# Generic Contingency Plan

# Exotic chewing insects affecting the grains industry

## Specific examples detailed in this plan:

## Wheat stem sawfly (*Cephus cinctus*),
## False codling moth (*Thaumatotibia leucotreta* (syn. *Cryptophlebia leucotreta*))

**Plant Health Australia**

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# 1 Purpose and background of this contingency plan

Developing a generic contingency plan for groups of exotic pests will ensure the industry is prepared for a wider range of new pest incursions. These broader focused contingency plans are designed to assist the grains industry during an incursion of any chewing insect pests not already covered by a pest specific contingency plan. This is possible as most chewing insect pests share common traits (e.g. feeding and dispersal behaviours are often similar).

This contingency plan provides background information on the biology of the pest, available control measures, management options and other relevant information to assist with preparing for and responding to an incursion into Australia of a range of chewing insect pests. Wheat stem sawfly (*Cephus cinctus*) and False codling moth (*Thaumatotibia leucotreta,* syn. *Cryptophlebia leucotreta*) are used in this contingency plan as examples of exotic chewing insect pests that could potentially enter Australia and impact on the grains industry.

The contingency plan provides guidelines and options for steps to be undertaken and considered when developing a Response Plan for an incursion of an exotic chewing insect 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.

The information for this plan has been primarily obtained from documents as cited in the reference section. Information on background, lifecycle, host range, distribution and symptoms of pests are given as examples, with the emphasis of this document on the management options in the event of an exotic chewing insect pest incursion into Australia.

# 2 Australian grains industry

The grains industry is the largest plant industry in Australia and grain crops are grown in all states and territories. The grains industry is primarily situated in a narrow crescent running through the mainland states, known as the grain belt. This area stretches 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 with wheat being the most widely planted grain crop (Figure 1).

The grains industry consists of 25 viable crops, all are affected by one or more chewing insect pests.

Due to Australia’s relatively small population and domestic demand, export markets are essential for the viability of Australian grain farms. Australia is one of the world’s largest grain exporters, exporting millions of tonnes of grain annually. 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.

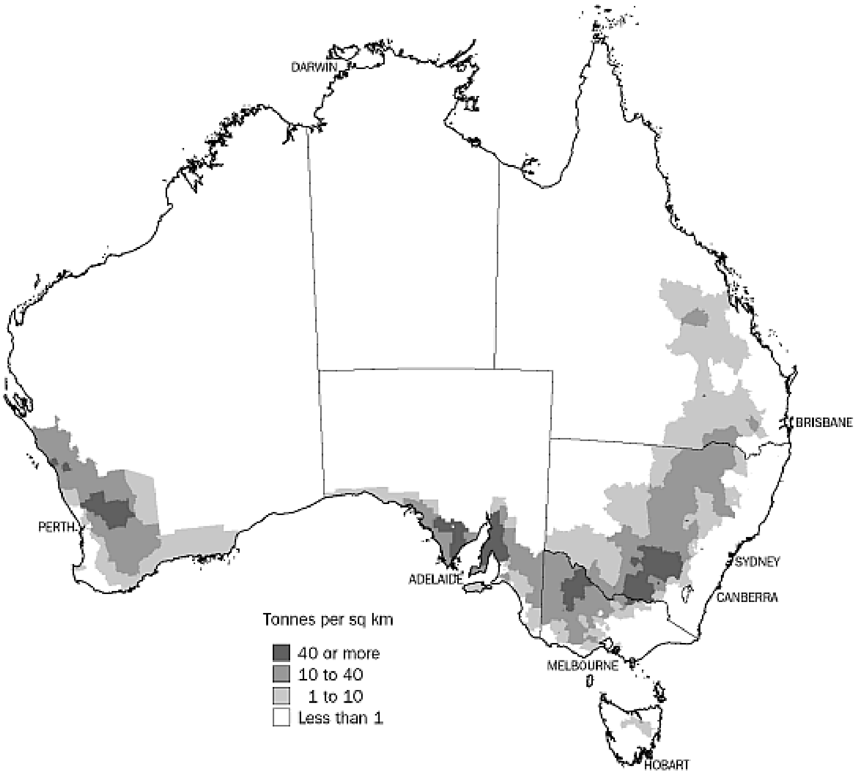


***Figure 1*** *Map of wheat producing regions in Australia (i.e. the grain belt) (ABS 2007)*

## 2.1 Notification process for the reporting of suspect pests

Early detection and reporting may prevent or minimise the long-term impact of an incursion into Australia of an exotic chewing insect pest. The notification process is described in Figure 2.

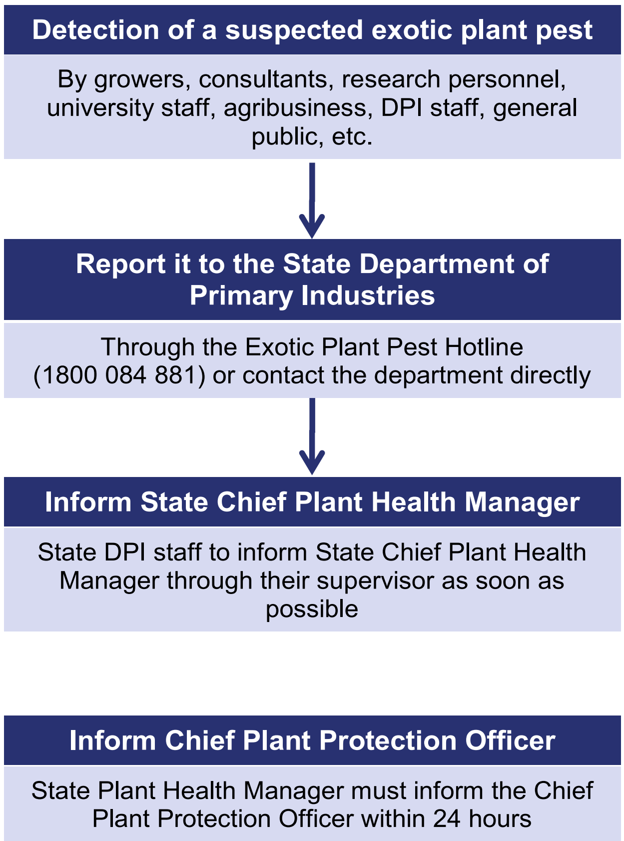


***Figure 2** Notification process for the reporting of suspect pests*

# 3 Eradication or containment decision matrix

The decision to eradicate should be based on the potential economic impact of host damage resulting from the introduction of a chewing insect, the cost of eradication and technical feasibility. Eradication costs must factor in long term surveys to prove the success of the eradication program.

A minimum of three years with no detection of the pest may be necessary before pest free status can be declared. The exact time required will depend on the survival ability of the specific pest (including eggs, larvae and adults) in the absence of host plants.

No specific eradication matrix has been determined for chewing insect pests; however the key decision points during the Investigation and Alert Phase are outlined in PLANTPLAN and Table 1 should be followed in determining if an incursion of a particular pest will result in eradication or management/containment. The final decision between eradication and management will be made through the National Management Group.

***Table 1.*** *Factors to consider regarding the technical feasibility of EPP eradication (taken from Table 2; Section 4.1.6 of PLANTPLAN)*

| **Factors to consider regarding the technical feasibility of EPP eradication** |
|---|
| a) the capability to accurately diagnose or identify the EPP. |
| b) the effectiveness of recommended control technique options, which are likely to be the most cost-effective in eradicating the EPP. |
| c) the ability to remove or destroy all EPPs present by the recommended control techniques. |
| d) the ability to remove the EPP at a faster rate than it can propagate until proof of freedom can be achieved. |
| e) the recommended control techniques are publicly acceptable (taking into consideration cultural and social values, humaneness, public health impacts, non-target impacts and environmental impacts). |
| f) whether Emergency Containment measures have been put in place by the Lead Agency(s). |
| g) whether there are controls methods, commonly employed for endemic pests and diseases, that may limit or prevent the establishment or impact of the EPP. |
| h) any legislative impediments to undertaking an emergency response. |
| i) the resources e.g. chemicals, personnel etc. required to undertake an emergency response are accessible or available. |
| j) the ability to delimit the known area of infestation. |
| k) the ability to identify the pathway for entry into, and trace the spread of the EPP within Australia. |
| l) the ability to determine whether the likelihood of further introductions is sufficiently low. |
| m) the dispersal ability of the EPP (that is, whether the EPP is capable of rapid spread over large distances). |
| n) the capability to detect the EPP at very low densities for the purpose of declaring freedom, and that all sites affected by the EPP have or can be found. |
| o) the ability to put in place surveillance activities to confirm Proof of Freedom for sites possibly infested by the EPP. |
| p) whether community consultation activities have or will be undertaken. |

# 4 Pest information/status – Exotic chewing insect pests affecting grain crops

## 4.1 Background

There are a number of exotic chewing insect pests identified in the Grains Industry Biosecurity Plan (Plant Health Australia 2009-review 2014). Chewing insects are insects with chewing mouthparts (i.e. mandibles), which damage plants during at least one phase of their lifecycle, as opposed to sucking insects which feed on the plants' sap using modified mouthparts to suck material from the plant.

Chewing insects belong to several insect orders including: Coleoptera (beetles), Diptera (flies, midges and leafminers), Hymenoptera (wasps and sawflies), Isoptera (termites), Lepidoptera (moths and butterflies), Dermaptera (earwigs) and Orthoptera (locusts and grasshoppers).

Chewing insect pests include both internal feeders (i.e. insects that feed inside the plant protected by the leaves or tissue of the host plant) and external feeders (i.e. insects that live and feed on the outside of the plant) (see Table 2). Internal and external feeding insects need to be managed differently. For example it is comparatively easy to control external feeding insects as the insect is more easily seen (on the external surfaces of the plant) and contact pesticides sprayed over the surface of the plant can easily contact the pest. In contrast internal feeders are more difficult to detect (such pests are hidden inside the plant) and their control requires more sophisticated methods such as the use of systemic insecticides (that are taken up and spread through the plant and then poison the insect).

It should be noted that different life stages of insects may involve multiple feeding mechanisms (e.g. Lepidoptera larvae may be internal or external feeders but do not damage plants as adults and instead feed on nectar using a proboscis, or lack mouthparts altogether).

The two species used as examples in this contingency plan help illustrate the management options available in the event of an incursion of an exotic chewing insect pest. Although there are some differences, most chewing insect pests will be controlled in a similar manner. However specific chemicals, application rates, biological controls, etc. are likely to vary between species and will have to be considered on a case by case basis. Details such as the general procedures for control (Section 6.1), surveillance (Section 7.2), quarantine and movement controls (Section 8.2), zoning requirements (Section 8.3) and other components of this contingency plan will be the same for all exotic chewing insect pests that could enter Australia and impact on the grains industry.

This means that this contingency plan can provide useful information in the event of an incursion of any exotic chewing insect pest not already covered by a pest specific contingency plan.

***Table 2:*** *High priority chewing insect pests identified in the Grains Industry Biosecurity Plan (Plant Health Australia 2009-review 2014)*

| Order | Life stage that causes chewing damage | Common name | Scientific name | Grains affected | Overall risk[1] |
|---|---|---|---|---|---|
| Coleoptera | Adults (external feeder) larvae (internal feeder) | Cabbage seed weevil | *Ceutorhynchus assimilis (syn. Ceutorhynchus obstrictus)*[2] | Canola | MEDIUM |
| Coleoptera | Adults (external feeder) larvae (internal feeder) | Rape stem weevil | *Ceutorhynchus napi* | Canola | MEDIUM |
| Coleoptera | Adults (external feeder) larvae (internal feeder) | Cabbage stem weevil | *Ceutorhynchus pallidactylus* | Canola | MEDIUM |
| Coleoptera | Larvae (internal feeder) | Sunflower stem weevil | *Cylindrocopturus adspersus* | Sunflower | MEDIUM |

[1] Note: when more than one crop is affected by the same species of nematode, the highest overall risk has been included in the table.

