Nursery levy at work: **Building Resilience & Biosecurity Capacity**

Contingency Plan for Black Bean Aphid *Aphis fabae*

Queensland Department of Agriculture and Fisheries

Greenlife Industry Australia Limited

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Queensland Government

Acknowledgements

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Disclaimer

1 Purpose and background of this contingency plan

This plan is specifically written to assist in the preparedness of a detection of *Aphis fabae*, black bean aphid, in Australia. The focus of the plan is on detection at a production nursery at the very early stage of detection. If the aphid is found only in a protected cropping nursery environment, with few hosts outside the nursery, then it would be worthwhile to attempt to eradicate the pest. If the aphid is present outside of a protected cropping environment, the likelihood of eradication might be considered low.

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. This contingency plan was developed for the Greenlife Industry Australia (GIA) incorporating content from Plant Health Australia Ltd (2015) *Generic contingency plan – Exotic sap-sucking pests of grain (*Version 1, May 2015). In the event of an incursion, operations not covered by the GIA (e.g. retail outlets) will not be eligible for Owner Reimbursement Costs, as defined in the Emergency Plant Pest Response Deed, if affected by actions carried out under an approved Response Plan.

2 Australian nursery industry

The Australian nursery industry is a significant and diverse horticultural sector with total greenlife sales valued at $2.29 billion annually[1]. The industry employs approximately 27,000 people in approximately 1,777 businesses[1]. The industry is located predominantly along the Australian coastline and in major inland regions servicing urban and production horticulture. It is estimated that 1.618 billion plants were sold nationally in the 2015/2016 year and the production area covered 6,229 Ha (outdoor) and 1,273 Ha (indoor)[1].

3 Impact of black bean aphid

Aphis fabae feeds on a large number of plant species from many different plant families. Many of its host plants are grown in Australia. They can survive a large temperature range and cause damage directly to plants or by transmitting viruses.

4 Critical tasks

Initial delimiting surveillance is critical for any detection. If *Aphis fabae* is found to be present outside of a production nursery or other protected cropping environment the chance of eradication falls drastically. Destruction of plant material may not be necessary with the appropriate use of fungicides. Management actions can be put in place to stop the spread of all aphids at IPs until surveillance indicates that it is widespread or area freedom can be established at the site. Beyond this there are a number of specific areas that should be established early on:

1. *Aphis fabae* has a number of recognised sub-species that have somewhat different host ranges. It will be important to use molecular diagnostics to confirm the species and subspecies of the aphid. This will also assist in determining what region the aphid has been introduced from and may in turn indicate if pesticide resistance

2. It will also be important to test the aphid population for the presence of any viruses, both endemic and exotic. Presence of exotic viruses will drastically alter response actions.

3. As *Aphis fabae* is not a notifiable pest in each state, it is important that each states makes it notifiable in the event of an incursion.

[1] https://www.ngia.com.au/Attachment?Action=Download&Attachment_id=2170

5 Pest information/status

5.1 Pest details

Common names: Black bean aphid, Bean aphid, Beet leaf aphid, Blackfly

Scientific name: *Aphis fabae* Scopoli

Subspecies: *A. f. cirsiiacanthoidis*, *A. f. eryngii*, *A. f. evonymi*, *A. f. fabae*, *A. f. mordvilkoi*, *A. f. solanella*

Synonyms: *Anuraphis cynariella; Aphis abietaria; Aphis acanthi; Aphis addita; Aphis adducta; Aphis advena; Aphis aparines; Aphis aparinis; Aphis apii; Aphis apocyni; Aphis atriplicis; Aphis bazzii; Aphis brevisiphona; Aphis cardui var. naumburgensis; Aphis castanea; Aphis chaerophylii; Aphis cirsina; Aphis compositae; Aphis dahliae; Aphis dusmeti; Aphis erecta; Aphis eryngii; Aphis euonymi auctt.; Aphis euonymi; Aphis hortensis; Aphis indistincta; Aphis inducta; Aphis insularis; Aphis neoreticulata; Aphis papaveris; Aphis philadelphi; Aphis phlomoidea; Aphis polyanthis; Aphis reticulata; Aphis rumicis; Aphis serratulae; Aphis silybi; Aphis sinensis; Aphis solanella; Aphis solanophilus; Aphis thlaspeos; Aphis translata; Aphis tuberosae; Aphis valerianina; Aphis watsoni; Doralis fabae; Doralis papaveris; Myzus roseum; Myzus rubrum*

