore survival of the bacteria in soil over summer in Australia may be limited which may explain the limited damage the disease causes in Australian crops. Spread of the bacteria within a crop can occur through plant-to-plant contact, spike-visiting insects (e.g. aphids) or by water (splashing from rain and sprinklers or through furrow irrigation). Wet conditions are required for disease development.



Figure 1. Bacterial streak on wheat at watery-ripe stage. Streaks may coalesce to kill large portions of leaf, or even the entire plant (Image EA Milus University of Arkansas, Bugwood.org).

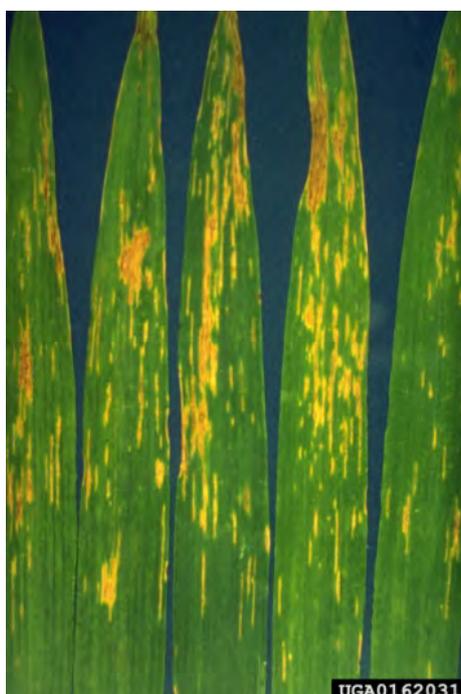


Figure 2. Bacterial leaf streak on wheat (Image by EA Milus, University of Arkansas, Bugwood.org)

4.2 Affected hosts

4.2.1 Host range

Scientific name	Major hosts	Minor hosts	Wild hosts
<i>Xanthomonas translucens</i> pv. <i>translucens</i>	<i>Hordeum vulgare</i> (barley), <i>Secale cereale</i> (rye), <i>Triticale</i> , <i>Triticum aestivum</i> (wheat)	<i>Avena sativa</i> (oats), <i>Triticum spelta</i> (spelt)	<i>Bromus inermis</i> (Awnless brome)
<i>Xanthomonas translucens</i> pv. <i>undulosa</i>	<i>Hordeum vulgare</i> (barley), <i>Secale cereale</i> (rye), <i>Triticale</i> , <i>Triticum aestivum</i> (wheat)	<i>Avena sativa</i> (oats), <i>Triticum spelta</i> (spelt)	<i>Bromus inermis</i> (Awnless brome), <i>Phleum pratense</i> (timothy grass), <i>Elymus repens</i> (quackgrass), <i>Phalaris canariensis</i> (canarygrass), <i>Poa pratensis</i> (Kentucky bluegrass), <i>Festuca arundinacea</i> (tall fescue), <i>F. rubra</i> (red fescue), <i>Hordeum leporinum</i> (barley grass), <i>Medicago sativa</i> (lucerne)

4.2.2 Geographic distribution

X. translucens has been reported in the following countries (see Figure 3):

- Asia: Azerbaijan, China, Georgia (Republic), India, Iran, Israel, Japan, Kazakhstan, Malaysia, Pakistan, Syria, Turkey, Yemen
- Europe: Belgium, Bulgaria, France, Poland, Romania, Russian Federation, Spain, Sweden, Ukraine
- Africa: Ethiopia, Kenya, Libya, Madagascar, Morocco, South Africa, Tanzania, Tunisia, Zambia
- North America: Canada, Mexico, USA
- South America: Argentina, Bolivia, Brazil, Paraguay, Peru, Uruguay
- Oceania: Australia

