Industry Biosecurity Plan for the Grains Industry
Threat Specific Contingency Plan

Lentil anthracnose
Colletotrichum truncatum

Prepared by Dr Trevor Bretag
and Plant Health Australia

August 2008

1 Purpose of this Contingency Plan

This Contingency Plan provides background information on the pest biology and available control measures to assist with preparedness for an incursion into Australia of Lentil anthracnose (*Colletotrichum truncatum*). It provides guidelines for steps to be undertaken and considered when developing a Response Plan to this pest. Any Response Plan developed using information in whole or in part from this Contingency Plan must follow procedures as set out in PLANTPLAN and be endorsed by the National Management Group prior to implementation.

2 Pest information/status

2.1 Pest Details

2.1.1 General information

Taxonomic position – Kingdom: Fungi; Phylum: Ascomycota; Class: Sordariomycetes; Subclass: Incertae sedis; Order: Phyllachorales; Family: Phyllachoracea; Genus: *Colletotrichum*; Species: *truncatum*

Common names: Lentil anthracnose or soybean anthracnose (Crop Protection Compendium 2008; www.nappfast.org).

Lentil anthracnose is a relatively new and serious disease of lentils and is caused by the fungal pathogen *Colletotrichum truncatum* (Schwein.) Andrus & Moore. Anthracnose causes necrotic lesions on stems, leaves and pods, and may cause plant death (Buchwaldt et al. 1996). Yield losses may be as high as 60-70% (Morrall et al. 1990; Morrall and Pedersen 1991).

The causal pathogen of anthracnose (*Colletotrichum truncatum*) has an extensive distribution worldwide including Australia. However, there is no evidence that the lentil attaching form of *C. truncatum* is present in Australia. The disease, lentil anthracnose has been recorded in lentil-producing countries including Bangladesh, Bulgaria (Kaiser et al. 1998), Brazil, Pakistan, Ethiopia, Morocco, Syria, the USA (Venette et al. 1994) and Canada (Morall 1988; Platford 1988; Gibson et al. 1991). It was not until the discovery of the disease in Manitoba, Canada in 1987, that lentil anthracnose was recognised as an economically important disease of lentil. Hosts of C. truncatum include not only *Lens culinaris* (lentil), but also other leguminous hosts including *Vicia* spp., *Vigna* spp., *Phaseolus* spp., and several specific crop species including *Pisum sativum* (field pea), *Arachis hypogea* (peanut) and *Glycine max* (soybean).

In Australia, *Colletotrichum truncatum* has been identified on other host species including peanut and soybean, generally in northern cropping areas of New South Wales and parts of Queensland. The disease has not been observed on lentil under field conditions. Scientific literature suggests the existence of host specific pathotypes within the pathogen species. In Canada the lentil attacking form of *C. truncatum* can also infect faba bean and wild vetches. It has also been shown to infect field pea in glasshouse testing (Morrall et al. 1989). Results of disease screening in Canada of the current commercial cultivars grown in Australia shows they are all highly susceptible to lentil anthracnose (Michael Materne, personal communication).

The anthracnose pathogen survives between growing seasons primarily on infected stubble. However, microsclerotia, which are formed within stem lesions, can persist freely in the soil and remain viable for up to four years. Infection is initiated within the crop by infected stubble or microsclerotia coming into contact with lentil seedlings. Leaf infection follows soon afterwards, which later develops into stem lesions. Spores formed within lesions are splashed dispersed by rain droplets to cause secondary infections on surrounding plants. When infected crops are harvested, small fragments of stem and pod

tissue can be dispersed by wind to surrounding paddocks, which can initiate infection in subsequent lentil crops. Seed can become infected by the pathogen, but generally at very low levels. Seed to seedling transmission of the disease has not been observed but cannot be discounted as a pathway of disease introduction.

In Canada lentil anthracnose is managed through a combination of crop rotation, tillage to encourage breakdown of infected stubble and microsclerotia and the use of foliar fungicides (Chongo et al. 1999). Crops left unprotected can suffer yield losses of up to 60% (Morrall 1997).

2.1.2 Life cycle

C. truncatum can survive in several forms, including infected seed, as microsclerotia and on infested trash. Seed infection levels rates of 2-3% have been reported from severely diseased crops (Morrall, 1997), but generally levels range from 0.5–1%. Transmission of the disease from seed to seedling has not been demonstrated, but cannot be discounted as a phytosanitary risk.

C. truncatum can survive as microsclerotia on crop residues for up to four years under Canadian conditions. Infested trash, which includes pod walls and small stem fragments, can carry microsclerotia, which can initiate infection in subsequent lentil crops. When the plant debris decomposes the microsclerotia can survive free in the soil for some time. Canadian research found that survival of *C. truncatum* increased from 12 months, when left on the soil surface, to 4 years when buried on lentil debris (Buchwaldt et al. 1996).

Spores are initially dispersed from old lentil debris near the soil surface to newly establishing lentil plants by rain splash. Symptoms usually appear 7 – 8 days following infection. Newly infected plants produce new generations of spores that disperse to infect neighbouring plants by rain splash. Spores are produced in large numbers on infected host material, even on leaflets that have dropped onto the ground. Observations in Canada have revealed that the number of rainfall events is more important than the total amount of rainfall. Once the pathogen has entered the plant the fungus will grow regardless of temperature and humidity. The optimal conditions for lentil anthracnose infection are temperatures of 16 – 24^{o}C in conjunction with 18 – 24 hours of leaf wetness (Chongo 1998; Chongo and Bernier 2000).