Taxonomic position:

Kingdom: Animalia (Metazoa)

Phylum: Arthropoda

Class: Insecta

Order: Hemiptera

Family: Aphididae

5.1.1 Pest description

The black bean aphid, *Aphis fabae*, is 1-2mm long, soft-bodied, black coloured aphid with both wingless (apterous) and winged (alate) adult forms. It has a small head and bulbous abdomen and is usually seen in large numbers. Winged adults are relatively long and more slender and have shiny heads and thoraxes. Their membranous wings are held angled over the body. Their antennae are less than two-thirds of the length of the body and are pale yellow with black tips (https://bie.ala.org.au/species/ALA_Aphis_fabae#overview) as are the legs.

Aphis fabae is a major pest of many crops, ornamental plants and weeds (Table 1). The aphid damages plants by physically piercing the leaves and stems of the host plant to feed on the phloem (Wilkinson & Douglas 2003; Powell & Hardie 2003). Only winged aphids feed on the xylem (Powell & Hardie 2003).

There are six described subspecies that are identified based on the host plant that they can feed on (Tosh *et al.* 2004; Fauna Europaea 2004*),* although they do have overlapping host ranges. Some host plant species are common to all subspecies while other species are subspecies specific (Wilkinson & Douglas 2003). Some taxonomists suggest that *A. fabae solanella* and *A. fabae evonymi* should be separate species, *A. solanella* and *A. evonymi,* respectively. Subspecies described are:

1. *A. fabae fabae*: overwinters on *Euonymous europaeus* (spindle), feeds on *Vicia faba* (broad bean)
2. *A. fabae mordvilkoi (often spelt mordwilkoi)*: overwinters on *Euonymous europaeus* (spindle), feeds on *Tropaeolum majus,* host alternates to *Arctium* sp. (burdock)
3. *A. fabae cirsiiacanthoidis:* overwinters on *Euonymous europaeus* (spindle), feed on *Cirsium* spp. (thistle)
4. *A. fabae solanella:* overwinters on *Euonymous europaeus* (spindle), feeds on *Solanum nigrum* (black nightshade)
5. *A. fabae evonymi (often spelt euonymi):* spends all year on *Euonymous europaeus* (spindle)
6. *A. fabae eryngii: feeds on Eryngium spp. in Argentina*. Not a lot of information available.

Reproduction occurs by both sexual and asexual (parthenogenesis) generations in its lifecycle and it alternates hosts at different times of the year. Asexual reproduction results in the birth of live nymphs (all female), while

sexual reproduction results in the production of eggs, which overwinter until conditions are suitable for the eggs to hatch. The lifespan of an asexual female is up to 50 days and during this period, each can produce as many as 30 larvae (Berim 2009), but may be as high as about 85 larvae on some hosts (Meradsi and Laamari 2018).

Once the eggs hatch in spring the nymphs pass through four instar stages before becoming winged adults which migrate to secondary host plants (typically herbaceous plants with soft young flush) where they reproduce asexually on the underside of leaves giving birth to live nymphs (all female). These in turn pass through four instars to become either winged or wingless adults (winged adults are more common if the population becomes crowded (Hardie *et al.* 1994)). Reproduction of these insects is primarily asexual. The switch from asexual to sexual reproduction is triggered by shorter day lengths and decreasing temperatures which triggers winged males and females to migrate back to their primary host plants to reproduce (Hardie *et al.* 1994; Sandrock *et al.* 2011). Wingless aphids were found to complete a lifecycle in as little as 5.4 days at 28.5°C. Development takes longer at cooler temperatures with a complete lifecycle taking 21.7 days at 11.5°C (Tsitsipis & Mittler 1976).