[2] Factsheet and contingency plan available (**www.phau.com.au**).

| Order | Life stage that causes chewing damage | Common name | Scientific name | Grains affected | Overall risk[1] |
|---|---|---|---|---|---|
| Coleoptera | Adults (external leaf feeder) Larvae (internal and external root feeder) | Northern corn rootworm | *Diabrotica barberi* | Maize, wheat, sunflower, soybean | MEDIUM |
| Coleoptera | Adults (external leaf feeder) Larvae (internal and external root feeder) | Southern corn rootworm; spotted cucumber beetle | *Diabrotica undecimpunctata* | Peanuts, soybean, common bean, maize, sweet potato, sunflower | MEDIUM |
| Coleoptera | Adults (external leaf feeder) Larvae (internal and external root feeder) | Western corn rootworm | *Diabrotica virgifera* | Maize, soybean, wheat, sunflower | MEDIUM |
| Coleoptera | Adults and larvae cause damage (mostly external feeders) | Larger grain borer | *Prostephanus truncatus* | Stored grain including: maize, sorghum, winter cereals, peanut, cowpea, common bean. Maize is the most affected host | MEDIUM |
| Coleoptera | Mostly larvae (external feeder) | Khapra beetle | *Trogoderma granarium*[3] | Stored products including: peanut, oat, chickpea, soybean, buck wheat, sunflower, barley, lentil, flax, lucerne, rice, millet, common bean, field pea, rye, sesame, sorghum, wheat, faba bean, cowpea, triticale, maize | HIGH |
| Diptera | Larvae (feeds under leaf sheaths) | Hessian fly | *Mayetiola destructor*[3] | Wheat, barley, triticale and rye | HIGH |
| Diptera | Larvae (feeds under leaf sheaths) | Barley stem gall midge | *Mayetiola hordei*[3] | Barley, oat, wheat, rye | HIGH |

[3] Factsheet and contingency plan available (**www.phau.com.au**).

| Order | Life stage that causes chewing damage | Common name | Scientific name | Grains affected | Overall risk[1] |
|---|---|---|---|---|---|
| Hymenoptera | Larvae (internal feeder) | Wheat stem sawfly | *Cephus cinctus*[4] | Barley, triticale, rye and wheat. | HIGH |
| Hymenoptera | Larvae (internal feeder) | European wheat stem sawfly | *Cephus pygmeus*[5] | Oats, wheat, rye, barley, triticale | HIGH |
| Lepidoptera | Larvae (internal feeders) | Coastal stalk borer | *Chilo orichalcociliellus*[6] | Maize, sorghum, millet | MEDIUM |
| Lepidoptera | Larvae (external then internal feeders) | Spotted stalk borer; Pink borer | *Chilo partellus*[5] | Sorghum, maize, foxtail millet, finger millet, pearl millet | MEDIUM |
| Lepidoptera | Larvae (external feeders) | Sunflower moth | *Homoeosoma electellum* | Sunflower | MEDIUM |
| Lepidoptera | Larvae (internal feeder) | False codling moth | *Thaumatotibia leucotreta* (syn. *Cryptophlebia leucotreta*)[7] | Feeds on more than 50 species of plants in over 30 plant families including: lima bean, sorghum, maize, cowpea | MEDIUM |

## 4.2 Generic information on lifecycles

The exact details of the pest's lifecycle (such as the number of instar stages that are involved, speed of the lifecycle, temperatures and conditions required, etc.) are individual to the species concerned making it difficult to provide generic information. In the event of a pest incursion the lifecycles and biology of each species would have to be considered on an individual basis.

Understanding the lifecycle of the pest can aid in its control, as some stages of the pests lifecycle may be more susceptible to chemical control than others. For example adults may be easier to control with contact insecticides than internal feeding larvae (as is the case with Wheat stem sawfly (see Section 6.1.4)).

[4] This species is used in this contingency plan as an example of a chewing insect pest.

[5] Contingency plan available (**www.phau.com.au**).

[6] Included in *Chilo* spp. management plan, available from: **www.phau.com.au/wp-content/uploads/2013/03/Chilo-species-CP-2002.pdf**.

[7] Factsheet available (**www.phau.com.au**).

## 4.3 Dispersal and establishment

To a greater or lesser extent all of the pests described in Table 2 are capable of flight. This means that once in the country they would be able to travel and spread to new areas. Chewing insect pests could also be spread by the accidental transport of adults, larvae, or eggs on vehicles, machinery, or goods. For example larvae of the Wheat Stem Sawfly could be spread with straw, while stored grain pests such as Khapra beetles or the Larger grain borer could be spread by the movement of infested grain.

The ability of exotic chewing insect pests to develop and establish in Australia will be determined by the presence of suitable hosts, suitable conditions to spread, and the suitability of the environment for the establishment of the pest. In the absence of these it is unlikely that the pest will successfully establish.

## 4.4 Symptoms

The symptoms caused by chewing insect pests vary between species. For example some species are external feeders and cause obvious damage to the leaves, seeds or stems of the host plant, whereas others feed inside the host plant and cause little in the way of outward symptoms until the crop is near maturity (e.g. Wheat stem sawflies). Generally the first symptom of a chewing insect pest would be signs of feeding damage such as the damage shown in Figure 3, Figure 4 and Figure 6.

## 4.5 Sampling

Samples of the insects should be collected and treated as described in Section 7.3. In most cases samples should include adult insects, infected plants and their roots (if roots are affected). Exact details will be determined by the species concerned.

## 4.6 General information on the diagnosis of chewing insect pests

The National Plant Biosecurity Diagnostic Network website (**http://plantbiosecuritydiagnostics.net.au/**) includes a list of the current list of endorsed National Diagnostic Protocols developed by the Subcommittee on Plant Health Diagnostic Standards (SPHDS).

Generally insects are identified based on the characteristics of the adults or by the use of molecular techniques. A suitably qualified entomologist would be required to identify specimens to a species level.

For diagnostic facilities and advisory services that can be utilised in the event of an incursion see Section 11.2 Appendix 2.

## 4.7 General comments on control

If allowed to enter and establish in Australia exotic chewing insect pests (such as the pests listed in Table 2) could have significant impacts on the grains industry. The application of insecticides and other control strategies can allow the pest to be managed or eradicated.

The chemical required and application rates will need to be determined on a case by case basis and be tailored to the specific species involved. Currently there are a large number of insecticides registered for the control of endemic pests. Such chemicals, if proven to be effective overseas, could be used to manage/eradicate new pest incursions in Australia. However before pesticides can be used appropriate permits will need to be acquired from the Australian Pesticides and Veterinary Medicines Authority (APVMA).

Host plant resistance and the use of crop rotations incorporating non-host crops are common ways of managing insect pests both in Australia and overseas. For example Wheat stem sawfly resistant solid-stemmed wheat cultivars are used overseas to reduce the impact of this pest on American wheat production (Wendell et al., 1992; Morrill et al., 1994). Crop rotations are also widely used as rotating between host and non-host crops reduces the risk of the pest population building up to damaging levels, which could occur if the paddock was planted to successive host crops.

The use of biological control of chewing insect pests is another method of control. Section 6.1.7 provides more information on biological control of the two example species.

# 5 Specific examples of exotic chewing insect pests

## 5.1 Pest Details – Wheat Stem Sawfly (*Cephus cinctus*)

| | |
|---|---|
| Common name: | Wheat stem sawfly |
| Scientific name: | *Cephus cinctus* (Norton) |
| Synonyms: | *Astatus cinctus;*<br>*Astatus occidentalis;*<br>*Cephus occidentalis* |
| Taxonomic position: | Kingdom: Animalia<br>Phylum: Arthropoda<br>Class: Insecta<br>Order: Hymenoptera<br>Family: Cephidae<br>Genus: *Cephus* |

### 5.1.1 Background

The wheat stem sawfly is considered to pose a High overall risk to the grains industry based on its potential to enter, establish, spread and its economic impact (Plant Health Australia 2009-review 2014; see Table 2).

The Wheat stem sawfly (*Cephus cinctus*) is a black and yellow coloured wasp (Figure 5) that is approximately 7 - 12 mm long and affects winter cereals and some grasses. The Wheat stem sawfly is a major pest of spring wheat in the southern prairies of Canada and the adjoining parts of the United States (Beres et al., 2007). The larva feed on the parenchyma and vascular tissues through the stem and internodes, causing a reduction in seed weight and seed set (Holmes 1977). Internal feeding by the larvae (Figure 3) can also cause lodging. Damage caused by this species can result in yield losses of up to 80% (Ivie 2001). .

Host plants are susceptible to oviposition after stem elongation. Larvae are unable to complete their development if oviposition occurs after the flowering stage (Weiss et al., 1987). Because of this, crop damage is limited to the northern Great Plains of North America because wheat in southern (warmer) areas matures too early in the season for the pest's establishment (Painter 1953).

***Figure 3*** *Wheat stem sawfly larvae in wheat stem. Source: Frank Peairs, Bugwood.org*

### 5.1.2 Life cycle

The general life cycle of Wheat stem sawfly is described below:

- Each female produces an average of 35 eggs which are laid in the stems of host plants (one egg per stem). Larvae are highly cannibalistic, so if subsequent wasps lay eggs within the stem, only one individual will survive.
- Larvae feed inside the stem filling it with frass.
- Larvae bore down to the crown as the stem moisture decreases. The larvae then create a V shaped groove inside the stem (Fulbright et al., 2011). The area below this groove is tightly packed with frass to help protect the larvae from low winter temperatures.
- Pupation occurs the following spring.
- Adult wasps emerge 1 - 2 weeks after pupation.
- Adults live for about one week. Emergence occurs over a varying period of time (flight periods studied over seven years ranged between 9- and 34 days (Morrill and Kushnak 1999)).

This species produces a single generation of offspring each year. Perez-Mendoza and Weaver (2006) found that optimal conditions for the development of adults occurred when temperatures were between 20 and 25°C and 60 – 75% Relative Humidity.

### 5.1.3 Dispersal

The Wheat stem sawfly can be spread between countries and regions either by the transport of larvae in cereal straw (or hay) or by the natural flight ability of adults.

The most likely way that the pest could enter the country is by the accidental introduction of larvae in cereal straw. For example the related European wheat stem sawfly (*C. pygmaeus*) has in the past been recovered in harvested straw (Ivie 2001) and it is likely through this pathway that the European wheat stem sawfly was introduced from Europe to North America. Quarantine measures are aimed at reducing this risk, and Australian Department of Agriculture strictly regulates the importation of the cereal straw. However there is still a risk that this pest could enter in undeclared items or via other means.

Once in the country adults can disperse between paddocks of suitable hosts by flight (although the Wheat stem sawfly is reported to be a slow flier (Ivie 2001)). Straw containing larvae could also allow the domestic dispersal of the pest over significant distances.

### 5.1.4 Host range

Wheat stem sawfly is known to infest wheat, barley, triticale and cereal rye (Knodel et al., 2009). Non-crop hosts include wheatgrass (*Agropyron* spp.), wildrye (*Elymus* spp.) and timothies (*Phleum* spp.) (Holmes 1977). Brome grasses (*Bromus* spp.), barleys (*Hordeum* spp.) and *Triticum* spp. can also act as hosts (Ivie 2001).

Oats appear not to be hosts of the Wheat stem sawfly. Solid stemmed wheats (i.e. varieties with large amounts of pith in the stems) are less affected than hollow stemmed varieties (Holmes and Peterson 1964).