C. truncatum has a very wide host range including many pulse crop and weed species. Host range testing in Canada has shown faba bean (*Vicia faba*) and vetch (*Vicia sativa*) to be highly susceptible when inoculated with isolates of *C. truncatum* from lentil (Buchwaldt et al. 1996). Under greenhouse testing, field pea (*Pisum sativum*) has also been shown to become infected, but cause minor symptoms (Morrall et al. 1989). Field pea crops may have a role to play in the carryover of anthracnose inoculum at low levels when rotated with lentil (Morrall 1997). *C. truncatum* has been isolated from infected faba bean seed in Hungary (Simay 1990) which may also enable the fungus to survive between seasons.

During the growing season, the inoculum is primarily spread by rain splash and to some extent by windblown infected debris (Buchwaldt et al. 1996). It appears that small pieces of infested debris, dust and seed, play an important role in the spread and over summer survival of this pathogen (Buchwaldt et al. 1996). If introduced into Australia, infected crop residues would be expected to play a major role in over-summer survival of the pathogen in the cool season cropping environments of southern and Western Australia.

Optimum temperatures for *C. truncatum*, the cause of Lentil anthracnose, and other climatic factors that influence development of an epidemic are very similar to those of lupin anthracnose in Western Australia (Mark Sweetingham, personal communication). In addition, other diseases of lentil such as ascochyta blight and botrytis grey mould are also prevalent in both Canada and Australia. This suggests that conditions in Australia will also be favourable for lentil anthracnose development.

2.1.3 Dispersal

The fungus survives on lentil debris as small black sclerotia. Dispersal of *C. truncatum* inoculum can occur in several forms viz. infested debris, dust and seed. Each can be important in the spread and establishment of the disease.

Anthracnose infested debris from previous crops is often the major source of inoculum (Buchwaldt et al. 1996). Under Canadian conditions significant spread of the pathogen occurs during harvest operations. Small fragments of pod wall and stem pieces carrying microsclerotia can be blown into surrounding paddocks following harvest and allow the pathogen to move considerable distances away from the infested crop. These same small fragments can be carried within infested seed lots, in other bulk commodities and in machinery over larger distances.

The pathogen also has potential to be transmitted in infected seed. Seed from severely anthracnose infected crops have relatively low levels of seed-borne infection (0.5-1.0%). While seed to seedling transmission has not been reported, this pathway of dispersal cannot be discounted.

Spores of *C. truncatum* can also be dispersed before the crop reaches maturity, generally over shorter distances.

Spores are generally dispersed within crops by rain splash. This will spread the disease from primary sources of infection within the crop to surrounding plants. Windblown rain may create aerosols, which may spread the disease to neighbouring crops. Spores can also adhere to clothing, machinery or animals that have been in contact with sporulating lesions, thereby spreading the disease to nearby crops.

2.2 Affected Hosts

2.2.1 Host range

The lentil attacking form of *Colletotrichum truncatum* is an important exotic pathogen to the Australian lentil industry. Studies in Canada suggest that this strain of the pathogen only attacks plant species belonging to the Lens and Vicia family. However, other strains of the fungus have been shown to attack a wide range of species (Hartman et al. 1986).

Other strains of *C. truncatum* has been isolated from many hosts including *Aeschynomene* (jointvetch), *Aeschynomene americana* (American jointvetch), *Arachis hypogaea* (groundnut), *Bryophyllum pinnatum* (air plant), *Cajanus cajan* (pigeon pea), *Capsicum annuum* (bell pepper), *Centrosema, Centrosema pubescens* (Centro), *Clitoria ternatea* (Butterfly-pea), *Crotalaria juncea* (sunn hemp), *Desmodium* (tick clovers), *Gliricidia sepium* (mother of cocoa), *Glycine max* (soyabean), *Lens culinaris* ssp. culinaris (lentil), *Medicago sativa* (lucerne), *Panax ginseng* (Asiatic ginseng), *Phaseolus* (beans), *Phaseolus lunatus* (lima bean), *Phaseolus vulgaris* (common bean), *Pisum sativum* (pea), *Stylosanthes* (pencil-flower), Stylosanthes guyanensis, Trifolium pratense (purple clover), Trifolium subterraneum (subterranean clover), *Vicia sativa* (common vetch), *Vigna* (cowpea), *Vigna aconitifolia* (moth beans), *Vigna mungo* (black gram), *Vigna radiata* (mung bean), *Vigna unguiculata* (cowpea), *Zornia, Zornia diphylla* and to a lesser extent on *Abutilon theophrasti* (velvet leaf), *Amaranthus hybridus* (smooth pigweed), Apocynum cannabinum (Hemp dogbane), Asclepias (Silkweed), Chenopodium album (fat hen), *Datura stramonium* (jimsonweed), *Ipomoea* (morning glory), *Polygonum* (knotweed), *Solanum* (nightshade), *Xanthium strumarium* (common cocklebur) (see Crop Protection Compendium 2008; www.nappfast.org).

2.2.2 Geographic distribution

The forma specialis of *C. truncatum* that is specific to *Lens* and *Vicia* causing Lentil anthracnose has been identified in Bangladesh, Bulgaria, Canada, Ethiopia, Morocco, Pakistan, Syria and the USA. This disease is most serious in Canada where it causes yield losses of up to 60% (Gibson et. al. 1991). In Canada, it was first identified in Manitoba in 1987 (Platford 1988) and surveys in 1988 and 1989 have found that the disease is now present in all major areas of lentil production in Manitoba. It has also since been discovered in Saskatchewan (Morrall and Pedersen 1991).

Two theories have been suggested regarding the likely source of introduction of the disease into Canada. First, that *C. truncatum* was introduced on Faba bean into Canada in the 1970's, or second, it is actually indigenous to Western Canada (Morrall 1997). In either case, the current pathotype appears specialised and highly virulent to lentil.