The primary host plants are woody shrubs (e.g. European spindle (*Euonymus europaeus*), water elder (*Viburnum opulus*) or mock orange (*Philadelphus coronarius*) (Vantaux *et al.* 2011)) and black eggs (6 to 10) are usually laid on the bark of older wood and on year old twigs by winged females in the autumn. The adults then die.

All information suggests that the black bean aphid has the potential to impact on the agriculture industry if it was to become established in Australia.

5.1.2 Dispersal

The main means of natural dispersal of *A. fabae* is through migratory flight. Winged adults are able to fly short distances but can be blown by the wind relatively long distances.

Cockbain (1961a) suggests that a minimum of 13°C is required for horizontal flight while a minimum of 15°C is required for vertical flight, suggesting that flight would mostly occur in spring, summer and early autumn if *A. fabae* was to become established in Australia.

Black bean aphid can also be dispersed by the movement of plant material (including nursery plant hosts), machinery, equipment, and on people and clothing.

5.1.3 Host range

The black bean aphid is polyphagous and feeds and reproduces asexually on a large number of hosts. These should all be considered in surveys during an incursion. The aphid reproduces sexually on a limited number of plants (Vantaux *et al.* 2011). The primary hosts plants are woody shrubs (e.g. European spindle (*Euonymus europaeus*), water elder (*Viburnum opulus*) or mock orange (*Philadelphus coronarius*)

Some hosts are only fed on by one of the *A. fabae* subspecies, e.g. faba beans are only attacked by *A. fabae fabae* and not by the other subspecies of the aphid. Other plants, however, such as *Rumex obtusifolius* are used by other subspecies of *A. fabae*.

Table 1: List of known hosts of *Aphis fabae*. Where the host is known to be present in Australia it is marked as 'Yes', otherwise it is left blank.

Common name	Species name	Family	Reference	Present in Australia	Notes
Welsh onion	*Allium fistulosum*	Amaryllidaceae	Maharani *et al.* (2018)	Yes	
Red-root amaranth	*Amaranthus retroflexus*	Amaranthaceae	Culjak *et al.* (2012); Fernandez-Quintanilla *et al.* (2002)	Yes	
Fiddleneck	*Amsynckia intermedia*	Boraginaceae	Fernandez-Quintanilla *et al.* (2002)	Yes	
Dill	*Anethum graveolens var. hortorum*	Apiaceae	Culjak *et al.* (2012)	Yes	
Celery	*Apium graveolens*	Apiaceae	Culjak *et al.* (2012)	Yes	

Common name	Species name	Family	Reference	Present in Australia	Notes
Greater burdock	*Arctium lappa*	Asteraceae	Feraru *et al.* (2005)	Yes	
Lesser burdock	*Arctium minus*	Asteraceae	Barnea *et al.* (2005)	Yes	Utilised by *A. f. mordvilkoi* (Wilkinson & Douglas 2003)
Horse radish	*Armoracia rusticana*	Brassicaceae	Culjak *et al.* (2012)	Yes	
Asparagus	*Asparagus officinalis*	Asparagaceae	Culjak *et al.* (2012)	Yes	
Milkvetch	*Astragalus ovinus*	Fabaceae	Alikhani *et al.* (2010)		
Sugar beet	*Beta vulgaris*	Chenopodiaceae	Razmjou and Fallahi (2009); Alikhani *et al.* (2010); Barnea *et al.* (2005)	Yes	
Cabbage	*Brassica oleracea* var. *capitata*	Brassicaceae	Culjak *et al.* (2012)	Yes	
Cauliflower	*Brassica oleracea* var. *botrytis*	Brassicaceae	Culjak *et al.* (2012)	Yes	
Brussels sprouts	*Brassica oleracea* var. *gemmifera*	Brassicaceae	Culjak *et al.* (2012)	Yes	
Savoy cabbage	*Brassica oleracea* var. *sabauda*	Brassicaceae	Culjak *et al.* (2012)	Yes	
Marigold	*Calendula alata*	Asteraceae	Baciu *et al.* (2009)	Yes	
Field marigold	*Calendula arvensis*	Asteraceae	Baciu *et al.* (2009)	Yes	
Pot marigold	*Calendula officinalis*	Asteraceae	Baciu *et al.* (2009)	Yes	
Marigold	*Calendula stellata*	Asteraceae	Baciu *et al.* (2009)		
Marigold	*Calendula suffruticosa*	Asteraceae	Baciu *et al.* (2009)		
Shepard's purse	*Capsella bursa-pastoris*	Brassicaceae	Fernandez-Quintanilla *et al.* (2002); Alikhani *et al.* (2010); Culjak *et al.* (2012)	Yes	
Capsicum	*Capsicum annuum*	Solanaceae	Culjak *et al.* (2012)	Yes	
White top	*Cardaria draba*	Brassicaceae	Culjak *et al.* (2012)	Yes	
Thistle	*Cardus* spp.	Asteraceae	Culjak *et al.* (2012)	Yes	
Meridian fennel; Persian cumin	*Carum carvi*	Apiaceae	Culjak *et al.* (2012)	Yes	
Iberian starthistle	*Centaurea iberica*	Asteraceae	Alikhani *et al.* (2010)		
Greater knapweed	*Centaurea scabiosa*	Asteraceae	Barnea *et al.* (2005)	Yes	
Yellow star-thistle	*Centaurea solstitialis*	Asteraceae	Culjak *et al.* (2012)	Yes	
Sour cherry	*Cerasus (syn. Prunus) vulgaris*	Rosacea	Culjak *et al.* (2012)	Yes	
Fat-hen	*Chenopodium album*	Amaranthaceae	Fernandez-Quintanilla *et al.* (2002); Hardie (1989); Culjak *et al.* (2012)	Yes	Utilised by *A. f. fabae* (Wilkinson & Douglas 2003)