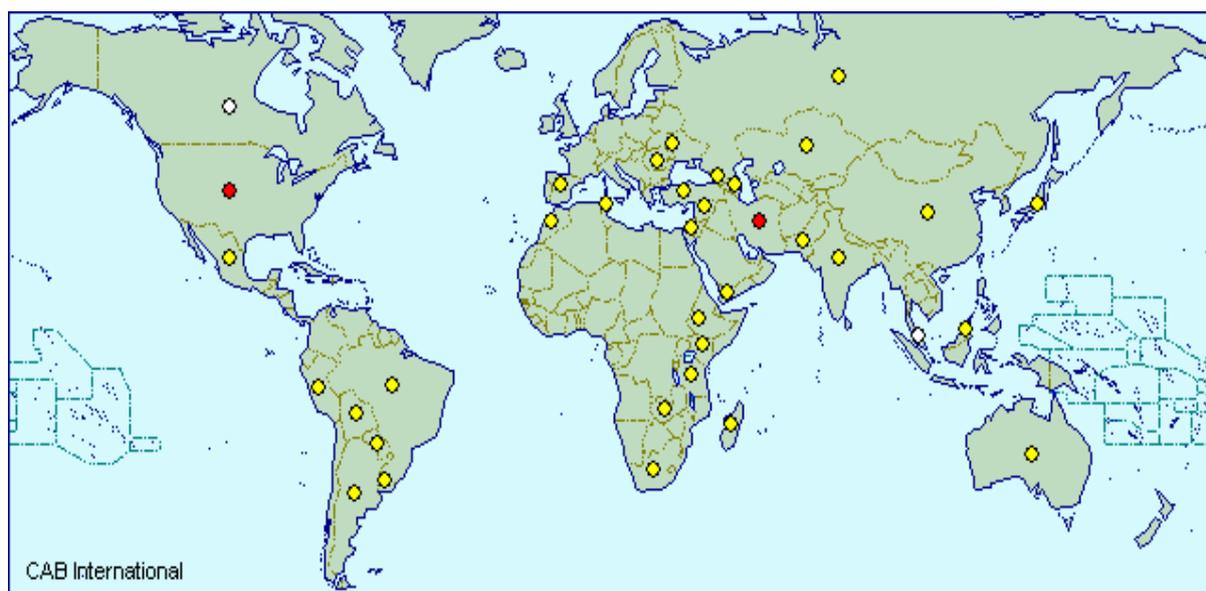


Figure 3. Geographic distribution of *X. translucens* pv. *translucens* reports. Yellow dots represent reports of *X. translucens* pv. *translucens* detection. White dots represent localised distribution while red dots indicate widespread distribution. Figure obtained from www.cabicompendium.org.

4.2.3 Symptoms

Plants may develop symptoms at all growth stages, however these are more frequent following flowering. These may include:

- **Leaves:** Symptoms begin, normally at the edges or midrib, as small, light-brown, water-soaked streaks that are confined by the veins. On non-susceptible hosts or under dry conditions, the streaks remain small and turn chlorotic or necrotic within a few days, but on susceptible hosts under moist conditions the streaks will elongate parallel to the veins and develop a dark-brown water-soaking that is translucent when held up to the light. Streaks are typically yellow to brown and infected areas ooze bacteria seen as yellow thread-like masses under moist conditions (Stromberg *et al.*, 2004) or thin shiny scales when dry. Streaks may coalesce to form large lesions and even kill entire leaves (Figures 1, 2 and 4).
- **Heads:** When symptoms develop on the heads these are called 'black chaff' and appear as distinct thin black streaks between the veins beginning at the tips of the glumes and lemmas. In severe conditions, the streaks may coalesce giving the heads a dark appearance and the grain may be brown and shrivelled.
- **Stem and peduncle:** Black streaks or uniform black lesions. On certain cultivars, black peduncle lesions may have a light coloured centre.
- **Seeds:** May be shrivelled and usually have a lower kernel weight.

Symptom summary by affected plant parts are as follows:

- Inflorescence: lesions on glumes
- Leaves: necrotic lesions, abnormal colours, odour
- Seeds: discolouration, galls, lesions
- Stems: external discolouration



Figure 4. Bacterial streak on wheat (Image EA. Milus, University of Arkansas, Bugwood.org)

4.3 Entry, establishment and spread

When the Industry Biosecurity Plan for the Grains Industry was prepared in 2004 and more recently reviewed in 2009, Black Chaff (or bacterial streak) was given an overall risk rating as Medium and as a consequence, this contingency plan was commissioned. During preparation of the contingency plan, literature searches undertaken have shown that this pathogen is already present in Australia and management practices are currently used.

4.3.1 Entry potential

Rating: Medium

X. translucens pv. *translucens* and *X. translucens* pv. *undulosa* have been reported in Australia in wheat and to date have not caused serious crop losses (Murray and Brennan 2009, 2010). *X. translucens* pv. *translucens* is highly seed borne and could be easily spread to new regions.