In Australia the strains of *C. truncatum* that are endemic on other crops do not attack lentils.

Further details of the host range of *C. truncatum* are provided by Lindbeck and Ford 2005.

2.2.3 Symptoms

Excellent descriptions of the symptoms of lentil anthracnose are provided by Agriculture and Agri-Food Canada (http://paridss.usask.ca/specialcrop/pulse_diseases/lentil/anthracnose.html). The following descriptions are based on observations of the disease in Canada.

Leaf lesions and premature leaf drop

In most lentil crops, the first symptoms of anthracnose appear before flowering, when the plants have 8 to 12 nodes on the main stem. This is also the time when the first tendrils form, and approximately a week before flowers start to open. If there is a large amount of inoculum in the field the first symptoms may appear earlier. The initial symptoms of lentil anthracnose are greenish water-soaked lesions on the lower stems and leaves that become necrotic with time. Tan colored lesions of variable size develop on the lower leaflets and the most severely affected leaflets die prematurely and drop to the ground. Creamy white lesions are also sometimes evident on the upper foliage.

Stem lesions

Lesions on stems develop soon after the appearance of leaf lesions, during flowering, primarily at the base of the plant. Stem lesions may be small, brownish with a black border, or larger, stretching along the stem. As the season progresses, more and more golden-brown lesions develop at the stem base, as well as on the upper part of the stems, and many stems are girdled. Finally there is a marked blackening of old infected tissues due to the production of stromatic mycelium (microsclerotia) under acervuli.

Microsclerotia (fungal survival structures)

Small, pinhead sized fungal structures (microsclerotia) form on the older infected plant tissue. They may be seen with the unaided eye in the centre of stem lesions or more easily with a hand lens (10 -15 x magnification). Each microsclerotia consists of a few hundred cells with thick, black cell walls that protect the fungus from colonisation by other micro-organisms. Microsclerotia enable the fungus to survive between lentil crops either on the plant debris or free in the soil. They remain viable longer when buried in the soil by tillage than left exposed to weather extremes on the soil surface. These fungal structures survive on dead lentil debris or in the soil during periods when a host is not available.

Wilt

Anthracnose causes defoliation and stem girdling, which inhibits utilisation of water and nutrients, and causes the lentil plants to wilt. The fungus girdles the stems resulting in wilting of the entire plant. As a result, large areas of brown and dying plants can be found in the field.

2.3 Entry, establishment and spread

Entry potential: Low to Medium

The fungus can be seed-borne, therefore entry is possible on infected seed or via seed lots contaminated with infected lentil trash or soil.

Australia currently imports 2000 – 3000 tonnes of whole green lentils for human consumption from Canada. Current AQIS import conditions require that imported consignments be grown in an area free of *C. truncatum* and be accompanied by a phytosanitary certificate. Despite this legislation, there is no guarantee that the pathogen cannot enter via infected seed or infested lentil trash bearing microsclerotia that may accompany the consignment.

In addition, the pathogen is also seedborne in a number of other legume species including *Vicia* spp (Neergaard 1979), *Vicia villosa* (Richardson 1990), *Arachis hypogeal* (Olivia et al. 1990), *Glycine max*, *Phaseolus lunatus* (Agarwal and Sinclair 1987), *Vigna sesquipedalis* (Olivia et al. 1990). Seed of these species entering Australia may also carry the pathogen and hence pose a possible pathway of entry.

There is a high frequency of travel between Australia and Canada where the pathogen is now endemic.

Establishment potential: High

The climatic conditions for growing lentils in Australia are similar to those in overseas countries where lentil anthracnose is a serious problem. Day time temperatures in Australia during the lentil growing season are very similar to those in Canada. Even though rainfall is lower in Australia, the climate is still conducive for pathogen establishment. Based on these similarities it would be assumed that the disease could cause serious economic loss should the pathogen become established in lentil growing regions in Australia. In addition, because the lentil growing season in Australia (May to November) is much longer than that in Canada (May to September), the disease would be able to complete more than 1 infection cycle per season in Australia.

Races of *C. truncatum* already occur in Australia on other crop host species which demonstrates that local conditions are suitable for the pathogen. In addition host species such as vetch and faba bean are grown in close rotation with lentil, allowing the pathogen to survive and spread, even in the absence of lentil.

Microsclerotia of the pathogen can survive in the soil for up to 4 years and provide a reservoir of inoculum in the absence of any host plants.

All of the current commercial lentil cultivars and most of the advanced breeding lines grown in Australia are highly susceptible to lentil anthracnose according to the results of disease screening in Canada (Michael Materne, personal communication).

Spread potential: High

Lentil anthracnose has the potential to spread in Australia. The broad host range together with its life cycle and survival mechanism increases its spread potential. The host range of the pathogen includes

lentil, faba bean and vetch. The disease is likely to spread quickly due to the high susceptibility and widespread cultivation of these crops. All of the current commercial lentil cultivars in Australia are highly susceptible to lentil anthracnose. Field pea and chickpea can also be infected by the pathogen but are less susceptible and therefore less likely to contribute significantly to the spread of the disease.

Spores are splash dispersed, rain splash can carry spores short distance to surrounding plants. Windblown rain can carry spores longer distances into neighbouring crops. Microsclerotia of the pathogen can be transported over large distances in infested grain and harvesting equipment into new areas.

Windblown plant debris could spread the pathogen over moderate distances following harvest into adjacent paddocks.

The long growing season in Australia would also enable the pathogen to complete more than 1 infection cycle per season. With each cycle of infection the amount of inoculum available to spread the disease is substantially increased.