Common name	Species name	Family	Reference	Present in Australia	Notes
Common chicory	*Cichorium intybus*	Asteraceae	Feraru *et al.* (2005)	Yes	
Thistle	*Cirsium* spp.	Asteraceae	Tosh *et al.* (2004); Alikhani *et al.* (2010)	Yes	Utilised only by *A. f. cirsiiacanthoidis* (Tosh 2004)
Watermelon	*Citrulus lanatus*	Cucurbitaceae	Culjak *et al.* (2012)	Yes	
Lime	*Citrus aurantifolia*	Rutaceae	Maharani *et al.* (2018)	Yes	
Muskmelon	*Cucumis melo*	Cucurbitaceae	Culjak *et al.* (2012)	Yes	
Cucumber	*Cucumis sativus*	Cucurbitaceae	Culjak *et al.* (2012); Maharani *et al.* (2018)	Yes	
Squash	*Cucurbita maxima*	Cucurbitaceae	Maharani *et al.* (2018)	Yes	
Zucchini	*Cucurbita pepo*	Cucurbitaceae	Culjak *et al.* (2012)	Yes	
Artichoke	*Cynara scoyimus*	Asteraceae	Culjak *et al.* (2012)	Yes	
Carrot	*Daucus carota*	Apiaceae	Culjak *et al.* (2012); Szwejda & Wrzodak (2007)	Yes	
European spindle	*Euonymus europaeus*	Celastraceae	Vantaux *et al.* (2011); Culjak *et al.* (2012); Tosh *et al.* (2004)	Yes	Eggs produced on this host (Vantaux 2011)
Japanese spindle	*Euonymus japonica*	Celastraceae	Sadoff & Raupp (1991)	Yes	
Cleavers; catch weed; goosegrass	*Galium aparine*	Rubiaceae	Culjak *et al.* (2012)	Yes	
Soybean	*Glycine max*	Fabaceae	Culjak *et al.* (2012); Summerfield *et al.* (1998)	Yes	
Sunflower	*Helianthus annus*	Asteraceae	Culjak *et al.* (2012); Barnea *et al.* (2005)	Yes	
Common hop	*Humulus lupulus*	Cannabaceae	Culjak *et al.* (2012)	Yes	
Lettuce	*Lactuca sativa*	Asteraceae	Culjak *et al.* (2012)	Yes	
Purple deadnettle	*Lamium purpureum*	Lamiaceae	Wilkinson & Douglas (2003)	Yes	Only utilised by *A. f. fabae* (Wilkinson & Douglas 2003)
Lentil	*Lens esculenta*	Fabaceae	Culjak *et al.* (2012)	Yes	
Tomato	*Lycopersicum esculentum*	Solanaceae	Alikhani *et al.* (2010); Culjak *et al.* (2012)	Yes	
Marshmallow	*Malva parviflora*	Malvaceae	Fernandez-Quintanilla *et al.* (2002)	Yes	
German chamomile	*Matricaria chamomilla*	Asteraceae	Culjak *et al.* (2012)	Yes	
Lucerne	*Medicago sativa*	Fabaceae	Culjak *et al.* (2012)	Yes	
Tobacco	*Nicotiana tabacum*	Solanaceae	Culjak *et al.* (2012)	Yes	
Long-headed poppy	*Papaver dubium*	Papaveraceae	Wilkinson & Douglas (2003)	Yes	Only utilised by *A. f. fabae* (Wilkinson & Douglas 2003)
Flanders poppy	*Papaver rhoeas*	Papaveraceae	Culjak *et al.* (2012); Barnea *et al.* (2005)	Yes	
Opium poppy	*Papaver somnifernus*	Papaveraceae	Culjak *et al.* (2012)	Yes	