4.3.2 Establishment potential

Rating: High

The pathogens *X. translucens* pv. *translucens* and *X. translucens* pv. *undulosa* have been recorded in the eastern growing regions in Australia on wheat and barley for a number of years. The pathogens survive within infected seed, crop debris and on alternate hosts.

4.3.3 Spread potential

Rating: Medium-High

The primary means of spread of the bacteria is within infected seed, which can be transported large distances. Despite this, the bacterium has only been reported in eastern Australia, with Western Australia currently free of this pest. Short distance dispersal can be through rain splash, sprinkler irrigation, plant contact or spike-visiting insect movement.

4.3.4 Economic impact

Rating: Low

The bacteria are present in eastern grain growing areas of Australia but cause little, if any, economic impact on wheat or barley crops (Murray and Brennan, 2009; 2010).

4.3.5 Environmental impact

Rating: Low

The bacteria have been present in Australia for a number of years without any apparent adverse effects on the environment.

4.3.6 Overall risk

Rating: Low

4.4 Diagnostic information

Inspect heads, peduncles and uppermost leaves for characteristic symptoms and dried exudate between the flowering and soft dough stages. It may be necessary to use a hand lens and hold the specimen at the proper angle to observe thin scales of dried bacterial exudate.

Suspect lesions on leaves can be examined for bacterial streaming to confirm the bacterial nature of the symptoms. Cut across the lesion perpendicular to the veins, mount the cut tissue in water between a glass slide and cover slip, and observe under low magnification (approximately 40 X). Fresh water-soaked lesions caused by *X. translucens* will ooze masses of bacterial cells that are easily seen streaming from the cut ends of the lesion. A cell suspension can be dilution plated to isolate the pathogen.

Older necrotic leaf lesions, and lesions on glumes and peduncles, will stream a few bacterial cells or none at all, but it is still possible to isolate the pathogen from these tissues by dilution plating. It is not possible to inspect seeds visually for the pathogen.

4.4.1 Diagnostic protocol

Identification of *X. translucens* as the pathogen can be achieved through plating on semi-selective medium, antibody recognition or molecular techniques. It is recommended following the initial isolation and identification of the pathogen that a Koch's postulates experiment be carried out with a susceptible host to verify the results.

Semi-selective growth of *X. translucens* occurs following dilution plating on selective media (Schaad and Forster, 1985; Duveiller, 1989; Duveiller, 1990; Forster *et al.*, 1995) and incubation at 25-30°C for 2-3 days. Current selective media composition is 23 g Difco nutrient agar, 2.5 g glucose in 1 litre of distilled water plus 200 mg cycloheximide, 10 mg cephalixin, and 1450 µg gentamicin after autoclaving. *X. translucens* colonies are pale yellow, convex, and smooth with entire margins.

Fatty acid analysis (Stead, 1989; Yang *et al.*, 1993), selective infection by bacteriophage (Mohan and Mehta, 1985), seriological methods (Azad and Schaad, 1988), RFLP analysis (Berthier *et al.*, 1993) and PCR based methods (Maes and Garbeva, 1995) can all be used to identify *X. translucens*.

Both monoclonal (Bragard & Verhoyen, 1993) and polyclonal (Frommel and Pazos, 1994) antibodies have been developed that specifically bind to *X. translucens*, and can thus be utilised in identification.

5 Pest management

5.1 Response checklist

As *X. translucens* has been recorded in eastern Australia, it is unlikely a Response Plan or Checklist would be required.

5.2 Delimiting survey and epidemiology study

From the records this pathogen has been recorded in the eastern states on both wheat and barley and has not caused significant crop losses to date. For these reasons it is unlikely that a delimiting survey and epidemiology study would be undertaken. However, it is possible a delimiting survey may be required if the pathogen were detected in a new area or if detected in Western Australia or should a new virulent strain be detected.

The following sections (section 5.2.1 – 5.2.4) would only be required if a new, more virulent strain of this pathogen was suspected.

5.2.1 Sampling method

Once initial samples have been received and preliminary diagnosis made, follow up samples to confirm identification of the pathogen will be necessary. This will involve sampling directly from the infected crop, and sampling crops over a larger area to determine the extent of disease distribution.

From each crop sampled, at least 100 plants should be taken at random. However, preference may be given to symptomatic plants in fields where the disease incidence is low.

All plants should be assessed for the presence of bacterial leaf streak (*X. translucens*) symptoms (i.e. yellow streaks, bacterial ooze – see 4.2.3).