Economic impact: High

The impact on yield and cost of protection for *C. truncatum* is rated as high as, once established; the disease has the potential to greatly downsize the lentil industry in Australia in a similar manner to the ascochyta blight outbreak in chickpea in 1998.

All of the current commercial lentil cultivars in Australia are highly susceptible to lentil anthracnose. An outbreak of lentil anthracnose would result in a dramatic reduction in the area of production, due to increased costs of production making lentils less competitive compared to other crops. Faba bean production may also be affected as this crop species can be infected by the lentil anthracnose pathogen.

A substantial loss would also be incurred in the year of the outbreak. This not only includes lost production but also indirect impact on other business sectors such as other agricultural enterprises, storage, transport, manufacturing and wholesale trade. The losses would be similar to those incurred as a result of the outbreak of ascochyta blight in chickpeas in 1998 which has been calculated to have cost the Wimmera region in Victoria, $62 million.

Under Canadian conditions, lentil anthracnose causes yield losses of up to 60% if left uncontrolled.

Overall risk: High

At present, by combining the likelihoods of entry, establishment and spread the overall risk to the lentil industry is medium to high.

The level of risk is likely to remain high because all of the current commercial lentil cultivars in Australia are highly susceptible to lentil anthracnose, large quantities of lentil seed continues to be imported and there is frequent travel between Australia and countries where *C. truncatum* is endemic.

The pathogen is most likely to be introduced via infected seed lots or infected plant residues.

2.4 Diagnostic information

2.4.1 Diagnostic protocol

Diagnosis of lentil anthracnose is a two-stage process (Lindbeck and Ford 2005).

Firstly, a preliminary microscopic examination is undertaken to determine whether disease symptoms and pathogen morphology are consistent with lentil anthracnose or an endemic disease, such as ascochyta blight or botrytis grey mould. An experienced plant pathologist should perform the preliminary examination.

If the symptoms appear to be caused by *C. truncatum*, a PCR test is then undertaken to determine whether the pathogen is the lentil attacking strain of *C. truncatum* or another pathogen also found on lentil (such as *Ascochyta lentis* and *Botrytis* spp.). The test is a PCR-based assay, using highly specific diagnostic molecular markers (Ford et al. 2004). This test can use either fungal cultures or infected plant material as the source of DNA. The primary test requires sample processing in a specialised laboratory capable of molecular techniques.

Currently this is the only PCR diagnostic test available worldwide that is able to distinguish the lentil attacking strain of *C. truncatum* both from other isolates of *C. truncatum* and other pathogens also found on lentil (such as *Ascochyta lentis* and *Botrytis* spp.).

Microscopic examination, based upon the morphological features of fungal isolates, can be used to confirm whether or not they are *C. truncatum*. However this method cannot be used to distinguish between the different forms of *C. truncatum*. These tests require the skills of an experienced mycologist.

2.5 Response checklist

2.5.1 Checklist

Guidelines for Response Checklists are still to be endorsed. The following checklist provides a summary of generic requirements to be identified and implemented within a Response Plan:

- Destruction methods for plant material, soil and disposable items
- Disposal procedures
- Quarantine restrictions and movement controls
- Decontamination and farm cleanup procedures
- Diagnostic protocols and laboratories
- Trace back and trace forward procedures
- Protocols for delimiting, intensive and ongoing surveillance
- Zoning
- Reporting and communication strategy

Additional information is provided by Merriman and McKirdy (2005) in the Technical Guidelines for Development of Pest Specific Response Plans and by Lindbeck and Ford (2005) in National Diagnostic Protocols - Lentil anthracnose.

2.6 Delimiting survey and epidemiology study

Delimiting surveys should comprise local surveys around the area of initial detection concentrating on areas of poor growth. The normal procedure is to collect symptomatic plants and to test them to

confirm the presence of *C. truncatum*. If confirmed, plants taken at random from the same crop should be tested to enable an estimate to be made of the disease incidence. Surrounding crops would then be surveyed. The extent of the survey beyond the initial infected crop should be guided by the test results from surrounding crops.

Seed trace-back will indicate how many seed lots and crops will need to be tested. If the seed used has been sown at several sites, delimiting surveys should be conducted at each site.

2.6.1 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. 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 disease distribution. The disease will appear as patches within the crop given the nature of dispersal of the pathogen. Depending on the stage of infection the symptoms may appear as:

- Plants with premature defoliation
- Plants with stem lesions
- Patches of plants dying within the crop

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

It is vitally important that all personnel involved in crop sampling and inspections take all precautions to minimise the risk of disease spread between crops by decontaminating between paddocks.

All foliage can become infected by *C. truncatum*, this includes leaves, stems and pods. Samples should be collected that represent a range of symptoms observed in the infected crop. Preferably 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.

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. Infected plant tissue to be used for PCR analysis can be placed in a –80^{o}C freezer and stored for an indefinite period without damaging fungal DNA.

Long term storage of isolates can occur as fungal cultures that can be freeze dried for future reference (without loss of viability) or as deep frozen plant specimens maintained at –80^{o}C, which can be used to extract DNA.

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.

It is important that all diagnoses of suspected exotic and emergency pathogens are undertaken according to the following parameters: the laboratory diagnostician has expertise in this form of diagnosis, the test is undertaken as described by Lindbeck and Ford (2005), the results are confirmed by diagnosis in another recognised laboratory or by another diagnostician and where possible diagnosis is confirmed by a second method.