### 5.1.5 Current geographic distribution

The origin of this species has been debated, some such as Ivie (2001) suggest that this species originated in Asia and was subsequently spread to North America. Others suggest that the species is native to North America (Shanower and Hoelmer 2004; Beres et al., 2011).

Countries where the pest is known to occur are listed below in Table 3.

***Table 3*** *Current distribution of Wheat stem sawfly*

| Countries | Reference |
|---|---|
| Canada | Nansen et al., (2005); Shanower and Hoelmer (2004); Ivie (2001). |
| Japan | Ivie (2001) |
| Russia (eastern) | Shanower and Hoelmer (2004); Ivie (2001). |
| USA | Nansen et al., (2005); Shanower and Hoelmer (2004); Ivie (2001). |

### 5.1.6 Potential geographic distribution in Australia

Based on its current distribution and optimal temperature requirements (20 and 25°C and 60 – 75% Relative Humidity (Perez-Mendoza and Weaver 2006)) it is likely that parts of Australia's grain belt could be affected by this pest if an incursion was to occur in the future.

### 5.1.7 Symptoms

Typical symptoms of Wheat stem sawfly infestation include:

- Lodging of mature plants with broken stems filled with frass.
- Lodged stems will often be cleanly cut (Figure 4).
- Darkened spots are usually visible on stems below nodes as a result of the accumulation of carbohydrates that are unable to pass through stems to developing heads (Holmes, 1977).
- Feeding damage causes seeds to shrivel (Morrill et al., 1994).

***Figure 4*** *Crown damage caused by Wheat stem sawfly. Note cleanly cut stems (arrows). Source: Frank Peairs, Bugwood.org*

### 5.1.8 Diagnostic information

Currently there is not an endorsed diagnostic protocol available for this species. However the species can be identified based on its morphology (morphological diagnosis should be confirmed by a second entomologist and/or laboratory).

#### *5.1.8.1 MORPHOLOGICAL IDENTIFICATION*

This species can be identified based on the morphology of the insect. A brief description given in Table 4.

***Table 4*** *Morphology of Wheat stem sawfly*

| Life stage | Description |
|---|---|
| Eggs | White, round and about 1 - 1.5 mm in diameter |
| Larvae | White with tan head capsules, can reach about 14 mm and have a prominent caudal (tail) horn |
| Pupae | White but become a darker colour before adult emergence |
| Adults | Prominent bright yellow bands across the abdomen against a black body (Figure 5), size ranges from 7 to 12 mm long. Adults usually sit on grasses with their head pointing downwards (Fulbright et al., 2011). |


***Figure 5*** *Wheat stem sawfly adult (Source: Willow Warren, DAFWA, www.padil.gov.au)*

## 5.1.9 Pest risk analysis – Wheat stem sawfly

| Potential or impact | Rating |
|---|---|
| Entry potential | Medium |
| Establishment potential | High |
| Spread potential | High |
| Economic impact | High |
| **Overall risk** | **High** |

### *5.1.9.1 ENTRY POTENTIAL*

***Rating: Medium***

Wheat stem sawfly could be introduced as a 'hitchhiker' on straw and plant material from infected areas (see Section 5.1.3). Entry would most likely occur through older larvae and pupae as adults are too short lived to survive extended periods of transport and the eggs and young larvae are only found in growing stems which are unlikely to be transported. Given the increase in volumes and speed of international trade there is a potential of Wheat stem sawfly to enter Australia.

Based on this information the entry potential of Wheat stem sawfly can be considered as being **Medium**.

### *5.1.9.2 ESTABLISHMENT POTENTIAL*

***Rating: High***

Wheat stem sawfly affects are range of grasses that includes both crops and grasses used for livestock production (see Section 5.1.4). Many of these hosts are widely planted, or have become naturalised, over large areas of Australia.

The pest is widely distributed in North America and the climate in much of Australia's grain belt appears to be suitable for the establishment of the pest.

Therefore large areas of Australia have suitable climates and available host plants, which would allow the establishment of the pest.

Therefore the establishment potential of Wheat stem sawfly is considered to be **High**.

### *5.1.9.3 SPREAD POTENTIAL*

***Rating: High***

The flight of adult Wheat stem sawflies can spread this species over moderate distances allowing them to spread between paddocks. Long distance dispersal could also occur if older larvae and pupae are transported as contaminants of straw. For example is has been suggested that straw, used as packaging material or fodder, may have spread the Wheat stem sawfly over long distances in North America (Ivie 2001).

For these reasons the spread potential of Wheat stem sawfly is considered to be **High**.

### *5.1.9.4 ECONOMIC IMPACT*

***Rating: High***

Wheat stem sawfly has a significant impact on cereal production overseas. Yield losses of up to 80% have been reported in the United States (Ivie 2001).Such losses would suggest that this pest is likely to have a significant impact on Australian cereal production.

Therefore the economic impact of Wheat stem sawfly is considered to be **High.**

### *5.1.9.5 OVERALL RISK*

***Rating: High***

Based on the individual ratings above, the combined overall risk of Wheat stem sawfly is considered to be **High**.

## 5.2 Pest Details – False Codling Moth (*Thaumatotibia leucotreta*)

| | |
|---|---|
| Common names: | False codling moth; <br> Citrus codling moth; <br> Orange codling moth; <br> Orange moth |
| Scientific name: | *Thaumatotibia leucotreta* (Meywick) |
| Synonyms: | *Cryptophlebia leucotreta;* <br> *Cryptophlebia roerigii;* <br> *Olethreutes leucotreta;* <br> *Thaumatotibia roerigii* |
| Taxonomic position: | Kingdom: Animalia <br> Phylum: Anthropoda <br> Class: Insecta <br> Order: Lepidoptera <br> Family: Tortricidae <br> Genus: *Thaumatotibia* |

### 5.2.1 Background

The False codling moth (FCM) (*Thaumatotibia leucotreta*) is a medium sized (15 - 20 mm long) brown/grey coloured moth, which is native to sub-Saharan Africa. This species has been recorded to feed on more than 50 species of plants in over 30 plant families (Glass, 1991).

Larvae are internal feeders and occur year round in warm climates. Although it is principally a pest of fruit this species also economically affects a range of broadacre crops including cotton, sorghum and maize (United States Department of Agriculture, Animal Plant Health Inspection Service, Plant Protection and Quarantine, Emergency and Domestic Programs (USDA APHIS PPQ) 2010; Bloem et al., 2003).

Infestation of plants by this pest causes various symptoms such as: frass, exit holes and reduced yields. Adults live for between 14 and 70 days (USDA APHIS PPQ, 2010), meaning that they have the capability to fly reasonable distances during their lifetime.

### 5.2.2 Life cycle

The life cycle of FCM is similar to other Lepidoptera species and follows the same life stages. However specifics such as temperature requirements and time taken to complete the different life stages are species specific. The life cycle of FCM is summarised below:

- Eggs are laid either singly or in small groups. Laboratory studies in South Africa have shown that this species requires temperatures of >10ºC in order to lay eggs and that 25ºC is the optimal temperature for egg laying (Daiber 1980).

- Eggs hatch in 2 to 22 days depending on the temperature, with warmer temperatures resulting in faster hatching of the eggs (USDA APHIS PPQ 2010).
- After hatching larvae burrow into the host leaving a small (approximately 1 mm diameter) hole that is filled with frass. Larvae complete 5 instar stages in between 12 and 67 days, with the time taken varying with temperature (USDA APHIS PPQ 2010).
- Final (fifth) instars leave the host plant to spin a silken cocoon on the soil surface this is known as a pre-pupal stage and can last between 2 and 27 days.
- The pre-pupa moults and becomes a true pupa. The insect then spends 11 to 39 days inside the pupa before emerging as an adult (USDA APHIS PPQ 2010).
- Females mate and start laying eggs a few days after emergence, producing up to 800 eggs over their lifespan (Stibick 2006). In their natural range they are able to breed throughout the year, taking advantage of a continuous range of fruiting hosts. There can often be five to six generations per year, often generations will overlap. Adult males live 14 to 57 days and adult females live for 16 to 70 days. (USDA APHIS PPQ 2010).

### 5.2.3 Dispersal

FCM only flies at night and rest during the day on shaded portions of the host plant. It is generally thought that this species does not naturally disperse over long distances, however males have been shown to travel more than a kilometre to find females (EPPO 2013).

Human assisted movement of larvae, pupae and adults on or in fruit, goods and equipment could also potentially spread this pest over long distances to new areas.

### 5.2.4 Host range

FCM is a pest of economic importance to many crops throughout sub-Saharan Africa, South Africa and the islands of the Atlantic and Indian oceans. A detailed list of the known hosts of FCM is given in Table 5.

***Table 5** Known hosts of False coddling moth*

| Common name | Scientific name | Family | Reference |
|---|---|---|---|
| Okra | *Ablemoschus esculentus* | Malvaceae | Venette et al., (2003) |
| Indian mallow | *Abutilon hybridum* | Malvaceae | Venette et al., (2003) |
| Jute | *Abutilon* spp. | Malvaceae | Venette et al., (2003) |
| Pineapple | *Ananas comosus* | Bromeliaceae | Venette et al., (2003) |
| Soursop | *Annona muricata* | Annonaceae | Venette et al., (2003) |
| Custard apple | *Annona reticulata* | Annonaceae | Venette et al., (2003) |
| Star fruit | *Averrhoa carambola* | Oxalidaceae | Venette et al., (2003) |
| Red orchid bush | *Bauhinia galpinii* | Fabaceae | Venette et al., (2003) |
| Peacock flower | *Caesalpinia pulcherrima* | Fabaceae | Venette et al., (2003) |
| Sodom apple | *Calotropis procera* | Asclepiadaceae | Venette et al., (2003) |

| Common name | Scientific name | Family | Reference |
|---|---|---|---|
| Tea | *Camellia sinensis* | Theaceae | Venette et al., (2003) |
| Woolly caper bush | *Capparis tomentosa* | Capparaceae | Venette et al., (2003) |
| Capsicum | *Capsicum* spp. | Solanaceae | Venette et al., (2003) |
| Monkey pod | *Cassia petersiana* | Fabaceae | Venette et al., (2003) |
| Khat | *Catha edulis* | Celastraceae | Venette et al., (2003) |
| Kapok | *Ceiba pentandra* | Malvaceae | Venette et al., (2003) |
| Stamvrugte | *Chrysophyllum palismontatum* | Sapotaceae | Venette et al., (2003) |
| Citrus | *Citrus* spp. | Rutaceae | Venette et al., (2003) |
| Coffee | *Coffea Arabica; Coffea* spp. | Rubiaceae | Venette et al., (2003) |
| Cola | *Cola nitida* | Malvaceae | Venette et al., (2003) |
| Bush willow | *Combretum apiculatum* | Combretaceae | Venette et al., (2003) |
| Raasblaar | *Combretum zeyheri* | Combretaceae | Venette et al., (2003) |
| Jackal berry | *Diospyros mespiliformis* | Ebenaceae | Venette et al., (2003) |
| Persimmon | *Diospyros* spp. | Ebenaceae | Venette et al., (2003) |
| Stem fruit | *Englerophytum magalismontanum* | Sapotaceae | Venette et al., (2003) |
| Loquat | *Eriobotrya japonica* | Rosaceae | Venette et al., (2003) |
| Surinam cherry | *Eugenia uniflora* | Myrtaceae | Venette et al., (2003) |
| Cape fig | *Ficus capensis* | Moraceae | Venette et al., (2003) |
| Governor's plum | *Flacourtia indica* | Salicaceae | Venette et al., (2003) |
| Mangosteen | *Garcinia mangostana* | Clusiaceae | Venette et al., (2003) |
| Cotton | *Gossypium hirsutum, Gossypium* spp. | Malvaceae | Venette et al., (2003); Reed (1974) |
| Kaffir plum | *Harpephyllum caffum* | Anacardiaceae | Venette et al., (2003) |
| Mallow | *Hibiscus* spp. | Malvaceae | Venette et al., (2003) |
| English walnut | *Juglans regia* | Juglandaceae | Venette et al., (2003) |
| Litchi | *Litchi chinensis* | Sapindaceae | Venette et al., (2003) |
| Macadamia nut | *Macadamia ternifolia* | Proteaceae | Venette et al., (2003) |
| Mango | *Mangifera indica* | Anacardiaceae | Venette et al., (2003) |
| Red milkweed | *Mimusops zeyheri* | Sapotaceae | Venette et al., (2003) |
| Banana | *Musa paradisiaca* | Muscaceae | Venette et al., (2003) |
| Olive | *Olea europaea* | Olacaceae | Venette et al., (2003) |
| Elephant grass | *Pennisetum purpureum* | Gramineae | Venette et al., (2003) |
| Avocado | *Persea americana* | Lauraceae | Venette et al., (2003) |
| Lima bean | *Phaseolus lunatus* | Fabaceae | Venette et al., (2003) |
| Bean | *Phaseolus* spp. | Fabaceae | Venette et al., (2003) |