Cut across suspect lesions perpendicular to the veins, which will stream bacterial cells. These can be collected for dilution plating or other analysis methods (see Diagnostic protocol). Infected plant material can also be collected using sterile scissors.

Any personnel collecting samples for assessment should notify the diagnostic laboratory prior to submitting samples to ensure expertise is available to undertake the diagnosis. General protocols for collecting and dispatching samples are available within Appendix 3 of PLANTPLAN (Plant Health Australia, 2011).

The total number of samples collected at this point may run into the hundreds or even thousands. It is vital that a system of sample identification is determined early in the procedure to allow for rapid sample processing and accurate recording of results. Follow up samples will be forwarded to the nominated diagnostic laboratories for processing.

Samples should be initially collected over a representative area of the infected crop to determine the pathogen distribution. The disease may appear as patches within the crop depending on the source of the pathogen.

It is important to note the distribution of disease in the initial crop, as this will indicate whether the pathogen has been seed-borne, carried on trash from adjacent paddocks or originated from contaminated machinery or human movement.

All personnel involved in crop sampling and inspections must take all precautions to minimise the risk of disease spread between crops or human health impacts by decontaminating between paddocks.

Samples should be collected from plants that represent a range of symptoms observed in the infected crop. Enough material should be collected to allow for immediate processing and retention of a portion that can be placed into long term storage as a reference.

Samples should be treated in a manner that allows them to arrive at the laboratory in a fresh, well-preserved state. An esky with ice packs or portable fridge should be carried when sampling crops. Samples should be wrapped in damp newspaper, bundled into a plastic bag and clearly labelled. For appropriate labelling and packaging procedures for suspect emergency plant pests consult PLANTPLAN (Plant Health Australia, 2011).

Samples should be processed as quickly as possible after sampling from the field if sub-cultures are to be made from infected tissue. Once removed from the field, fresh plant samples can deteriorate and become contaminated by other mould, fungi and bacteria, which may prevent successful sub-culturing of the pathogen. Sub-culturing should be done within three to four days after sampling from the field.

It is important to record the precise location of all samples collected, preferably using GPS, or if this is not available, map references including longitude and latitude and road names should be recorded. Property and owners names should also be included where possible.

All diagnoses of suspected exotic pathotypes should be undertaken according to the following parameters:

- The laboratory diagnostician has expertise in this form of diagnosis
- The results are confirmed by diagnosis in another recognised laboratory or by another diagnostician
- Where possible diagnosis is confirmed by a second method usually PCR

5.2.2 Epidemiological study

The number of infected plants within a crop will depend on the amount of inoculum available and whether conditions have been favourable for the disease to spread from initial foci.

Sampling of crops within a district and beyond will be based upon the origins of the initial suspect sample(s). Factors to consider will be:

- The source of seed used and how long that seed has been used by the grower
- If any other crops have been sown from the same source seed
- The proximity of other susceptible crops to the initial infected crop, both in the current growing season and previous season. This will include the growers own crops and those on neighbouring properties
- What machinery or vehicles have been into the infected crop
- The extent of human movements into the infected crop

5.2.3 Models of spread potential

No modelling data are available.

Spread may occur in the following ways:

- Movement of infected seed. The bacteria have the potential to be transmitted as infected seed. Seed to seedling transmission has been documented and this pathway of dispersal should not be ignored. Small infected fragments can also be carried within infested seed lots
- Infected trash may also carry the pathogen. This may occur locally as wind blown plant debris from an infected crop following harvest, or over longer distances if the crop, or parts of, have been cut for hay
- Mechanical transmission via plant-to-plant contact, insects and rain splash movement

5.2.4 Pest Free Area (PFA) guidelines

The establishment and maintenance of pest free areas (PFAs) would be a resource-intensive process, especially as the pathogen already occurs within Australia. Prior to development of a PFA due consideration should be given to alternative methods (e.g. treatments or enclosed quarantine) that achieve an equivalent biosecurity outcome to a PFA. A benefit-cost analysis is useful for this purpose.

Additional information is provided by the IPPC (1995) in Requirements for the Establishment of Pest Free Areas. This standard describes the requirements for the establishment and use of PFAs as a risk management option for phytosanitary certification of plants and plant products. Establishment and maintenance of a PFA can vary according to the biology of the pest, pest survival potential, means of dispersal, availability of host plants, restrictions on movement of produce, as well as PFA characteristics (size, degree of isolation and ecological conditions).