2.6.2 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 lentil crops have been sown from the same source seed.
- The proximity of other pulse crops, especially lentils, to the initial infected crop, both in the current growing season and previous season. Faba bean and vetch crops should also be considered as these crops can also host the pathogen. This will include the growers own pulse crops and pulse crops on neighbouring properties.
- What machinery or vehicles have been into the infected crop.
- The extent of human movements into the infected crop. A possible link to recent overseas travel or visitors from other regions should also be considered.

2.6.3 Models of spread potential

No modelling data are available.

Spread may occur in the following ways:

- Movement of infected seed. The pathogen has the potential to be transmitted as infected seed. While seed to seedling transmission has not been documented, this pathway of dispersal should not be ignored. Small infected fragments can also be carried within infested seed lots.
- Mechanical transmission through movement on contaminated vehicles and machinery.
- Small fragments of pod walls and stem pieces carrying microsclerotia can be blown into surrounding paddocks during harvesting and allow the pathogen to move considerable distances away from the infected crop. In Canada, significant spread of the pathogen occurs during harvesting.
- Fungal spores can be dispersed before a crop reaches maturity. Within a crop the spores are usually dispersed relatively short distances by rain splash but can sometimes be carried to neighbouring crops by windblown rain.
- Fungal spores that adhere to clothing, machinery or animals can be carried large distances into other lentil crops.

2.6.4 Pest Free Area (PFA) guidelines

Points to consider are:

- Design of a statistical delimiting field survey for symptoms on host plants (See 2.6.1 for points to consider in the design).
- Plant sampling should be based on at least 100 plants taken at random per crop.
- PCR methods are required to distinguish between the lentil attacking form of *C. truncatum* and other lentil pathogens.
- Seed sampling should be based on a minimum of 400 seeds (preferably 1000) as infection levels in seed are usually below 1%.
- Surveys should also consider alternative host plants, in particular faba beans and vetch.
- The use of aerial inspection or remote sensing may be possible, with suspect patches inspected and sampled to confirm or deny the presence of lentil anthracnose.

2.7 Availability of control methods

Methods used in Canada for the control of anthracnose include crop rotation, not planting adjacent to previous lentil crops, tillage practices, anthracnose resistant cultivars and fungicide applications.

- Growers are encouraged to adopt a three year field break from lentils to allow time for adequate reduction of the stubble borne inoculum. A shorter rotation, combined with removal of straw is considered adequate in the drier regions.
- Lentil crops can be infested by wind-borne inoculum. New lentil crops should be planted as far from previous lentil crops as possible.
- Plant breeders and pathologists in Canada have identified primitive lentil lines with excellent resistance to anthracnose and are developing new cultivars with resistance to the disease (Chongo and Bernier 1999; Chongo et al. 1999; Chongo et al. 2002; Tar'an et al. 2003; Tullu et al. 2003; Tullu et al. 2006a,b). In collaboration with the Canadian lentil breeders, Australian plant breeders are also developing anthracnose resistant cultivars.
- Zero-tillage can be used to take advantage of the quicker break down of anthracnose inoculum on the soil surface compared to infected plants buried in the soil.
- Fungicide application is the major method for the control of anthracnose.

2.7.1 General procedures for control

- Keep traffic out of affected areas and minimize it in adjacent areas.
- Adopt best-practice farm hygiene procedures to retard the spread of the pest between fields and adjacent farms.
- Ensure seed production does not take place on affected farms and do not use lentil, faba bean or vetch seed from affected areas to plant new crops as this seed may be infected with C. truncatum.
- After surveys are completed, destruction of infected crops and seed lots should be undertaken. Infected crops should be destroyed by burning and ploughing. Any infected seed lots should be incinerated or buried deeply (in a non-cropping area).

- Ongoing surveillance of infected paddocks and adjacent paddocks should continue for several years.

2.7.2 Control if small areas are affected

As above.

2.7.3 Control if large areas are affected

A large area may become affected if a large quantity of infected seed has been widely distributed or if the disease has gone unnoticed for a number of years.

Implementation of large area controls will depend on the ability to determine the original source and track/trace the spread. It will also depend on whether the source is lentil seed or another source e.g. contaminated clothing or machinery. If the disease is found to be confined to a single seed lot and only found in lentil crops, it may be possible to eradicate the disease by destroying all lentil crops in that region. However, unless the pathogen is detected very early it is unlikely that disease eradication will be possible. The fungus is able to produce microsclerotia that can survive in soil for several years and be spread by vehicles and farm machinery. Infected plant debris are also likely to be spread by wind over moderate distances.

If eradication was attempted, there would need to be ongoing monitoring of infected paddocks to ensure there was no opportunity for the pathogen to re-establish on self sown plants.

Because microsclerotia are able to survive in soil for several years, a break of at least three years (preferably longer) would be needed before lentils could be safely grown again in the same area.

2.7.4 Cultural control

Cultural control may be possible by growing non-host crops such as cereals and oilseeds as this would enable ongoing spraying with selective herbicides of any self-sown lentils or other legumes. This would remove any potential hosts of the pathogen.

2.7.5 Host plant resistance

Lentil lines with resistance to anthracnose have been identified (Buchwaldt et al. 2004). At present, there are no commercial lentil cultivars with resistance to anthracnose, but plant breeders at the Crop Development Centre, University of Saskatchewan are in the process of breeding cultivars with both anthracnose and ascochyta resistance. Australian plant breeders, in collaboration with the Canadian lentil breeders, are also incorporating anthracnose resistance into new cultivars.

2.7.6 Chemical control

Fungicide application:

In Canada, anthracnose in lentils can be economically controlled using fungicides. However, because the growing season in Australia is much longer than the growing season in Canada, additional fungicide sprays will be required. It may not be profitable to grow lentils in the drier regions of Australia if regular fungicide sprays are required.