Common name	Species name	Family	Reference	Present in Australia	Notes
Parsnip	*Pastinaca sativa*	Apiaceae	Culjak *et al.* (2012)	Yes	
Parsley	*Petroselinum crispum*	Apiaceae	Culjak *et al.* (2012)	Yes	
Common bean	*Phaseolus vulgaris*	Fabaceae	Ogenga-Latigo *et al.* (1993); Larocca *et al.* (2011); Barnea *et al.* (2005)	Yes	
Sweet mock-orange	*Philadelphus coronaries*	Hydrangeaceae	Vantaux *et al.* (2011)	Yes	Eggs produced on this host (Vantaux 2011)
Field pea	*Pisum sativum*	Fabaceae	Culjak *et al.* (2012)	Yes	
Common knotgrass	*Polygonum aviculare*	Polygonaceae	Fernandez-Quintanilla *et al.* (2002)	Yes	
cherry laurel	*Prunus laurocerasus*	Rosaceae	Culjak *et al.* (2012)	Yes	
Radish	*Raphanus sativus*	Brassicaceae	Culjak *et al.* (2012)	Yes	
Rose	*Rosa* sp.	Rosaceae	Culjak *et al.* (2012)	Yes	
Common sorrel	*Rumex acetosa*	Polygonaceae	Wilkinson & Douglas (2003)	Yes	Only utilised by *A. f. fabae* (Wilkinson & Douglas 2003)
Broad-leaved dock	*Rumex obtusifolius*	Polygonaceae	Tosh *et al.* (2004)	Yes	Only utilised by *A. f. fabae* (Wilkinson & Douglas 2003)
Dock	*Rumex chalepensis*	Polygonaceae	Alikhani *et al.* (2010)	Yes	
Elderberry	*Sambucus nigra*	Adoxaceae	Culjak *et al.* (2012)	Yes	
Egg plant	*Solanum melongena*	Solanaceae	Culjak *et al.* (2012); Scorsetti *et al.* (2007); Maharani *et al.* (2018)	Yes	
European black nightshade	*Solanum nigrum*	Solanaceae	Tosh *et al.* (2004); Culjak *et al.* (2012); Fernandez-Quintanilla *et al.* (2002)	Yes	Only utilised by *A. f. solanella* (Tosh 2004)
Potato	*Solanum tuberosum*	Solanaceae	Culjak *et al.* (2012); Fericean *et al.* (2010)	Yes	
Spinach	*Spinacia oleracea*	Amaranthaceae,	Culjak *et al.* (2012)	Yes	
Common comfrey	*Symphytum officinale*	Boraginaceae	Culjak *et al.* (2012)	Yes	
Feverfew	*Tanecetum parthenium*	Asteraceae	Blackman & Eastop (2006)	Yes	
Tansy	*Tanecetum vulgare*	Asteraceae	Blackman & Eastop (2006)	Yes	
Hedge parsley	*Torilis leptophylla*	Apiaceae	Alikhani *et al.* (2010)		
Clover	*Trifolium* spp.	Fabaceae	Culjak *et al.* (2012)	Yes	
Garden nasturtium	*Tropaeolum majus*	Tropaeolaceae	Tosh *et al.* (2004)	Yes	Only utilised by *A. f. mordvilkoi* (Tosh 2004)
Ivy-leaved speedwell	*Veronica hederifolia*	Plantaginaceae	Fernandez-Quintanilla *et al.* (2002)	Yes	
Guelder rose; water elder	*Viburnum opulus*	Adoxaceae	Culjak *et al.*, (2012); Vantaux *et al.* (2011)	Yes	Eggs produced on this host (Vantaux 2011)
Faba bean	*Vicia faba*	Fabaceae	Way (1967); Tosh *et al.* (2004); Larocca *et al.* (2011)	Yes	Only utilised by *A. f. fabae* (Tosh 2004)