Points to consider are:

- Design of a statistical delimiting field survey for symptoms on host plants (See 5.2.1 for points to consider in the design)
- Plant sampling should be based on at least 100 plants taken at random per crop
- Preliminary diagnosis can be based on leaf symptoms
- Cultural methods for confirmation of identity
- Seed sampling should be based on a minimum of 400 seeds (preferably 1000)
- Surveys should also consider alternative host plants
- Survey around irrigation systems or waterways that may have transported the pathogen.

5.3 Availability of control methods

5.3.1 General procedures for control

- Keep traffic out of affected areas and minimize movement in adjacent areas
- Stop irrigating affected (irrigated crops) areas and use bunding to divert overland flood flows around them (both irrigated and dryland crops)
- Adopt best-practice farm hygiene procedures to retard the spread of the pest between fields and adjacent farms
- After surveys are completed, destruction of the infected crop is an effective control
- On-going surveillance of infected paddocks to ensure bacterial leaf streak is eradicated
- Ensure that planting seed production does not take place on affected farms and do not use seed from these farms to plant next crop as bacterial leaf streak can be seed borne

5.3.2 Control if small areas are affected

Current management practices and varieties grown are such that active control of the disease is not required.

5.3.3 Control if large areas are affected

Current management practices and varieties grown are such that active control of the disease is not required.

5.3.4 Cultural control

X. translucens can survive at low levels on alternative hosts and plant debris, but these sources are only a minor source of inoculum (Mehta *et al.*, 1992). Therefore, standard cultural control methods such as crop rotation, tillage and weed control (in crop and over summer) would be effective in lowering disease levels.

There are no seed treatments that eradicate *X. translucens* without excessive damage to the seed. Hot, acidified cupric acetate (Forster & Schaad, 1988; Duveiller, 1989), dry heat (Fourest *et al.*, 1990) and Guzatine Plus (Mehta & Bassoi, 1993) have been shown to greatly reduce seedborne populations of *X. translucens* and bacterial streak in the field. However, acidified cupric acetate and dry heat are best suited to small seedlots, and none of the treatments are 100% effective for eradicating the pathogen or preventing transmission to plants (Duveiller, 1994). Sands *et al.* (1986) reported a hot-water treatment at 53°C for 10 minutes followed by immediate cooling and drying.

The use of clean, uninfected seed would also be a very effective method of removing the disease risk.

5.3.5 Host plant resistance

Host plant resistance to *X. translucens* appears to be quantitative and polygenic (Duveiller *et al.*, 1993). Genetic resistance to the pathogen has been identified in a wide range of wheat genotypes (Sun and He, 1986; Akhtar and Aslam, 1988; Thompson and Souza, 1989; Duveiller *et al.*, 1993; Milus *et al.*, 1996) and a small number of triticale genotypes (Bekele *et al.*, 1985; Johnson *et al.*, 1987). Identification of resistance in other crop species has not been confirmed.

5.3.6 Chemical control

Sun *et al.* (1988) in China reported control of black chaff with TF-128, and Luz *et al.* (1993) in Brazil reported control of *X. translucens* with probenazole, but no other information is known about these compounds.

5.3.7 Mechanical control

There is no specific mechanical control method, but ploughing in a crop before seed set will vastly reduce the chance of spreading the disease off-farm (as long distance dispersal is predominantly seed-borne) and contain the disease to a manageable area. Ploughing will also accelerate decomposition of the infected plants.

5.3.8 Biological control

Biological control using phyllosphere-inhabiting bacterial epiphytes prior to colonization of *X. translucens* was shown to decrease leaf-associated population sizes of *X. translucens* and subsequent severity of bacterial leaf streak symptoms (Stromberg *et al.*, 2000). However, because pathogen populations were not completely controlled, these populations can still serve as inoculum sources for dispersal to other plants or hosts. Thus, biological control using bacterial epiphytes is not an effective standalone control measure.

6 Course of action – eradication methods

As Bacterial leaf streak already occurs in eastern Australia, it may be some time before an introduced pathotype was confirmed. Given that the feasibility of an eradication program will depend on early detection, delays in detecting new pathotypes are likely to reduce the likelihood of developing a technically feasible, cost beneficial eradication Response Plan.