In Canada, the first anthracnose symptoms generally appear when lentil plants have 8 to 12 nodes on the main stem (e.g. when the first tendrils form, and a week before flowering). If there is a large amount of inoculum in the field, symptoms may appear earlier. Tan coloured lesions develop on lower leaflets. The most severely affected leaflets die and drop to the ground. This premature leaf drop indicates that anthracnose may become a problem and fungicide application should therefore be considered.

There is a narrow window for control of anthracnose. The optimum time of application is at the 10-12 node stage or early flowering, and before the fungus attacks the stems.

To be effective, fungicides must be applied prior to the onset of fungal infection. A second application 10-14 days later may be necessary under wet weather conditions and to protect new growth.

Fungicide(s):

In Canada, at the time of preparation of this document Bravo 500 (50% cholorothalonil, Zeneca Agro) was the only fungicide registered for control of anthracnose and ascochyta blight in lentil. It sticks well to the plant surface and resists removal by rain. The recommended rate was 2.0-4.0 L/ha with a maximum of two applications in a season. The water rate was 220-1600 L/ha.

http://paridss.usask.ca/specialcrop/pulse_diseases/lentil/anthracnose_con.html

In Australia, the fungicides Barrack (Crop Care), Unite (Nufarm) and Bravo (Syngenta), which contain 720 g/L chlorothalonil, are also registered for use on lentils and chickpea to control ascochyta blight (Hawthorne 2008). The recommended rate of 1.0–2.0 L/ha to control ascochyta blight in lentils in Australia is lower than the rates currently used to control lentil anthracnose and ascochyta blight in Canada. However, the lower rates have been shown to provide excellent disease control.

In Australia, Barrack, Unite or Bravo at a rate of 2.0 L/ha should effectively control lentil anthracnose.

Fungal resistance to cholorothalonil has not been detected.

2.7.7 Mechanical control

Cultivation of infested paddocks does not significantly reduce the amount of inoculum (microsclerotia) that survives in soil.

2.7.8 Biological control

No biological control agents are available to control lentil anthracnose.

3 Course of Action – Eradication Methods

3.1 Destruction strategy

3.1.1 Destruction protocols

Infected crops should be destroyed by burning and ploughing. This will prevent aerial dispersal of the pathogen via infected crop residues. Microsclerotia may survive in the soil for several years and the paddock should not be re-cropped to lentils, faba beans or vetch for at least three years.

The paddock may be cropped with cereals or oilseed crops for several years following the incursion and selective herbicides used to ensure the area remains free of lentils and other potential host plants.

All vehicles and farm machinery that enter the infected field should be thoroughly washed, preferably using a detergent such as Decon 90.

Any infected plant material or soil removed from the site should be incinerated, autoclaved or buried deeply (in a non-cropping area).

Unless the pathogen is detected very early it is unlikely that the disease could be eradicated. It is able to survive as microsclerotia in soil and 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.

3.1.2 Decontamination protocols

If containment, eradication and/or best practice hygiene measures are implemented, 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 area. 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
- Away from hazards such as power lines
- Waste water, soil or plant residues should be contained (see PLANTPLAN 2008 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.

3.1.3 Priorities

- Confirm the presence of the pathogen.
- Prevent movement of vehicles and equipment through affected areas.
- Priority of eradication/decontamination of infected host material.
- Determine the extent of infection through survey and seed trace back.
- Stop the movement of any seed that may be infected with *C. truncatum*.

3.1.4 Plants, by-products and waste processing

- Seed harvested from infected plants and any infected soil or plant material removed from the paddock should be destroyed by (enclosed) high temperature incineration, autoclaving or deep burial (in a non-cropping area).
- Crops or stubble should be destroyed by burning and deep ploughing.
- Infested paddocks should remain free of host plants for at least three years.

3.1.5 Disposal issues

- Once introduced and established, anthracnose can survive in soils for long periods, even in the absence of plant hosts and thus be difficult to eradicate.
- Particular care must be taken to minimize the transfer of infected soil and trash from the area.
- Raking and burning infected crops is not an option as this procedure is likely to spread the pathogen greater distances during the raking phase.

3.2 Quarantine and movement controls

3.2.1 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.
- Harvesting of anthracnose infected crops should be prevented as the dust created during harvesting can spread the disease to neighbouring areas.
- Wind-borne inoculum can escape from anthracnose infested crops; therefore the establishment of a quarantine area may be impractical.

3.2.2 Movement control for people, plant material and machinery

Once symptoms of lentil anthracnose are observed the pathogen is usually well established in the soil and eradication 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, to and from affected farms, must be controlled to ensure that infected soil or plant debris is not moved off-farm on clothing, footwear, vehicles or machinery.

Examples of movement controls include:

- 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 recollected 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 should not be removed from the site.

3.3 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.

3.3.1 Destruction zone

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.

If the movement of air-borne inoculum to adjacent crops appears likely, they will also need to be destroyed.

Particular care needs to be taken to ensure that soils 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.

3.3.2 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.

3.3.3 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 infested area (and is therefore part of the Control Area) or may be adjacent to an infested area.

3.3.4 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.

3.3.5 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 suspected 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.

3.4 Decontamination and farm clean up

Decontaminant practices are aimed at eliminating the pathogen thus preventing its spread to other areas.

3.4.1 Decontamination procedures

General guidelines for decontamination and clean up

- Refer to PLANTPLAN (Plant Health Australia 2008) for further information.
- Keep traffic out of affected area and minimize it in adjacent areas.
- Adopt best-practice farm hygiene procedures to retard the spread of the pathogen 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 as described in 3.1.2.
- Only recommended materials should be used when conducting decontamination procedures, and should be applied according to the product label.