| Common name | Scientific name | Family | Reference |
|---|---|---|---|
| Yellow wood berries | *Podocarpus falcatus* | Podocarpaceae | Venette et al., (2003) |
| Apricot | *Prunus armeniaca* | Rosaceae | Bloem et al., (2003) |
| Peach | *Prunus persica* | Rosaceae | Venette et al., (2003) |
| Plum | *Prunus* spp. | Rosaceae | Venette et al., (2003) |
| Kudu-berry | *Pseudolachnostylis maprouneifolia* | Phyllanthaceae | Venette et al., (2003) |
| Guava | *Psidium guajava* | Myrtaceae | Venette et al., (2003) |
| Pomegranate | *Punica granatum* | Lythraceae | Venette et al., (2003) |
| Oak | *Quercus* spp. | Fagaceae | Venette et al., (2003) |
| Castor bean | *Ricinus communis* | Euphorbiaceae | Venette et al., (2003) |
| No common name | *Royena pallens* | Ebenaceae | Venette et al., (2003) |
| Karoo boer bean | *Schotia afra* | Fabaceae | Venette et al., (2003) |
| Marula | *Sclerocarya caffra; S.birrea* | Anacardiaceae | Venette et al., (2003) |
| Choko | *Sechium edule* | Cucurbitaceae | Venette et al., (2003) |
| Sida | *Sida* spp. | Malvaceae | Venette et al., (2003) |
| Sorghum | *Sorghum bicolor* | Gramineae | Venette et al., (2003); Reed (1974) |
| Water-bessie | *Syzygium cordatum* | Myrtaceae | Venette et al., (2003) |
| Cacao | *Theobroma cacao* | Malvaceae | Venette et al., (2003) |
| Snot apple | *Thespesia garckeana (syn. Azanza garckeana)* | Malvaceae | Venette et al., (2003) |
| Bur weed | *Triumfeta* spp. | Malvaceae | Venette et al., (2003) |
| Wild medlar; African medlar | *Vangueria infausta* | Rubiaceae. | Venette et al., (2003) |
| Cowpea | *Vigna unguiculata; Vigna* spp. | Fabaceae | Venette et al., (2003) |
| Grape | *Vitis* spp. | Vitaceae | Venette et al., (2003) |
| Wing bean | *Xeroderris stuhlmannii* | Fabaceae | Venette et al., (2003) |
| Large sour plum | *Ximenia caffra* | Olacaceae | Venette et al., (2003) |
| Maize | *Zea mays* | Gramineae | Venette et al., (2003); Reed (1974) |
| Jujube | *Zizyphus jujuba* | Rhamnaceae | Venette et al., (2003) |
| Buffalo thorn | *Zizyphus mucronata* | Rhamnaceae | Venette et al., (2003) |

### 5.2.5 Current geographic distribution

To date FCM is restricted to Africa occurring in most countries south of the Sahara desert as well as isolated islands near the African mainland. These are described in Table 6.

FCM has occasionally been found in Europe, where it was imported with produce from Africa (Bradley et al., 1979). Border inspections have intercepted FCM in Denmark, Finland, Netherlands and the United Kingdom; these countries have remained free of the pest (Karvonen, 1983). Similarly, the pest has been intercepted multiple times at borders in the United States (USDA APHIS PPQ 2010; Gilligan et al., 2011).

***Table 6*** *Geographic distribution of False codling moth (Source: Stibick 2006)*

| Country | Country |
|---|---|
| Angola | Mauritius |
| Benin | Mozambique |
| Burkina Faso | Niger |
| Burundi | Nigeria |
| Cameroon | Rwanda |
| Cape Verde | Réunion |
| Central African Republic | Saint Helena |
| Chad | Senegal |
| Côte d'Ivoire | Sierra Leone |
| Democratic Republic of Congo | Somalia |
| Eritrea | South Africa |
| Ethiopia | Sudan |
| Gambia | Swaziland |
| Ghana | Tanzania |
| Kenya | Togo |
| Madagascar | Uganda |
| Malawi | Zambia |
| Mali | Zimbabwe |

### 5.2.6 Potential geographic distribution in Australia

FCM is predominantly a warm climate pest. Their development is limited by cold temperatures. Exposure to temperatures below 10ºC reduces the survival and development of several life stages, and eggs have been reported to be killed at temperatures below 1ºC (Reed et al*.,* 1974). Currently there are no models predicting the potential geographic distribution of this pest in Australia. However, from its known distribution in Africa it is possible that many parts of Australia could be affected, including northern parts of the grain belt and areas of tropical and sub-tropical Australia.

### 5.2.7 Symptoms

FCM causes damage only during its larval stage. Symptoms vary depending on the host plant.

In maize, larvae damage the developing seed head by entering the husk through the silk channel (Stibick 2006). Larvae may also feed inside maize stems in some cases (Songa et al., 2001).

On sorghum the pest damages the seed head (Reed (1974).

On fruit such as citrus, plums and even cotton bolls the larvae chew holes into the fruit which become filled with frass (Figure 6). These symptoms are also indicative of other chewing insects, all of which should be investigated.


***Figure 6*** *FCM damage to citrus fruit. Note frass which is often associated with this and other chewing insect pests (Source: JH Hofmeyr, Citrus Research International, Bugwood.org)*

### 5.2.8 Diagnostic information

Currently there is not an endorsed diagnostic protocol available for this species. However it can be identified based on its morphology (morphological diagnosis should be confirmed by a second entomologist and/or laboratory) or by molecular methods if available.

#### *5.2.8.1 MORPHOLOGICAL IDENTIFICATION*

This species can be identified based on its morphology. Some of the key morphological features of this species are described in Table 7, Figure 7 and Figure 8. Additional information regarding specific features are described by Venette et al., (2003). This and other texts will be useful for the identification of this species.

***Table 7*** *Some key morphological features of False codling moth*

| Life stage | Description |
|---|---|
| Eggs | Oval, flattened, almost 1 mm in length and grey in colour (Figure 7) |
| Larvae | Yellow/white with dark spots but bright red or pink when fully grown (Figure 7) with a yellow-brown head. Mature larvae are approximately 15 mm long. |
| Pupae | Chestnut brown in colour (Figure 7) and approximately 6 - 10 mm long. |
| Adults | 15 - 16 mm (males) and 19 - 20 mm (female) in length. Forewings have grey, brown, black and orange-brown markings (Figure 7), the male and female can be identified by the shape of the hind wing (Figure 8). |


***Figure 7*** *Clockwise from top left) eggs, larvae, pupae and adult False codling moth (Larvae image source: Marja Van Der Straten, NVWA Plant Protection Service, Bugwood.org. Other images source: JH Hofmeyr, Citrus Research International, bugwood.org)*


***Figure 8** Adult male (left) and female (right) False codling moth, note slight differences in hind wing shape. Source: PaDIL, Bugwood.org.*

#### *5.2.8.2 MOLECULAR DIAGNOSIS*

Timm et al., (2008) describe a molecular method to distinguish the larvae of False codling moth from Codling moth (*Cydia pomonella*), Oriental fruit moth (*Grapholita molesta*) and Carnation worm (*Epichoristodes acerbella*). A similar study by Timm et al., (2007) also looked at distinguishing False codling moth from Macadamia nut borer (*Thaumatotibia batrachopa*), and Litchi moth (*Cryptophlebia peltastica*) using molecular techniques.

### 5.2.9 Pest risk analysis – False Codling Moth

| Potential or impact | Rating |
|---|---|
| Entry potential | High |
| Establishment potential | Medium |
| Spread potential | High |
| Economic impact | High |
| **Overall risk** | **High** |

#### *5.2.9.1 ENTRY POTENTIAL*

***Rating: High***

FCM could enter the country through the movement of fruit infested with larvae. FCM larvae and eggs are difficult to detect once they enter a host especially as they are often laid individually. FCM is often intercepted at borders. For example the pest has been intercepted multiple times in the United States (USDA APHIS PPQ 2010; Gilligan et al., 2011) and Europe (Bradley et al., 1979; Karvonen, 1983). This would suggest that it is possible for this species to be introduced in fruit from infected countries.

This together with the increasing number of international visitors and the increasing movement of goods between countries means that there is a significant risk of this pest being introduced into Australia

Based on this information the entry potential of FCM is considered to be **High**.

### *5.2.9.2 ESTABLISHMENT POTENTIAL*

***Rating: Medium***

This pest occurs naturally in much of sub-Saharan Africa (Table 6). Parts of the grain belt and parts of tropical and sub-tropical Australia would have similar climatic conditions for the establishment of this species. However not all of Australia will be affected by this species as exposure to temperatures below 10 ºC reduces the survival several life stages, while eggs have been reported to be killed at temperatures below 1 ºC (Reed et al., 1974). This suggests that northern areas of Australia will likely be more affected by this pest than southern areas.

False codling moth also has a wide host range (see Table 5), many of which are widely planted species, such as sorghum and maize, cotton and fruit trees. This means that it is likely that False codling moth could find suitable hosts allowing it to survive, reproduce and become established in Australia.

Based on the suitability of the climate and the number of widely planted hosts this pest could establish in parts of Australia. Therefore the establishment potential of FCM is considered to be **Medium.**

### *5.2.9.3 SPREAD POTENTIAL*

***Rating: High***

Adult False codling moth are capable of flight and, as they are highly polyphagous, it is likely that host availability will not be a limiting factor of spread. The pest can also be dispersed with the assistance of humans as eggs and/or larvae can be spread between areas as contaminants of fruit, containers or related material.

Based on this information the spread potential of FCM is considered to be **High**.

### *5.2.9.4 ECONOMIC IMPACT*

***Rating: High***

The economic damage caused by this species varies depending on the host plant involved. On fruit and nut trees the larvae causes fruit to become unmarketable, while in Uganda it can cause significant cotton losses (Venette et al., 2003).

For grains the economic impact is expected to be significant as larvae of FCM feed on the seed heads/ears of both maize and sorghum. Both crops are planted in warm areas of Australia and are therefore planted in areas where the pest could establish. The levels of yield loss caused by this pest on maize and sorghum is unclear, however papers such as Venette et al., (2003) suggest that the economic impact is significant.

Based on this information the Economic impact of this species is expected to be **High.**

#### *5.2.9.5 OVERALL RISK*

***Rating: High***

Based on the individual ratings above, the combined overall risk of FCM is considered to be **High**.