Additional information is provided by the IPPC (1998) in Guidelines for Pest Eradication Programmes. This standard describes the components of a pest eradication programme which can lead to the establishment or re-establishment of pest absence in an area. A pest eradication programme may be developed as an emergency measure to prevent establishment and/or spread of a pest following its recent entry (re-establish a pest free area) or a measure to eliminate an established pest (establish a pest free area). If required the eradication process involves three main activities: surveillance, containment, and treatment and/or control measures.

6.1 Destruction strategy

6.1.1 Destruction protocols

- Transmission of the bacteria through seed is the most likely means of long-distance dissemination, where the seed can survive for more than 5 years. It can also survive on plant debris for several years. The pathogen is also likely to be transported over long distances via the movement of infested seed and contaminated vehicles and machinery
- If eradication is considered, infected crops should be destroyed by burning and ploughing. This will prevent spreading of the bacteria by direct plant to plant contact, insects and water dispersal. Infected trash may survive in the soil for several years and the paddock should not be re-cropped to susceptible hosts for at least three years
- The paddock may be cropped with pulses or oilseed crops for several years following the incursion and selective herbicides used to ensure the area remains free of potential host plants
- All vehicles and farm machinery that enter the infected field should be thoroughly washed, preferably using a detergent, farm degreaser or a 1% (available chlorine) bleach solution
- Any infected plant material or soil removed from the site should be incinerated, autoclaved or buried deeply (in a non-cropping area)
- Disposable equipment, infected plant material or soil should be disposed of by autoclaving, high temperature incineration or deep burial
- Any equipment removed from the site for disposal should be double-bagged

6.1.2 Decontamination protocols

Machinery, equipment, vehicles in contact with infected plant material or soil or present within the Quarantine Area, should be washed to remove soil and plant material using high pressure water or scrubbing with products such as a farm degreaser or a 1% bleach solution in a designated wash down. General guidelines for wash down areas are as follows:

- Located away from crops or sensitive vegetation
- Readily accessible with clear signage
- Access to fresh water and power
- Mud free, including entry and exit points (e.g. gravel, concrete or rubber matting)
- Gently sloped to drain effluent away. Effluent must not enter water courses or water bodies
- Allow adequate space to move larger vehicles and keep away from hazards such as power lines
- Waste water, soil or plant residues should be contained (see PLANTPLAN 2011 Appendix 18)
- Disposable overalls and rubber boots should be worn when handling infected soil or plant material in the field. Boots, clothes and shoes in contact with infected soil or plant material should be disinfected at the site or double-bagged to remove for cleaning
- Skin and hair in contact with infested plant material or soil should be washed

- Decon 90 is a suitable detergent for using to decontaminate equipment or personnel

6.1.3 Priorities

- Confirm the presence of the pest
- Prevent movement of vehicles and equipment through affected areas
- Priority of eradication/decontamination of infected host material
- If the decision is made to eradicate, determine the extent of infection through survey and seed trace back
- Stop the movement of any seed that may be infected with the pathogen

6.1.4 Plants, by-products and waste processing

- Infected plant material should be destroyed by (enclosed) high temperature incineration, autoclaving or deep burial (in a non-cropping area)
- As the bacteria can be mechanically transmitted, killed crops should be ploughed in
- Infected paddocks should remain free of host plants for at least 3 years

6.1.5 Disposal issues

- Once introduced and established, *X. translucens* can survive in crop residues and seed for long periods and thus be difficult to eradicate
- Particular care must be taken to minimise the transfer of soil, that may contain infected plant residues, or plant material from the area
- No particular issues with resistance of disease to chemicals or physical treatments are known to exist

6.2 Quarantine and movement controls

6.2.1 Quarantine priorities

- Plant material and soil at the site of infection to be subject to movement restrictions
- Machinery, equipment, vehicles and disposable equipment in contact with infected plant material or soil to be subject to movement restrictions

6.2.2 Movement control for people, plant material and machinery

Once symptoms of *X. translucens* are observed the pathogen is usually well established in the crop and eradication deemed difficult. Therefore, any zoning, quarantine or movement controls will usually pertain to containment and management.

If Restricted or Quarantine Areas are practical, movement of equipment or machinery should be restricted and movement into the area only occurs by permit. The industry affected will need to be informed of the location and extent of the disease occurrence.