3.4.2 General safety precautions

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

3.5 Surveillance and tracing

3.5.1 Surveillance

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

Initial surveillance priorities include the following:

- surveying all properties in the quarantine area with known hosts;
- surveying all properties identified in trace forward 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 lentil anthracnose;
- surveying commercial grain traders that may have held infected seed.

3.5.2 Survey regions

Establish survey regions around the surveillance priorities identified above. These regions will be generated based on the zoning requirements (section 3.3), 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 below form a basis for a survey plan. Although categorised in stages, some stages may be undertaken concurrently based on available skill sets and resources.

Phase 1:

Identify properties that fall within the buffer zone around the infested premise.

Complete preliminary surveillance to determine ownership, property details, production dynamics and tracings information (this may be an ongoing action).

Phase 2:

Preliminary survey of host crops in properties in buffer zone establishing points of pest detection.

Phase 3:

Surveillance of an intensive nature, to support control and containment activities around points of pest detection.

Phase 4:

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 infested 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 disease. Pathways to be considered are:

- 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; and
- Storm and rain events and the direction of prevailing winds that result in air-born dispersal of the pathogen during these weather events.

Phase 5:

Surveillance of nurseries, gardens and public land where plants known to be hosts of Lentil anthracnose are being grown.

Phase 6:

Agreed area freedom maintenance, post control and containment.

3.5.3 Post-eradication surveillance

Specific methods to confirm eradication of *C. truncatum* may include:

- Monitoring of sentinel plants
    - Sentinel plants are to be grown in pots using soils removed from the affected site. Plants are to be grown under quarantine containment glasshouse conditions and monitored for symptoms of infection.
- Surveys comprising soil and plant sampling for *C. truncatum* should be undertaken for a minimum of three years after eradication has been achieved.
- Alternate non-host crops should be grown on the site and any self-sown plants sprayed out with a selective herbicide.

4 References

Agarwal SC, Sinclair JB (1987) Principles of Seed Pathology. CRC Press: Boca Raton, Florida (2 Vols.).

Buchwaldt L, Anderson KL, Morrall RAA, Gossen BD, Bernier CC (2004) Identification of lentil germplasm resistant to *Colletotricum truncatum* and characterisation of two pathogen races. Phytopathology 94, 236-243.

Buchwaldt L, Morrall RAA, Chongo G, Bernier CC (1996) Windborne dispersal of *Colletotricum truncatum* and survival in infested lentil debris. Phytopathology 86, 1193-1198.

Chongo G (1998) Host, pathogen and environmental effects on incomplete resistance to anthracnose, *Colletotrichum truncatum*, in lentil, *Lens culinaris*. University of Manitoba, Ph.D. Thesis.

Chongo G, Bernier CC (1999) Field and growth chamber evaluation of components of partial resistance to *Colletotrichum truncatum* in lentil. Canadian Journal of Plant Pathology 21, 58-63.

Chongo G, Bernier CC (2000) Disease incidence, lesion size and sporulation in *Colletotrichum truncatum* as influenced by lentil genotype and temperature. Canadian Journal of Plant Pathology 22, 236-240.

Chongo G, Bernier CC, Buchwaldt L (1999) Control of anthracnose in lentil using partial resistance and fungicide applications. Canadian Journal of Plant Pathology 21, 16-22.

Chongo G, Gossen BD, Bernier CC (2002) Infection by *Colletotrichum truncatum* in resistant and susceptible lentil genotypes. Canadian Journal of Plant Pathology 24, 81-85.

Ford R, Banniza S, Photita W, Taylor PWJ (2004) Morphological and molecular discrimination of *Colletotricum truncatum* causing anthracnose of lentil in Canada. Australasian Plant Pathology 33, 559-569.

Gibson RJ, Bernier CC, Morrall RAA (1991) Anthracnose of lentil in Manitoba in 1990. Canadian Plant Disease Survey 71, 104.

Hartman GL, Manandhar JB, Sinclair J (1986) Incidence of *Colletotricum* spp on soybeans and weeds in Illinois and pathogenicity of *Colletotricum truncatum*. Plant Disease 70, 780-782.

Hawthorne WA (2008) Revised lentil variety disease resistance and controls. Pulse Australia Bulletin WH 2008 # 14

Kaiser WJ, Mihov M, Muehlbauer FJ, Hannan RM (1998) First report of anthracnose of lentil incited by *Colletotrichum truncatum* in Bulgaria. Plant Disease 82, 128.

Lindbeck KD, Ford R (2005) National Diagnostic Protocol - Lentil Anthracnose (*Colletotrichum truncatum*). Plant Health Australia, Canberra, ACT.

Merriman PR, McKirdy SJ (2005) Technical guidelines for development of pest specific response plans. Plant Health Australia, Canberra, ACT.

Morrall RAA (1997) Evolution of lentil diseases over 25 years in western Canada. Canadian Journal of Plant Pathology 19: 197-207.

Morrall RAA (1988) A new disease of lentil induced by *Colletotrichum truncatum* in Manitoba. Plant Disease 72, 994.

Morrall RAA, Gibson RJ, Bernier CC (1990) Anthracnose of lentil in Manitoba in 1989. Canadian Plant Disease Survey 70, 79.

Morrall RAA, McCallum BD, Bernier CC (1989) Anthracnose and other diseases of lentil in Manitoba. Canadian Plant Disease Survey 69, 66.

Morrall RRA, Pedersen EA (1991) Discovery of lentil anthracnose in Saskatchewan in 1990. Canadian Plant Disease Survey 71, 105-106.