# 6 Pest management

## 6.1 Availability of control methods

Once introduced and established, some chewing insect pests can survive for extended periods, even in the absence of host plants (e.g. as pupae or eggs), making eradication a long term process. Hence containment procedures to retard the spread of the pest are required.

### 6.1.1 General procedures for control

Control of chewing pests is likely to be largely reliant on the use of crop rotations, resistant hosts, pesticides, and reducing the spread of the pest between areas by controlling the movement of produce and machinery. Specific control measures will be determined by a CCEPP, however, general procedures include:

- Keep traffic out of affected areas and minimise movement in adjacent areas.
- Adopt best-practice property hygiene procedures to retard the spread of plant material, including plant material that may be adhering to machinery, etc., between paddocks and adjacent properties.
- After surveys are completed, and permission has been obtained from the Chief Plant Health Manager or the CCEPP, destruction of the infested plant material, is an effective control.
- Avoid including host plants in crop rotations. For example if Wheat stem sawfly was found hosts such as barley, triticale and wheat should not be included in the crop rotation for a number of years, however non-host crops such as legumes or canola could be planted to reduce erosion and allow the paddock to be used productively.
- On-going surveillance of infected areas to ensure the pest is eradicated.

### 6.1.2 Control of infected areas

If a large area is infected, spray the area with an approved pesticide and kill any surviving plants in the area with an appropriate herbicide (note: chemicals have to be permitted by the Australian Pesticides and Veterinary Medicines Authority (APVMA) for the purpose), plough in the crop debris. Remaining debris can be burnt once it has dried off to ensure no viable eggs, pupae etc. remain.

Particular care must be taken to minimise the transfer of plant material and/or soil from the area. Surveys of the surrounding area must continue for some time to ensure that the eradication regime was successful.

All equipment used on the site should be thoroughly cleaned down, with products such as a farm degreaser or a 1% bleach solution and washed down with a pressure cleaner on the affected farm. The clean down procedure should be carried out on a hard surface or preferably a designated wash-down area to avoid mud being recollected from the affected site onto the machine.

Host plants (crops, volunteer plants, weeds, etc.) should not be grown for a number of years to give the best possible chance of eradication success. The number of years required without host plants will depend on the survival ability of the pest concerned in the absence of host plants.

### 6.1.3 Weed management

Weeds can serve as alternate hosts for chewing pests. For example Brome grass (*Bromus* spp.) can act as hosts of Wheat stem sawfly (Ivie 2001) and some species are considered to be weeds in Australia. If weed species are found to be potential hosts of the exotic pest they will also need to be controlled, using a suitable chemical, along with the affected host plants. Special attention should be paid to weeds along fence lines and road sides adjacent to infected areas or crops. If weeds are not controlled they could allow the pest to persist in the area.

### 6.1.4 Chemical control

Chemicals can be an effective way of controlling insect pests, including chewing pests, and are an important component of eradication and control programs.

The feeding behaviour and biology of chewing insects can determine the most effective times to treat the crop. For example the larvae of the False codling moth and the Wheat stem sawfly live and feed inside the stems of the host plant making chemical control of the larvae difficult (as the chemical can't come into direct contact with the larvae) so adults are targeted, or systemic insecticides are used. Whereas external feeding insects, such as the Sunflower moth (*Homoeosoma electellum*) (see Table 2), live on the external surfaces of the plant and can be controlled with suitable contact insecticides.

A brief summary of the chemicals used to control the example pests are provided below. In the case of both pests several chemicals have been identified for their control (Table 8). In the event of a pest incursion these chemicals may have a role in the eradication of the pest, although appropriate permits (Emergency or Minor use permits) would need to be acquired from the APVMA before the chemical could be used for the control of the pest in Australia.

#### *6.1.4.1 WHEAT STEM SAWFLY*

In countries where the pest has become established chemical control is often considered to be less economically viable than the use of resistant cultivars. This is because the chemical control of larvae is difficult. Seed treatments such as Thiamethoxam have been shown to give unsatisfactory control of the pest (Knodel et al., 2009) and the adults emerge over a period of three to four weeks (Fulbright et al., 2011). Control of the adults therefore requires multiple chemical applications during the three to four week flight period to satisfactorily control of the pest (Knodel et al., 2009; 2010).

#### *6.1.4.2 FALSE CODLING MOTH*

False codling moth can also be controlled using chemicals; however research to date has principally focused on the chemical control of the pest in orchards, rather than in field crops. Currently there are no chemicals labelled for the control of False codling moth on maize, sorghum or other grain crops overseas.

In the event of a pest incursion it is possible that the use of the foliar sprays used on orchards could be used to treat infected broad acre crops or that incursions could be managed using 'attract and kill' products such as Last Call™ (which contains both a pheromone to attract male moths and an insecticide to kill the male moths). Kirkman (2007) discusses this technology and suggests it is effective when there are low populations of the insect (such as during the early stages of an incursion).

***Table 8*** *Chemicals used to control chewing insect pests overseas*

| Chemical | Application method | Comments | References |
|---|---|---|---|
| **Wheat stem sawfly (*Cephus cinctus*)** | | | |
| Zeta-cypermethrin | Foliar spray | Zeta-cypermethrin was found to be effective when applied at the beginning, peak and end of the sawfly flight period (Knodel et al., 2009; 2010).<br>In the USA this pest can be controlled when Mustang® (1.5 lb a.i/gallon (~180 g a.i/L)) is applied to wheat and triticale at a rate of 3.4 - 4.3 fl. oz./acre (248.5 - 314.3 ml (44.7 - 56.6 g a.i)/ha.<br>Zeta-cypermethrin is listed on the APVMA PUBCRIS website as being registered for use on Australian cereals but no label is available on the manufacturer's website. Registration of Zeta-cypermethrin expires 30 June 2014. | Knodel et al., (2009); Knodel et al., (2010); Mustang® label, FMC Corporation USA[8] |
| Chlorpyrifos with Zeta-cypermethrin | Foliar spray | Chlorpyrifos with Zeta-cypermethrin in the product Stallion™ is used in the USA to control adult Wheat stem sawflies on wheat when applied at a rate of 5 - 11.75 fl. oz./acre (365.5 – 858.8 ml (120.6 – 283.4 g Chlorpyrifos and 12 – 28.3 g Zeta-cypermethrin)/ha).<br>Both actives are available in Australia and are used on cereals. However they are not available as a single product containing both actives. Zeta-cypermethrin is listed on the APVMA PUBCRIS website as being registered but no label is available on the manufacturer's website. | Stallion™ label, FMC Corporation, USA[9] |

[8] Available from: **http://www.cdms.net/ldat/ld5FT021.pdf** .

[9] Available from: **www.cdms.net/ldat/ld9U4014.pdf**.

| Chemical | Application method | Comments | References |
|---|---|---|---|
| **False coddling moth (Thaumatotibia leucotreta)** | | | |
| Alpha cypermethrin | Foliar spray | Fastac® SC (100 g a.i/L) is used in South Africa on peaches to control False codling moth when applied as a solution containing 5 ml (0.5 g a.i)/100 L water. Multiple applications permitted. The chemical is applied as a high volume spray of 125 – 175 ml Fastac® SC (12.5 - 17.5 g a.i)/ha, which represents 2500 - 3500 L of solution/ha.<br><br>Fastac® SC is also used in South Africa on maize and sorghum (applied at 100 - 125 ml (10 – 12.5 g a.i)/ha) but not for the control of False codling moth.<br><br>Alpha cypermethrin is used on maize and sorghum (i.e. the grain hosts of the pest) in Australia | Fastac® SC label, BASF South Africa[10] |
| Azinphos-methyl | Foliar spray | Azinphos 200 SC is currently registered for use in South Africa for the control of False codling moth on peach.<br><br>Azinphos-methyl is not registered for the control of FCM on maize or sorghum.<br><br>Azinphos-methyl is available in Australia but is not used on maize or sorghum. | Azinphos 200 SC label, ADAMA, South Africa[11] |
| *Buveria bassiana* | Foliar spray | *Beauveria bassiana* has been shown by Coombes et al., (2013) to be an effective biological control agent against False codling moth. The product is commercially available in South Africa (BroadBand (4*10^9 viable spores/ml)) for use on tree crops to control FCM.<br><br>*Beauveria bassiana* is also not used on maize or sorghum in South Africa.<br><br>*Beauveria bassiana* is not available in Australia. | Coombes et al., (2013); BroadBand label, BASF, South Africa[12] |

[10] Available from: **www.agro.basf.co.za/agroportal/za/media/l6/productcatalogue/products/insekdoders/fastac_sc.pdf**.

[11] Available from: **www.adama.com/south-africa/en/Images/azinphos200sc_tcm54-23344.pdf**.

[12] Available from: **www.agro.basf.co.za/agroportal/za/en/special/product_catalogue_1/product_details_42880.html**.

| Chemical | Application method | Comments | References |
|---|---|---|---|
| Beta-cyfluthrin | Foliar spray | Bulldock® 050EC (50 g a.i/L) is used on peaches in South Africa to control False codling moth. The chemical is applied as 3 sprays at 14 day intervals using a 10 ml (0.5 g a.i)/100L solution.<br><br>The chemical is also applied to maize but is not labelled for the control of False codling moth on this crop.<br><br>Beta-cyfluthrin is used in Australia on sorghum but not on maize. | Bulldock® 050 EC label, Bayer South Africa[13] |
| Beta-cypermethrin | Foliar spray | Beta-cypermethrin in the product Akito is currently labelled for use in South Africa to control False codling moth on plums and peaches.<br><br>The chemical is also applied to maize and sorghum but is not labelled for the control of False codling moth on these crops.<br><br>Beta-cypermethrin is not used in Australia. | Akito label, Arysta LifeScience, South Africa [14] |
| Chlorantraniliprole | Foliar spray | Chlorantraniliprole in the product Coragen™ has been shown by Fullard and Hill (2013) to reduce the reproductive ability of False codling moth. Coragen™ (200 g a.i/L) is currently registered in South Africa to control False codling moth on citrus.<br><br>Chlorantraniliprole is not currently labelled for use on sorghum or maize in South Africa.<br><br>Chlorantraniliprole is used in Australia but not on sorghum or maize. | Fullard and Hill (2013); Coragen™ label, DuPont, South Africa[15] |
| Cypermethrin | Foliar spray | Cypermethrin in the product Villa Crop Protection Cypermethrin 200EC is used in South Africa to control False codling moth on peaches and plums when applied either in a solution containing 5 ml (1 g a.i)/100 L water or at a rate of 125 - 175 ml (25 - 35 g a.i)/ha.<br><br>The chemical is also applied to maize and sorghum but is not labelled for the control of False codling moth on these crops.<br><br>In Australia Cypermethrin is used on maize and sorghum crops. | Cypermethrin 200EC label, Villa Crop Protection, South Africa[16] |

[13] Available from: **www.wenkem.co.za/wenkem/labels/Bulldock%20050%20EC.pdf**.

[14] Available from: **http://arystalifescience.co.za/files/Akito_label-eng.pdf**.

[15] Available from: **www.villacrop.co.za/files/Coragen%20E_Dupont.pdf**.