Common name	Species name	Family	Reference	Present in Australia	Notes
Common vetch	*Vicia sativa*	Fabaceae	Culjak *et al.* (2012)	Yes	
Adams needle	*Yucca filamentosa*	Asparagaceae	Culjak *et al.* (2012)	Yes	
Maize	*Zea mays*	Gramineae	Culjak *et al.* (2012); Stoetzel & Millller (2001)	Yes	

5.1.4 Damage and symptoms

Black bean aphid symptoms on host plants can be direct damage of the plant via feeding or by transmission of viruses. Faba bean plants that have been fed on by aphids produce fewer pods per plant and fewer seeds per pod (Banks & Macaulay 1967). On common bean (*P. vulgaris*) the aphid causes stunting as well as fewer flowers, pods and seeds per plant, with the greatest damage occurring when the aphids infest the plant prior to flowering (Khaemba & Ogenga-Latigo 1985).

The aphids also produce honeydew (Fischer *et al*. 2005), which encourages the development of secondary fungal problems such as sooty mould. The small black aphids are visible on the host plant, especially on the underside of the leaves.

In addition, *Aphis fabae* has been reported to transmit at least 40 viruses on numerous susceptible hosts as outlined in Appendix 3. Potyviruses are of particular concern. It should be considered that *A. fabae* may potentially vector any potyvirus, unless literature suggests otherwise. Transmission is non-persistent; aphids feeding on an infected plant take up the virus quickly and can then immediately infect the next host that it feeds upon.

On celery, black bean aphid populations can build up to densities of several thousand per plant (Godfrey & Trumble 2009) inflicting three types of damage. First, it can stunt plant growth and reduce yields through removal of significant amounts of sap. Secondly, it can transmit virus diseases such as *Bean yellow mosaic virus* (Nakazono-Nagaoka *et al.* 2009) and *Beet mosaic virus* (Dusi & Peters 1999). Finally, it can contaminate celery produce, particularly fresh market celery, with aphid honeydew and debris; this contamination can lower the crop value; other produce could potentially be contaminated in a similar way.

Overseas *A. fabae* has been associated with faba bean losses of up to 14% when aphid populations reached up to 85 aphids/ plant, with losses of 100% reported when populations reached 6920 aphids/plant (Way 1967). Banks & Macaulay (1967) suggest that when ants are attending to the aphids the number of seeds and pods per plant is further reduced compared to an infestation of non-attended aphids.

5.1.5 Current geographic distribution

The black bean aphid has a very wide distribution and is found in most countries (Table 2) but not Australia.

Table 2: Countries where *A. fabae* is known to occur *(Source: CABI 2017)*

Continent	Country
Asia	Afghanistan; China; Georgia; India; Iran; Iraq; Israel; Japan; Jordan; Kazakhstan; Korea; Kyrgyzstan; Lebanon; Malaysia; Nepal; Pakistan; Philippines; Sri Lanka; Syria; Taiwan; Tajikistan; Turkey; Turkmenistan; Uzbekistan; Yemen West Java, Indonesia (Maharani 2018) (Refs: e.g. Zhang and Xin 1989; Raychaudhuri *et al.* 1980; Irshad 2001; Maharani 2018)
Africa	Algeria; Burundi; Cameroon; Congo; Côte d'Ivoire (Ivory coast); Egypt; Ethiopia; Kenya; Libya; Malawi; Mauritius; Morocco; Niger; Nigeria; South Africa; Sudan; Tunisia; Tanzania; Uganda; Zimbabwe (Refs: e.g. Ogenga-Latigo *et al.* 1993; Karel & Autrique 1989; Blackman & Eastop 2006)