Movement of people, vehicle and machinery, from and to affected farms, must be controlled to ensure that infected seed or plant debris is not moved off-farm on clothing, footwear, vehicles or machinery. This can be achieved through:

- Signage to indicate quarantine area and/or restricted movement in these zones
- Fenced, barricaded or locked entry to quarantine areas
- Movement of equipment, machinery, plant material or soil by permit only
- Clothing and footwear worn at the infected site should either be double-bagged prior to removal for decontamination or should not leave the farm until thoroughly disinfected, washed and cleaned
- All machinery and equipment should be thoroughly cleaned down with a pressure cleaner prior to leaving the affected farm. The clean down procedure should be carried out on a hard surface, preferably a designated wash-down area, to avoid mud being re-collected from the affected site onto the machine
- Seed from the affected site should not be used for planting new crops, feeding stock or for human consumption. Hay, stubble or trash must not be removed from the site

6.3 Zoning

The size of each quarantine area will be determined by a number of factors, including the location of the incursion, biology of the pest, climatic conditions and the proximity of the infected property to other infected properties.

6.3.1 Destruction Zone

If destruction of hosts is considered, the entire crop should be destroyed after the level of infection has been established. The delimiting survey will determine whether or not neighbouring host crops are infected and need to be destroyed.

The Destruction Zone will usually be the entire crop but may be the entire farm or contiguous areas of management if spread is likely to have occurred prior to detection.

Particular care needs to be taken to ensure that soil and plant material are not moved into surrounding areas not showing symptoms of disease. Where possible, destruction should take place in dry conditions to limit mud being spread within the field on boots and protective clothing.

6.3.2 Quarantine Zone

The Quarantine Zone is defined as the area where voluntary or compulsory restraints are in place for the affected property(ies). These restraints may include restrictions or movement control for removal of plants, people, soil or contaminated equipment from an infected property.

6.3.3 Buffer Zone

A Buffer Zone may or may not be required depending on the incident. It is defined as the area in which the pest does not occur but where movement controls or restrictions for removal of plants, people, soil or equipment from this area are still deemed necessary. The Buffer Zone may enclose an infected area (and is therefore part of the Control Area) or may be adjacent to an infected area.

6.3.4 Restricted Area

The Restricted Area is defined as the zone immediately around the infected premises and suspected infected premises. The Restricted Area is established following initial surveys that confirm the presence of the pest. The Restricted Area will be subject to intense surveillance and movement control with movement out of the Restricted Area to be prohibited and movement into the Restricted Area to occur by permit only. Multiple Restricted Areas may be required within a Control Area.

6.3.5 Control Area

The Control Area is defined as all areas affected within the incursion. The Control Area comprises the Restricted Area, all infected premises and all suspect infected premises and will be defined as the minimum area necessary to prevent spread of the pest from the Quarantine Zone. The Control Area will also be used to regulate movement of all susceptible plant species to allow trace back, trace forward and epidemiological studies to be completed.

6.4 Decontamination and farm clean up

Decontamination practices are aimed at eliminating the pest thus preventing its spread to other areas.

6.4.1 Decontamination procedures

General guidelines for decontamination and clean up

- Refer to PLANTPLAN (Plant Health Australia 2011) for further information
- Keep traffic out of affected area and minimise it in adjacent areas
- Adopt best-practice farm hygiene procedures to retard the spread of the pest between fields and adjacent farms
- Machinery, equipment, vehicles in contact with infected plant material or soil or present within the Quarantine Area, should be washed to remove soil and plant material using high pressure water or scrubbing with products such as Decon 90 detergent, a farm degreaser or a 1% bleach solution in a designated wash down area
- Plant material should be destroyed by high temperature incineration, autoclaving or deep burial (in a non-cropping area)

6.4.2 Decontamination if pest is identified in small or large areas

Destruction of plant material by herbicide is described. The infected area would need to be monitored for a few years for self-sown plants which should be tested for bacterial leaf streak and then destroyed.

6.4.3 General safety precautions

For any chemicals used in the decontamination, follow all safety procedures listed within each MSDS.

6.5 Surveillance and tracing

6.5.1 Surveillance

Detection and delimiting surveys are required to delimit the extent of the incursion, ensuring areas free of the pest retain market access and appropriate quarantine zones are established.

Initial surveillance priorities include the following:

- Surveying all host growing properties in the pest quarantine area.
- Surveying all properties identified in trace-forward or trace-back analysis as being at risk.
- Surveying all host growing properties that are reliant on trade with interstate or international markets which may be sensitive to bacterial leaf streak presence.
- Surveying commercial grain traders that may have held infected seed.
- Surveying other host growing properties and backyards.