[16] Available from: **www.villacrop.co.za/files/Cypermethrin%20200%20EC%20E_UCP.pdf**.

| Chemical | Application method | Comments | References |
|---|---|---|---|
| *Cryptophlebia/ Thaumatotibia leucotreta granulovirus* | Foliar spray | *Thaumatotibia leucotreta granulovirus* is a virus in the Baculoviridae family that has been shown to control False codling moth larvae (Kirkman 2007; Moore et al., 2011).<br>Moore et al., (2011) reported that the LC90 for this virus on neonate (1st instar) larvae was 1.185*$10^5$ Occlusion Bodies (OB)/ml.<br>Cryptex® (2*$10^{10}$ OB/ml) is used in South Africa to control False codling moth on citrus, pomegranate and persimmon.<br>Cryptex® is not used on maize or sorghum in South Africa.<br>The virus is not registered for use in Australia. | Kirkman (2007); Moore et al., (2011); Cryptex® label, Madumbi Sustainable Agriculture, South Africa[17] |
| Fenpropathrin | Foliar spray | Meothrin™ (200 g a.i/L) used in South Africa to control False codling moth on citrus when applied as a solution containing 30 ml (6 g a.i)/100 L water.<br>Fenpropathrin is not used on South African maize or sorghum.<br>Fenpropathrin is not used in Australia. | Meothrin™ label, Philagro South Australia[18] |
| Methomyl | Foliar spray | Lannate® 900 SP (900 g a.i/kg) is used in South Africa to control False codling moth on peaches when applied as two applications of a solution containing 50 g (45 g a.i)/100 L water.<br>The product is also applied to maize and sorghum but is not labelled for the control of False codling moth on these crops.<br>Methomyl is currently used in Australia on maize, sorghum and other crops. | Lannate® 900 SP label, DuPont, South Africa.[19] |
| Methoxyfenozide | Foliar spray | Methoxyfenozide registered for use in South Africa to control False codling moth in various types of orchards when applied as a solution containing 60 ml (14.4 g a.i)/100 L water.<br>Methoxyfenozide is not used on South African maize or sorghum.<br>Methoxyfenozide is used in Australia but not on maize or sorghum. | Runner™ 240 SC label, Dow Agrosciences, South Africa[20] |

[17] Available from: **www.madumbi.co.za/pdf/Cryptex/Cryptex%20Label.pdf**.

[18] Available from: **www.philagrosa.co.za/products/view_product/6**.

[19] Available from: **http://www2.dupont.com/South_Africa_Country_Site/en_ZA/assets/downloads/Lannate.pdf**.

[20] Available from: **http://msdssearch.dow.com/PublishedLiteratureDAS/dh_08ed/0901b803808ed003.pdf?filepath=/011-10213.pdf&fromPage=GetDoc**.

| Chemical | Application method | Comments | References |
|---|---|---|---|
| Novaluron | Foliar spray | Novaluron in the product Rimon® 10 EC is labelled for use in South Africa to control False codling moth on oranges when applied as two sprays of a solution containing 35 ml (3.5 g a.i)/100L or as a single application of 50 ml (5 g a.i)/100 L..<br><br>Novaluron is used on sorghum in South Africa but not for the control of False codling moths. It is not used on South African maize.<br><br>Novaluron is not used in Australia. | Rimon 10 EC label, ADAMA, South Africa[21] |
| Permethrin with synthetic pheromone (E-7-Dodecenyl acetate with E-8-Dodecenyl acetate and Z-8-Dodecenyl acetate) | Applied to foliage | Last Call™ FCM is used in South Africa to manage the pest. The product contains both a pheromone to attract male moths and an insecticide to kill the male moths.<br><br>Kirkman (2007) discusses this technology and suggests it is less effective than mating disruption chemicals when the pest is established because the efficacy of this method (called 'attract and kill') is dependent on the insects population size and is more effective when there are low populations of the insect. This is because a large population of the insect will result in some males avoiding the pesticide and reproducing.<br><br>This product is not used on maize or sorghum in South Africa.<br><br>This product is not available in Australia. | Kirkman (2007); Last Call™ FCM label, insect science, South Africa[22] |
| Spinetoram | Foliar spray | Spinetoram has been shown by Fullard and Hill (2013) to reduce the reproductive ability of False codling moth.<br><br>Spinetoram in the product Delegate 250 WG is currently used in South Africa to control False codling moth on citrus, persimmon, pomegranate and stone fruit when applied as a solution containing 20 g (5 g a.i)/100 L water<br><br>The chemical is not used on sorghum or maize in South Africa.<br><br>Spinetoram is used in Australia but not on maize or sorghum. | Fullard and Hill (2013); Delegate 250 WG label, Dow Agrosciences, South Africa[23] |

[21] Available from: **www.adama.com/south-africa/en/Images/rimon10ec_tcm54-23645.pdf**.

[22] Available from: **www.insectscience.co.za/images/pdf/LastCallabel/last%20call%20f.c.m%20label.pdf**.

[23] Available from: **www.dowagro.com/za/product/**.

| Chemical | Application method | Comments | References |
|---|---|---|---|
| Triflumuron | Foliar spray | Triflumuron in the product Alsystin® 480 SC is used in South Africa on citrus and peaches to control False codling moth when applied as 2 sprays of a solution containing 10 ml (4.8 g a.i)/100 L of water.<br>However Hofmeyr and Pringle (1998) suggest that some South African regions have populations of False codling moth that are resistant to Triflumuron. This suggests that this chemical may not be suitable to use in the event of an incursion.<br>The chemical is not used on sorghum or maize in South Africa.<br>Triflumuron is used in Australia but not on maize or sorghum. | Hofmeyr and Pringle (1998); Alsystin 480 SC Bayer, South Africa[24] |

## 6.1.5 Cultural Control

Cultural control is the deliberate alteration of the production system to reduce pest populations or avoid pest injury to crops. Simple cultural controls include:

- Crop rotations, which limit the build-up of pest populations in particular paddocks.
- The use of resistant rather than susceptible plants (see Section 6.1.6).
- Planting varieties that mature at different times. If a crop can pass through its most susceptible phase before the pest emerges damage to the crop and therefore yield losses may be reduced.
- The destruction of crop residue within which the pest could overwinter are all possible ways of controlling insect populations to reduce the numbers of chemical sprays required to manage the pest species.

### *6.1.5.1 WHEAT STEM SAWFLY*

Wheat stem sawfly can be controlled using several cultural control methods, including:

- Stubble that is knocked down and left on the soil surface by tillage equipment has been shown to cause 92-3% Wheat stem sawfly larval mortality, whereas larvae in untilled fields were reported to have a 90+% survival rate (Morrill et al., 1993). This suggests that tillage practices can be an effective cultural control for Wheat stem sawfly.
- Plants are more susceptible to oviposition after stem elongation, Therefore, sowing wheat later than usual and delaying stem elongation until after the wasps have emerged may avoid infestation and reduce damage (Weiss et al., 1987). However altering the planting date will also need to consider the impacts this may have on the yield potential of the crop.

[24] Available from: **www.mango.co.za/uploads/Alsystin%20480%20SC_Bayer.pdf**.

- Allowing sheep to graze the stubble of infected crops has been shown to reduce the number of Wheat Stem Sawflies that emerge and do so more effectively than tillage (using a chisel plough), or stubble burning treatments (Hatfield et al., 2007).
- Trap crops (plantings of more attractive hosts) is another method of managing the impact of Wheat stem sawfly that is being investigated by researches such as Weaver et al., (2009).

#### *6.1.5.2 FALSE CODLING MOTH*

Few cultural controls are widely used to control this species.

- Reed (1974) suggests that late sown cotton crops were more severely affected by this species than earlier sown crops. This suggests that altering sowing times may be a way of minimising the damage caused by this species.
- Reed (1974) also suggested trap crops of maize to minimise damage to cotton crops in Uganda. This principle may also be applicable to the control of this pest on other broadacre crops such as maize and sorghum if a suitable trap crop could be identified.

### 6.1.6 Host-Plant Resistance

Host plant resistance offers an affordable, non-chemical way of managing the damage caused by many insect pests. Chewing insect pests are no exception and can be controlled using host plant resistance as illustrated below

#### *6.1.6.1 WHEAT STEM SAWFLY*

Wheat stem sawfly is often managed overseas by the use of solid-stemmed wheat cultivars. These cultivars have been shown to be effective at reducing the impact of Wheat stem sawfly (Wendell et al., 1992; Morrill et al., 1994). Solid stem varieties are still attacked but at a much lesser rate than conventional hollow stemmed varieties (Morrill et al., 1994). Therefore such varieties would have a role in the ongoing management of the pest in the event of its establishment in Australia.

#### *6.1.6.2 FALSE CODLING MOTH*

At present false codling moth resistance has not been specifically breed for by plant breeders.

### 6.1.7 Biological control

Biological controls are another commonly used way of reducing pest populations. Biological control can offer an effective, economical and safe way of managing pests. In the case of chewing insects that feed within the plant, such as False codling moth and Wheat stem sawfly, biological controls offer a way of controlling life stages of the pest that are difficult to control using chemical controls (due to the difficulty of getting the chemical into contact with the insect).

Organisms with a narrow prey/host range are preferred for use in biological control programs; as such organisms pose less risk of affecting non-target species.

#### *6.1.7.1 WHEAT STEM SAWFLY*

There are a number of organisms that occur overseas and attack Wheat stem sawflies. The most important biological controls identified are organisms in the Ichneumonidae sub-family *Collyriinae* (Botha et al., 2004). There are also a number of other organisms that have been reported to parasitise Wheat stem sawflies that belong to the Braconidae, Eulophidae, Eupelmidae, Eurytomidae and Pteromalidae families in the order Hymenoptera (Shanower and Hoelmer 2004).

#### *6.1.7.2 FALSE CODLING MOTH*

Parasitoids have been identified for the control of the False codling moth overseas. The mass release of *Trichogrammoidea* spp. has been used effectively in Africa (Newton and Odendaal, 1990). Similarly a virus called *Cryptophlebia Leucotreta granulovirus* (CrleGV) has also been used to control the False codling moth overseas (Kirkman 2007; Moore et al., 2003; Moore et al., 2011) and is available as a commercial formulation called "Cryptex®[25]".

# 7 Epidemiological study, Surveillance and collection of samples

Information provided in Sections 7.1 and 7.2 provides a framework for the development of early detection and delimiting surveys for chewing insect pests. Section 7.3 provides information on collection procedures.

## 7.1 Epidemiological study

There are many factors that affect the development of exotic chewing pests. These include: susceptibility of the crop varieties, climatic conditions, irrigated or non-irrigated crops and interactions with other organisms. Chewing pest densities are also important as symptoms may not be apparent when the pest is present at low levels.

The number of infected plants within a crop will depend on the initial pest density and whether environmental conditions have been favourable for the chewing pest to complete its life cycle.

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 proximity of other susceptible plants to the initial infestation source, including both the current and previous growing seasons. This will include crops on the infected property and those on neighbouring properties. Alternative hosts should also be considered, including weeds, pasture, fruit trees and garden plants.
- Machinery or vehicles that have been into the infested area or in close proximity to the infestation source could be able to spread pests between areas.
- Plant material (including grain or hay) that has been moved into or from the infected area, as such material could potentially spread the pest.

[25] Cryptex® label, Madumbi, South Africa. Available from: **www.madumbi.co.za/pdf/Cryptex/Cryptex%20Label.pdf**.

- The extent of human movement into and around the infested area. A possible link to recent overseas travel or visitors from other regions or the recent importation of plant material, machinery or goods from other regions should also be considered.
- The temperature and environmental conditions. Temperature and environmental conditions affect the severity and spread of chewing pests and therefore need to be taken into account.
- The direction of the prevailing wind should be considered as the wind can assist the dispersal of some insects.

## 7.2 Surveillance

### 7.2.1 Surveillance priorities

Detection and delimiting surveys are required to delimit the extent of the outbreak, 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 and businesses in the pest quarantine area.
- Surveying all properties and businesses identified in trace-forward or trace-back analysis as being at risk.
- Surveying all host growing properties and businesses that are reliant on trade with interstate or international markets which may be sensitive to the presence of the pest.
- Surveying other host growing properties.