Neergaard P (1979) Seed Pathology. Volume I and Volume II. (Macmillan Press, Ltd: London).

Olivia P, Fresneda JA, Camacho JL (1990) A new *Colletotrichum* species in legumes plants in Cuba. Ciencias de la Agricultura 40, 173 – 174.

Plant Health Australia (2008). PLANTPLAN Australian Emergency Plant Pest Response Plan. Version 1. Plant Health Australia, Canberra, ACT.

Platford RG (1988) Incidence of plant diseases in Manitoba in 1987. Canadian Plant Disease Survey 68,1.

Richardson MJ (1990) An annotated list of seed-borne diseases (4th edition) (ISTA: Zurich, Switzerland).

Simay EI (1990) *Colletotrichum dematium* (Pers. ex Fr.) Grove f.sp. *truncata* (Schw./Arx), a new seed-transmitted pathogen of *Vicia faba* L. FABIS Newsletter 26, 32 – 33.

Tar'an B, Buchwaldt L, Tullu A, Banniza S, Warkentin TD, Vandenberg A (2003) Using molecular markers to pyramid genes for resistance to ascochyta blight and anthracnose in lentil (*Lens culinaris* Medik). Euphytica 134, 223-230.

Tullu A, Buchwaldt L, Lulsdorf M, Banniza S, Barlow B, Slinkard AE, Sarker A, Tar'an B, Warkentin T, Vandenberg A (2006a) Sources of resistance to anthracnose (*Colletotrichum truncatum*) in wild Lens species. Genetic Resources and Crop Evolution 53, 111-119.

Tullu A, Buchwaldt L, Warkentin T, Tar'an B, Vandenberg A (2003) Genetics of resistance to anthracnose and identification of AFLP and RAPD markers linked to the resistance gene in PI 320937 germplasm of lentil (*Lens culinaris* Medikus). Theoretical and Applied Genetics 106, 428-434.

Tullu A, Tar'an B, Breitkreutz C, Buchwaldt L, Banniza S, Warkentin TD, Vandenberg A (2006b) A quantitative-trait locus for resistance to ascochyta blight (*Ascochyta lentis)* maps close to a gene for resistance to anthracnose *(Colletotrichum truncatum)* in lentil. Canadian Journal of Plant Pathology 28, 588-595.

Venette JR, Lamey HA, Lamppa RL (1994) First report of lentil anthracnose (*Colletotrichum truncatum*) in the United States. Plant Disease 78, 1216.

4.1 Websites

1. Crop Protection Compendium (2008). CAB International. Wallingford, UK, (http://www.cabicompendium.org/cpc/home.asp)

2. Lentil anthracnose symptoms

http://paridss.usask.ca/specialcrop/pulse_diseases/lentil/anthracnose.html

3. Lentil anthracnose control

http://paridss.usask.ca/specialcrop/pulse_diseases/lentil/anthracnose_con.html

5 Appendices

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.

Appendix 2. Experts, resources and facilities

The following table lists the experts who can be contacted for professional diagnostics and advisory services in the case of an incursion.

Expert	State	Details
Rebecca Ford	Vic	BioMarka Faculty of Land and Food Resources The University of Melbourne VIC 3010 Ph: 03 8344 9753; Fax: 03 8344 9753
Kurt Lindbeck	NSW	NSW Department of Primary Industries Wagga Wagga Agricultural Institute Private Bag Pine Gully Road Wagga Wagga NSW 2650 Ph: 02 6938 1999; Fax: 02 6938 1809

The following table lists the facilities available for diagnostic services in Australia.

Facility	State	Details
The University of Melbourne BioMarka	Vic	Faculty of Land and Food Resources The University of Melbourne VIC 3010 Ph: (03) 8344 9753; Fax: (03) 8344 9753
DPI Victoria Knoxfield Centre	Vic	621 Burwood Highway Knoxfield VIC 3684 Ph: (03) 9210 9222; Fax: (03) 9800 3521
DPI Victoria Horsham Centre	Vic	Natimuk Rd Horsham VIC 3400 Ph: (03) 5362 2111; Fax: (03) 5362 2187
DPI New South Wales Elizabeth Macarthur Agricultural Institute	NSW	Woodbridge Road Menangle NSW 2568 PMB 8 Camden NSW 2570 Ph: (02) 4640 6327; Fax: (02) 4640 6428
DPI New South Wales Tamworth Agricultural Institute	NSW	4 Marsden Park Road Calala NSW 2340 Ph: (02) 6763 1100; Fax: (02) 6763 1222
DPI New South Wales Wagga Wagga Agricultural Institute	NSW	PMB Wagga Wagga NSW 2650 Ph: (02) 6938 1999; Fax: (02) 6938 1809
SARDI Plant Research Centre - Waite Main Building, Waite Research Precinct	SA	Hartley Grove Urrbrae 5064 South Australia Ph: (08) 8303 9400; Fax: (08) 8303 9403
Grow Help Australia	QLD	Entomology Building 80 Meiers Road Indooroopilly QLD 4068 Ph: (07) 3896 9668; Fax: (07) 3896 9446
Department of Agriculture and Food, Western Australia (AGWEST) Plant Laboratories	WA	3 Baron-Hay Court South Perth WA 6151 Ph: (08) 9368 3721; Fax: (08) 9474 2658

Appendix 3. Communications strategy

A general Communications Strategy is provided in PLANTPLAN

Appendix 4. Market access impacts

Within the AQIS PHYTO database, no countries appear to have a specific statement regarding area freedom from Lentil anthracnose. Should Lentil anthracnose be detected or become established in Australia, some countries may require specific declarations.