6.5.2 Survey regions

Establish survey regions around the surveillance priorities identified above. These regions will be generated based on the zoning requirements (see Section 6.3), and prioritised based on their potential likelihood to currently have or receive an incursion of this pest. Surveillance activities within these regions will either allow for the area to be declared pest free and maintain market access requirements or establish the impact and spread of the incursion to allow for effective control and containment measures to be carried out.

Steps outlined in table 1 form a basis for a survey plan. Although categorised in stages, some stages may be undertaken concurrently based on available skill sets, resources and priorities.

Table 1. Phases to be covered in a survey plan

Phase 1	<ul style="list-style-type: none"> • Identify properties that fall within the buffer zone around the infected premise • Complete preliminary surveillance to determine ownership, property details, production dynamics and tracings information (this may be an ongoing action)
Phase 2	<ul style="list-style-type: none"> • Preliminary survey of host crops in properties in buffer zone establishing points of pest detection
Phase 3	<ul style="list-style-type: none"> • Surveillance of an intensive nature, to support control and containment activities around points of pest detection
Phase 4	<ul style="list-style-type: none"> • Surveillance of contact premises. A contact premise is a property containing susceptible host plants, which are known to have been in direct or indirect contact with an infected premises or infected plants. Contact premises may be determined through tracking movement of materials from the property that may provide a viable pathway for spread of the pest. Pathways to be considered are: <ul style="list-style-type: none"> ○ Items of equipment and machinery which have been shared between properties including bins, containers, irrigation lines, vehicles and equipment ○ The producer and retailer of infected material if this is suspected to be the source of the outbreak ○ Labour and other personnel that have moved from infected, contact and suspect premises to unaffected properties (other growers, tradesmen, visitors, salesmen, crop scouts, harvesters and possibly beekeepers) ○ Movement of plant material and soil from controlled and restricted areas ○ Storm and rain events and the direction of prevailing winds that result in air-borne dispersal of the pest during these weather events
Phase 5	<ul style="list-style-type: none"> • Surveillance of nurseries, gardens and public land where plants known to be hosts of pest are being grown
Phase 6	<ul style="list-style-type: none"> • Agreed area freedom maintenance, post-control and containment

6.5.3 Post-eradication surveillance

The period of pest freedom sufficient to indicate that eradication of the pest has been achieved will be determined by a number of factors, including cropping conditions, the previous level of infection and the control measures applied. As a guide, the following activities should be carried out following the eradication of the pest:

- Establishment of sentinel plants at the site of infection
- Maintain good sanitation and hygiene practices throughout the year
- Sentinel plants should remain in place and inspected on a fortnightly basis for a further 6 weeks and then on a monthly basis
- Surveys comprising plant sampling for and testing for Bacterial leaf streak to be undertaken for a minimum of 12 months after eradication has been achieved

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7.1 Websites

CAB compendium (www.cabcompendium.org/cpc/home.asp)

Plant Health Australia (<http://www.planthealthaustralia.com.au>)

8 Appendices

8.1 Appendix 1. Standard diagnostic protocols

For a range of specifically designed procedures for the emergency response to a pest incursion refer to Plant Health Australia's PLANTPLAN (www.planthealthaustralia.com.au/plantplan).

8.2 Appendix 2. Resources and facilities

Formal diagnostic services for plant pests in Australia are delivered through a network of facilities located in every state and territory. These services are provided by a range of agencies, including state and territory governments, the Australian Government, commercial and private diagnostic laboratories, museums, CSIRO and universities. A current listing of these facilities can be found at **www.npbdn.net.au/resource-hub/directories/laboratory-directory**.

The national network is supported by the Subcommittee on Plant Health Diagnostic Standards (SPHDS), which was established to improve the quality and reliability of plant pest diagnostics in Australia. SPHDS also manages the production of National Diagnostic Protocols.

For more information on the diagnostic services, or to identify an appropriate facility to undertake specific pest diagnostic services, refer to **www.npbdn.net.au** or contact the SPHDS Executive Officer on SPHDS@daff.gov.au

8.3 Appendix 3. Market access impacts

Within the DAFF MICorP (plants) website, some countries (Turkey, China and Pakistan as at January 2013) have a specific requirement for a declaration/endorsement that a representation sample or the crop was inspected during active growth was found to be free from *Xanthomonas translucens pv. translucens*.

MICorR (plants) contains information about the conditions to export plant and plant products. For further information on MICOR see website at **<http://www.daff.gov.au/micor/plants>**