### 7.2.2 Technical information for planning surveys

When developing surveys for presence and/or distribution of exotic chewing pests, the following characteristics provide the basic biological knowledge that informs the survey strategy:

- Plant material may be asymptomatic, or may not display obvious symptoms at all growth stages.
- Host species in Australia are likely to be numerous and widely dispersed and may be present within farm paddocks, as well as home gardens, landscape plantings, nurseries and as weeds.
- There is a risk of pest movement on plant material, machinery, equipment, clothing and footwear.
- There is a risk that the wind could spread the pest between areas.
- Production areas and significant proportions of Australia may have favourable climatic conditions for the pest’s spread and establishment.

### 7.2.3 Surveys for early detection of an incursion

Points to consider in effectively monitoring chewing insect populations are:

- Ensure that the laboratory diagnostician has the relevant diagnostic tools and expertise in the specific pest to be identified.
- Initial surveys should concentrate on symptomatic plants (i.e. chewed leaves or stems (external feeders) or the presence of frass or lodging (internal feeders), see Sections 5.1.7, and 5.2.7 for details about the two species used as examples in this document).
- If a chewing pest is detected, or suspected, collections of suspected larvae or adults should be collected for diagnosis.

Points to consider in monitoring infected areas are:

- The host range of the pest must be determined.
- Conditions under which the pests spread, develop and reproduce must be determined to assess the likelihood of detection and reporting through general surveillance and to assist with the development of protocols for targeted surveillance.
- Potential pathways for the distribution of the pests must be determined. These could include natural and human assisted pathways.
- Depending on the pest, distribution of the pest on the plant may be irregular and the plant material most likely to be infected should be determined.
- Depending on the chewing pest, host species in Australia are likely to be numerous and widely dispersed. Hosts may be present within farms, nurseries, home gardens, landscape plantings, or as weeds.
- Entomologist expertise will be needed to determine diagnostic protocols and sampling requirements.

General points to consider when carrying out surveys for chewing insect pests include:

- The chances of detecting the pest if they are present depends on many factors including, crop and variety, time of year, number of samples collected, size of samples, etc.
- Symptomatic plants may be preferentially collected to establish the presence/absence of the pest.
- Systematic sampling such as zig-zag patterns can be used to estimate the population of the pest.
- Specimens must be prepared for identification using molecular or morphological techniques.
- All samples must be labelled with notes made of location, host, etc. Refer to Section 7.3 for further information.

### 7.2.4 Delimiting surveys in the event of an incursion

In the event of an incursion, delimiting surveys are essential to inform the decision-making process. Delimiting surveys should comprise local surveys around the area of initial detection concentrating on areas of poor growth, lodging or other symptoms attributed to the pest. The normal procedure is to collect symptomatic plants and samples of the pests found to confirm the presence of the pest. If confirmed as an exotic chewing pest, crops should be surveyed and monitored to enable an estimation to be made of the pest population. Surrounding crops should also be surveyed to determine the extent of the incursion. The extent of the survey beyond the initial infected crop should be guided by the results from surrounding crops.

When establishing delimiting surveys the following should be considered:

- The size of the survey area (Figure 9) will depend on the size of the infected area and the severity of the infection, as well as potential movement of material that could potentially spread the pest during the period prior to detection. It is recommended that delimiting surveys should comprise local surveys around the area of initial detection and concentrate on areas of poor crop growth, or where symptoms are apparent.
- A high intensity of field sampling is needed for a high degree of confidence.
- Chewing pests can spread through their own movement as well as on plant material (potentially including hay and grain), soil, machinery or equipment.
- All potential host species of the chewing pest (see Sections 5.1.4 and 5.2.4 ), should be surveyed, with particular attention paid to the species in which the pest was initially detected.
- In addition to the inspection of possible host plants, material should be collected for diagnostic purposes
- If the incursion is in a populated area, publication and distribution of information sheets and appeals for public assistance may be helpful.

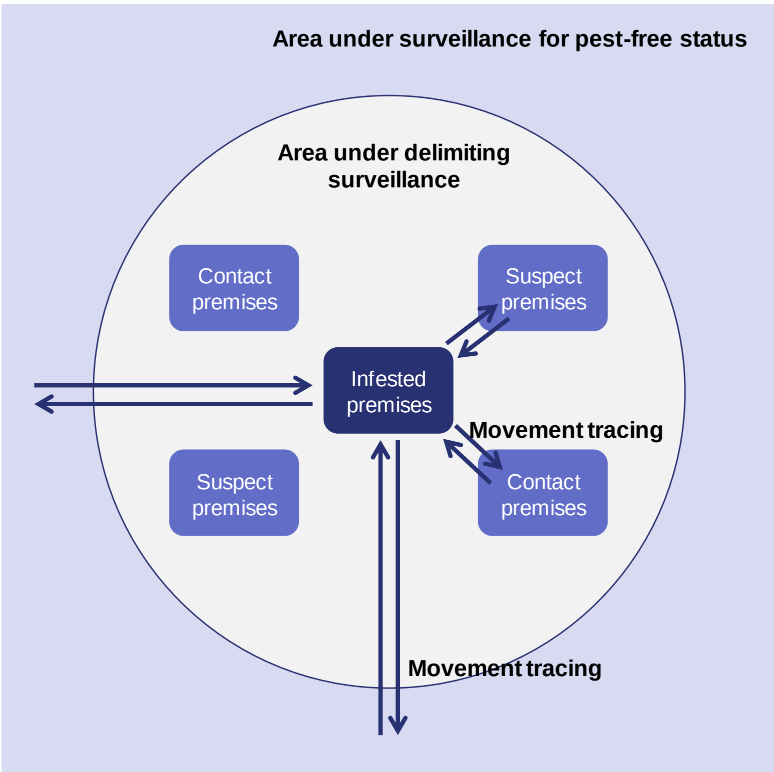


***Figure 9*** *Diagram of a delimiting survey showing surveillance activities from the infected premises*

## 7.3 Collection and treatment of samples

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

Protocols for the collection, transport and diagnosis of suspect Emergency Plant Pests (EPPs) must follow PLANTPLAN (Plant Health Australia 2014). Details are provided in the Guideline for the *Collection and transport of EPPs* available as a supporting document of PLANTPLAN (Plant Health Australia, 2014) (**www.planthealthaustralia.com.au/wp-content/uploads/2014/12/Guidelines-Collection-of-suspect-Emergency-Plant-Pests.pdf**). Any personnel collecting samples for assessment should notify the diagnostic laboratory prior to submitting samples to ensure expertise is available to undertake the diagnosis.

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. Data collected should include details such as geographical location using GPS, host infested (including approximate age, variety, plant part affected), symptoms, level of pest prevalence, detection method, movements of plants, people and equipment on property, climatic events (e.g. storms and prevailing wind directions) and farm management (e.g. irrigation methods, spray regime).

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

It is important to note the distribution of pest in the initial crop, as this may indicate how the pest has been spread/introduced.

It is important that all personnel involved in crop sampling and inspections take all precautions to minimise the risk of pest spread between crops or human health impacts by decontaminating between paddocks.

It should also be noted that except in exceptional circumstances (decided by State Coordination Centre (SCC) and/or Chief Plant Health Manager (CPHM)), no live insects should be sent to diagnostic laboratories.

The Chief Plant Health Manager will select the preferred laboratory. Samples will be forwarded to the nominated diagnostic laboratories for processing. All sample containers should be clearly labelled with the name, address and contact phone number of both the sending and receiving officers. In addition containers should be clearly labelled in accordance with the guideline for the *Collection and transport of EPPs* available as a supporting document of PLANTPLAN (Plant Health Australia, 2014) (**www.planthealthaustralia.com.au/wp-content/uploads/2014/12/Guidelines-Collection-of-suspect-Emergency-Plant-Pests.pdf**). Containers should be carefully sealed to prevent loss, contamination or tampering of samples.

# 8 Course of action – eradication methods

Additional information is provided by the IPPC (1998b) 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). The eradication process involves three main activities: surveillance, containment, and treatment and/or control measures.

## 8.1 Survey regions

Establish survey regions around the surveillance priorities identified above. These regions will be generated based on the zoning requirements (see Section 8.3), 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. Detailed information regarding surveys for exotic chewing pests have been outlined elsewhere in this plan (refer to Section 7.2).

Steps outlined in Table 9 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 9** Phases to be covered in a survey plan*

| | |
|---|---|
| Phase 1 | • Identify properties that fall within the buffer zone around the infected premise.<br>• 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 on 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 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 chewing pests. Pathways to be considered are:<br>o Items of equipment and machinery which have been shared between properties including: field bins, vehicles and equipment.<br>o The producer and retailer of infected material, if this is suspected to be the source of the outbreak.<br>o 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).<br>o Movement of plant material and soil from controlled and restricted areas.<br>o Storm and rain events and the direction of prevailing winds that result in air-borne dispersal of chewing pests during these weather events. |
| Phase 5 | • Surveillance of farms, gardens and public land where plants known to be hosts of the pest are being grown. |
| Phase 6 | • Agreed area freedom maintenance, post-control and containment. |

## 8.2 Quarantine and movement controls

Consult PLANTPLAN (PHA 2014) for administrative details and procedures.

### 8.2.1 Quarantine priorities

- Plant material and soil at the site of infestation to be subject to movement restrictions as such material could potentially spread the pest to new areas.
- Plant products such as grain, hay and straw could potentially spread some pests, or their eggs/larvae, to new areas.
- Machinery, equipment, vehicles and disposable equipment in contact with infested plant material or soil, or present in close proximity to the site of infestation to be subject to movement restrictions.

### 8.2.2 Movement controls

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 pest occurrence.

Movement of people, vehicles and machinery, from and to affected farms, must be controlled to ensure that infected soil or plant debris is not moved off-farm on clothing, footwear, vehicles or machinery. This can be achieved through the following; however specific measures must be endorsed in the Response Plan:

- Signage to indicate quarantine area and restricted movement into and within these zones.
- Fenced, barricaded or locked entry to quarantine areas.
- Movement of equipment, machinery, plant material or soil by permit only. Therefore, all non-essential operations in the area or on the property should cease.
- Where no dwellings are located within these areas, strong movement controls should be enforced.
- Where dwellings and places of business are included within the Restricted and Control Areas movement restrictions are more difficult to enforce, however limitation of contact with infested plants should be enforced.
- 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.
- Residents should be advised on measures to minimise the inadvertent transport of the pest from the infested area to unaffected areas.
- Plant material or plant products must not be removed from the site unless part of an approved disposal procedure.
- All machinery and equipment should be thoroughly cleaned down with a high pressure cleaner (see Section 8.3) or scrubbed with products such as a farm degreaser or a 1% bleach (available chlorine) solution, prior to leaving the affected area. Machinery should be inspected for the presence of soil and plant debris and if found must be treated in an appropriate

manner. 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. When using high pressure water, care should be taken to contain all plant material and mud dislodged during the cleaning process.

## 8.3 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 infested property to other infested properties. This will be determined by the National Management Group during the production of the Response Plan. Further information on quarantine zones in an Emergency Plant Pest (EPP) incursion can be found in Section 4.1.4 of PLANTPLAN (Plant Health Australia 2014). These zones are outlined below and in Figure 10.

### 8.3.1 Establishing Quarantine Zones

Delimiting surveillance will inform the establishment of quarantine zones and identify the Restricted Area(s) (RA), Control Area (CA) and Pest Free Area (PFA). The size of each quarantine zone will be determined by a number of factors including location of the incursion, climatic conditions, pest biology and proximity of an Infected Premises (IP) to other IPs.