Continent	Country
North America	Bermuda; Canada; Mexico; USA (Refs: e.g. Fernandez-Quintanilla et al. 2002; Stoetzel & Millller 2001; O'Doherty 1986)
South America	Puerto Rico; Argentina; Brazil; Chile; Peru; Uruguay (Refs: e.g. Scorsetti et al. 2007; Lazzarotto and Lazzari 1998)
Europe	Austria; Belgium; Bulgaria; Croatia; Cyprus; Czech republic; Denmark; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Latvia; Lithuania; Malta; Montenegro; Netherlands; Norway; Poland; Portugal; Romania; Russia; Serbia; Slovakia; Slovenia; Spain; Sweden; Switzerland; UK; Ukraine; Yugoslavia (Refs: e.g. Culjak *et al.* 2012; Stary & Havelka 2008; Cammell *et al.* 1989)

5.1.6 Potential geographic distribution in Australia

Despite its almost worldwide distribution, *A. fabae* does not occur in Australia or New Zealand and has only recently been reported in Southeast Asia in West Java, Indonesia (Maharani 2018). It can survive temperatures between -20°C (O'Doherty 1986) and 40°C (Halgren & Taylor 1986) therefore could survive over much of Australia. Black bean aphid is able to reproduce at 11.5°C (Tsitsipis & Mittler 1976) and requires temperatures of >13°C for flight (Cockbain 1961a), so most of Australia has suitable climatic conditions for the survival, reproduction and spread of this pest for most of the year. This species is also highly polyphagous (Table 1) and many host plants are widely planted in Australia.

5.2 Diagnostic information

Currently there is no endorsed National Diagnostic Protocol for black bean aphid. Appendix 1 contains a list of diagnostic facilities and advisory services that can be utilised in the event of a suspected incursion. Diagnostic expertise would be required to confirm the identification.

Aphis fabae is generally black in colour with faint banding on the abdomen. It has tan coloured legs and antennae. It is oval in shape and 1.7-2.2mm long (Stoetzel & Miller 2001). It has two siphunculi, a single cauda, and six antennal segments. There are both winged (apterous) and wingless (alate) adult forms.

There are six subspecies characterised by the plant hosts they are able to feed on: *A. fabae fabae*, *A. fabae mordvilkoi*, *A. fabae cirsiiacanthoidis, A. fabae solanella, A. fabae evonymi, A. fabae eryngii.*

Detailed descriptions of black bean aphid and other aphids are given in Raychaudhuri *et al.* (1980), and a pictorial key is given in Stoetzel & Miller (2001). Keys and descriptions in Aphids on World Plants (http://www.aphidsonworldsplants.info) may also assist along with the PaDIL Species Factsheet and Diagnostic Image Library (http://www.padil.gov.au:80/pests-and-diseases/Pest/Main/136090). These and similar texts would be helpful for the identification of this and other exotic aphids.

5.2.1 Molecular diagnosis

PCR is a rapid, specific, and sensitive test that can be used to detect and diagnose black bean aphid (Gauffre & D'Acier 2006) using multiplexing to identify and differentiate between the subspecies of the aphid.

5.3 Pest management

5.3.1 Detection and monitoring

Spring and autumn tend to be high risk periods for aphids. Frequent monitoring, particularly of potentially susceptible hosts will identify infestations while populations are still low, making management easier and less costly. Aphids can be monitored by visual inspection and beating plants, and winged aphids can be detected on sticky traps.

Visual inspection. Inspect a small percentage of each plant type by hand (up to 10%, depending upon the number of plants and their susceptibility). Examine leaves of plants that look stunted, chlorotic or have other unusual symptoms on both leaf surfaces using a hand lens. Aphids are generally found on flowers, young foliage, stems and the undersides of leaves.