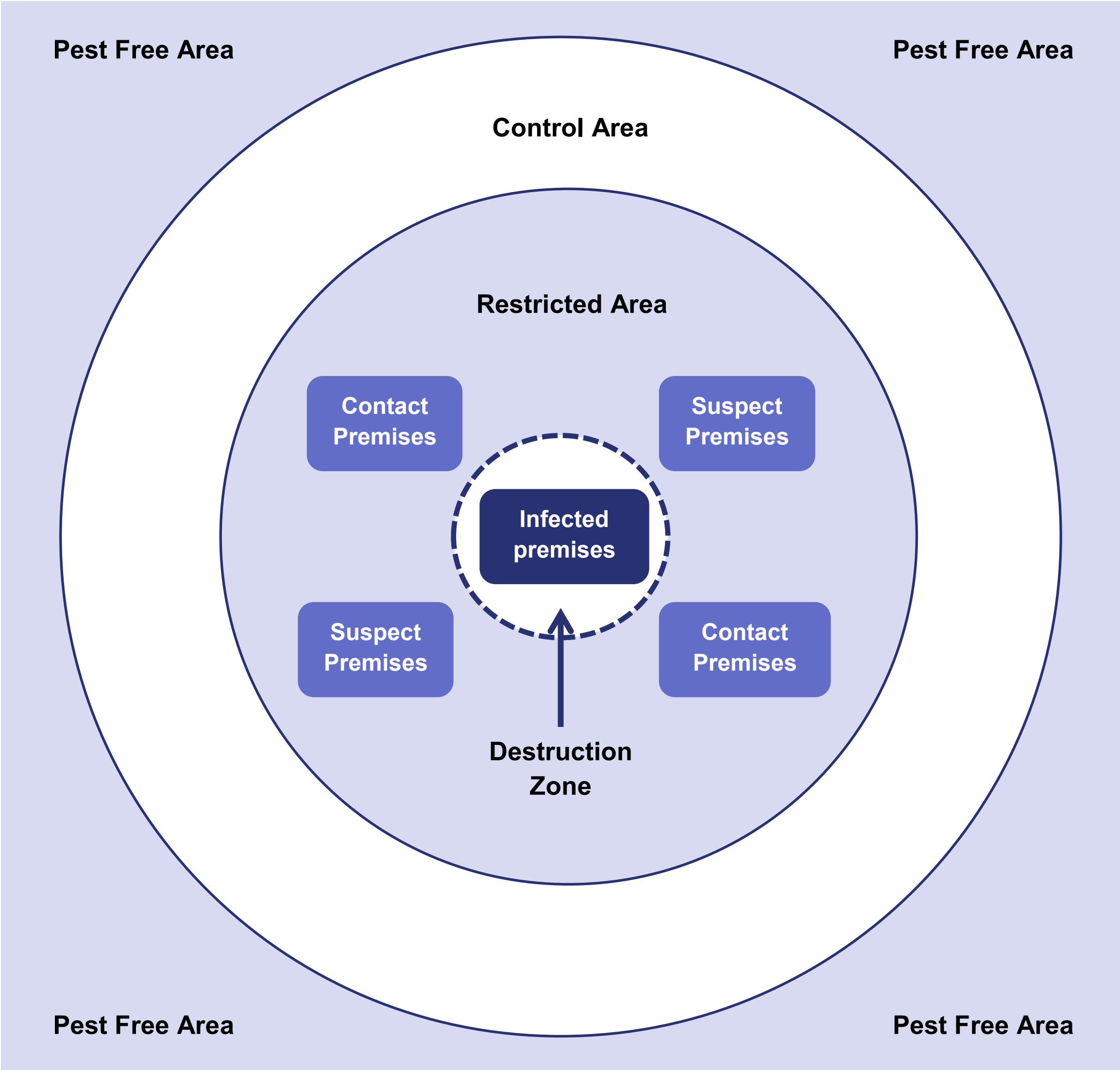


***Figure 10.*** *Schematic diagram of quarantine zones used during an EPP incursion (not drawn to scale)*

### 8.3.2 Destruction Zone

The size of the Destruction Zone (i.e. zone in which the pest and all host material is destroyed) will depend on, distribution of the pest (as determined by delimiting surveys), ability of the pest to spread, factors which may contribute to the pest spreading and the time of season.

All host plants 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. If spread is likely to have occurred prior to detection, the Destruction Zone may include contiguous areas that have been in contact with, or are associated with the same management practices as, the IP. Particular care needs to be taken to ensure that plant material and soil are not moved into surrounding areas that are not showing symptoms of the pest. Where possible, destruction should take place in dry conditions to limit mud being spread within the field on boots and protective clothing.

### 8.3.3 Restricted Area

Data collected from surveys and tracing (trace back and trace forward) will be used to define the RA, which comprises all properties where the pest has been confirmed (IP), properties which have come into direct or indirect contact with an IP or infected plants (Contact Premises or CP) and properties which may have been exposed to the pest (Suspect Premises or SP). The RA will be subject to intense surveillance and movement control, with movement out of the RA to be prohibited and movement into the RA to occur by permit only.

### 8.3.4 Control Area

A CA is established around a RA to control the movement of susceptible hosts and other regulated materials until the extent of the incursion is determined. There may be multiple RAs within one CA. When the extent of the EPP Incident has been confidently defined, the RA and CA boundaries and movement controls may need to be modified, and where possible reduced in size commensurate with appropriate controls.

Additional zones can be utilised as required for operational purposes.

### 8.3.5 Pest Free Area guidelines

The establishment and maintenance of pest free areas (PFAs) would be a resource-intensive process. Prior to development of a PFA 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.

Determination of PFAs should be completed in accordance with the International Standards for Phytosanitary Measures (ISPMs) 8 and 10 (IPPC 1998a, 1999).

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).

In the event of an incursion, specific guidelines for surveys and monitoring will be provided by the Consultative Committee on Emergency Plant Pests (CCEPP). General points to consider are:

- Design of a statistical delimiting survey for symptoms on host plants (see Section 7.2.4 for points to consider in the design).
- Plant sampling should be based on the rates required to give an appropriate level of confidence and taken at random with in the crop.
- Preliminary diagnosis can be based on plant symptoms and pest morphology.
- The results are confirmed by diagnosis in another recognised laboratory or by another diagnostician.
- Surveys should also consider alternative host plants (see Sections 5.1.4, and 5.2.4) and not be limited to the primary infected host.

- Information (including absence of the pest) should be recorded.

## 8.4 Destruction strategy

### 8.4.1 Priorities

- Confirm the presence of the pest.
- Limit movement or people and prevent movement of vehicles and equipment through affected areas.
- Stop the movement of any plant material, soil or machinery that could be carrying chewing pests or eggs from the infected area.
- Determine the strategy for the eradication/decontamination of infected host material.
- Determine the extent of the infestation through survey and plant material trace back and trace forward which would be assessed on a case by case basis and included within the response plan.

### 8.4.2 Destruction protocols

- No plant material should be removed from the infested area unless part of the disposal procedure.
- Disposable equipment, infested 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.
- 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.

### 8.4.3 Decontamination protocols

If decontamination procedures are required, machinery, equipment and 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
- Disposable overalls and rubber boots should be worn when handling infected soil or plant material in the field. Footwear and clothes 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.

In the event of an incursion of an exotic chewing pest, additional or modified procedures may be required for the destruction of the pest. Any sterilisation procedure must be approved for use in the endorsed Response Plan.

General guidelines for decontamination and clean up:

- Refer to the Guideline for the *Disinfection and decontamination guidelines* (available as a supporting document of PLANTPLAN (Plant Health Australia, 2014) (**www.planthealthaustralia.com.au/wp-content/uploads/2013/12/Guidelines-Disinfection-and-decontamination.pdf**)) for further information.
- Keep traffic out of affected area and minimise it in adjacent areas.
- Adopt best-practice property hygiene procedures to retard the spread of the pest between fields and adjacent properties.
- Machinery, equipment and vehicles in contact with infested plant material or soil present within the Quarantine Zone, should be washed to remove soil and plant material using high pressure water or scrubbing with products such as a degreaser or a bleach solution in a designated wash down area as described in Section 8.3.
- Only recommended materials are to be used when conducting decontamination procedures, and should be applied according to the product label.
- Infested plant material should be disposed of by autoclaving, high temperature (enclosed) incineration or deep burial.

### 8.4.4 Plants, by-products and waste processing

- Any soil or infected plant material removed from the infected site should be destroyed by (enclosed) high temperature incineration, autoclaving or deep burial.
- Plant debris from the destruction zone must be carefully handled and transported.
- Infested areas or paddocks should remain free of susceptible host plants (including weeds, alternative hosts and volunteer plants) (see Sections 5.1.4, and 5.2.4 for hosts of the example pests) until the area has been shown to be free from the pest. The exact period of time that the infested area should remain free of host plants will be determined by the survival ability of the pest in question. Most chewing pests do not have the survival ability of nematodes or fungal pathogens that are able to survive for many years without access to host plants. This means that three years without susceptible host plants will usually be sufficient to show the area to be free from the pest.

### 8.4.5 Disposal issues

- Particular care must be taken to minimise the transfer of infected plant material and soil from the infected area. As such material could potentially spread pests or their eggs to new areas.
- Chemical resistance to some pesticides may exist. In the event of a pest incursion this information needs to be considered when selecting pesticides to use for the eradication of the pest.

## 8.5 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 growth conditions, the previous level of infection, the control measures applied and the pest biology.

Specific methods to confirm the eradication of chewing pests may include:

- Establishment of sentinel plants at the site of infection.
- Maintain good sanitation and hygiene practices throughout the year.
- Monitoring of plants for signs of the pest.
- If symptoms are detected, samples are to be collected and stored and plants destroyed.
- Non-host crops should be grown on the site and any self-sown host plants sprayed out with a selective herbicide.
- Surveys should be undertaken for a minimum of 3 years after eradication has been achieved (or as endorsed by a CCEPP). Note the biology of the pest will dictate the minimum number of years that surveys need to be undertaken for, if long lived the surveys will need to continue for a longer period of time. Generally chewing pests are short lived as adults, eggs and larvae suggesting that in most cases three years without detection will be sufficient to show eradication success.

# 9 Technical debrief and analysis for stand down

Refer to PLANTPLAN (PHA 2014) for further details

The emergency response is considered to be ended when either:

- Eradication has been deemed successful by the lead agency, with agreement by the Consultative Committee on Emergency Plant Pests and the Domestic Quarantine and Market Access Working Group.
- Eradication has been deemed impractical and procedures for long-term management of the pest risk have been implemented.

A final report should be completed by the lead agency and the handling of the incident reviewed.

Eradication will be deemed impractical if, at any stage, the results of the delimiting surveys lead to a decision to move to containment/control.

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# 11 Appendices

## 11.1 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**).

## 11.2 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@agriculture.gov.au**

## 11.3 Appendix 3: Communications strategy

A general Communications Strategy is provided in Section 4.1.5 of PLANTPLAN (Plant Health Australia, 2014).

## 11.4 Appendix 4: Market access impacts

Within the Department of Agriculture Manual of Importing Country Requirements (MICoR) database (**http://micor.agriculture.gov.au/plants/Pages/default.aspx**) export of some material may require an additional declaration regarding freedom from particular pests. Should chewing insect pests become established in Australia, some countries may require specific declarations. Latest information can be found within MICoR, using a search for the specific pest.

The Department of Agriculture MICoR database was searched in May 2015 for current trade restrictions relating to Wheat stem sawfly and False codling. The search identified the following:

- South Africa has restrictions relating to the presence of Wheat stem sawfly on *Pennisetum* spp. nursery stock.
- Sri Lanka have restrictions relating to the presence of False codling moth on maize.