Plant beating. Gently but firmly hit foliage against a pale/white beating tray (which can be a folder, bucket or plastic plate). Sometimes the cast-off skins (exuviae) may be dislodged from plants and may provide evidence of the presence of aphids without finding living individuals. A hand lens can then be used to inspect any insects.

Ants: Presence of ants often indicates that aphids or another sap-sucking insect (e.g. scales or mealybugs) are present on a plant, therefore, a closer inspection is worthwhile.

Yellow sticky traps: Useful for trapping winged aphids. Traps should also be placed near doors, vents and any susceptible crops or areas. At least one trap per 100m^2 is recommended for greenhouse crops, more in varieties that are known to be susceptible to aphids. Inspect sticky traps at least weekly and change traps every 2 to 4 weeks.

5.3.2 Chemical control

There are many pesticides registered for the control of aphids in non-food nursery crops (Table 3). These include broad-spectrum, long residual products (e.g. organophosphate, neonicotinoid and synthetic pyrethroid products) and products that are specific to aphids (e.g. pirimicarb) or sucking insects. Oil products can also be effective for some species.

Products available include those with contact, translaminar (moving across the leaf surface but not between leaves) and systemic modes of action. If a portion of the lifecycle is concealed within leaf curls, galls or other protected areas it is recommended to use a translaminar or systemic product.

Choice of pesticide might also depend on the place of origin of the aphid in order to account for pesticide resistance.

Table 3 Pesticides registered for use against aphids relevant to the production nursery industry. Always read the label before applying a product to ensure that it is suitable for your situation. Mobility refers to contact (C), translaminar (T) and systemic (S).

MODE OF ACTION	ACTIVE INGREDIENT	PRODUCT NAME (e.g.)	REGISTRATION INFORMATION	Mobility
1A	Pirimicarb	Pirimor	PER84953. All aphids on non-food nursery stock.	C, T
1B	Dimethoate	Rogor	All aphids on nursery plants, selected states only. Other labels are registered for all aphids on ornamentals in all states.	C, S
1B	Maldison	Hy-Mal	All aphids on ornamentals, specific aphids on certain fruit and vegetable crops.	C
1B	Methidathion	Suprathion	All aphids on flower and vegetable seedings, ornamental trees and shrubs in nurseries.	C
3A	Alpha-cypermethrin	Crop Care Dominex Duo	PER81707 All aphids on non-food nursery stock.	C
3A	Bifenthrin	Talstar	Aphids on roses carnations and other ornamental plants	C

MODE OF ACTION	ACTIVE INGREDIENT	PRODUCT NAME (e.g.)	REGISTRATION INFORMATION	Mobility
4A	Imidacloprid	Confidor	All aphids on ornamentals, specific aphids on certain fruit and vegetable crops.	S
4A	Imidacloprid	Suscon Maxi soil insecticide	PER81707 All aphids on non-food nursery stock.	S
28 plus 4A	Chlorantranilipro le plus thiamethoxam	Durivo	PER81707 All aphids on non-food nursery stock.	S
9B	Pymetrozine	Chess	PER81707 All aphids on non-food nursery stock.	S
12A	Diafenthiuron	Pegasus	PER81707 All aphids on non-food nursery stock.	T
23	Spirotetramat	Movento	PER81707 All aphids on non-food nursery stock.	S
NA	Botanical oils	Eco-oil	All aphids on tomatoes, cucumbers, capsicums, strawberries and ornamental plants	C
NA	K salts of fatty acids	Natrasoap	All aphids on pot plants.	C
NA	Paraffinic and Petroleum oils	Sacao BioPest, Biocover	All aphids on ornamentals and certain fruit or vegetable crops. Registration not always available in all states. Also, PER81707. All aphids on non-food nursery stock.	C

* Afidopyropen is a new product that has not been researched to know whether it is systemic, translaminar or only contact. The extent of non-target impacts is also unknown.

Table 4. Pesticides registered for use against aphids in home garden situations. Mobility refers to contact (C), translaminar (T) and systemic (S).

MODE OF ACTION	ACTIVE INGREDIENT	PRODUCT NAME (e.g.)	REGISTRATION INFORMATION	Mobility
1B	Maldison	Malathion	Aphids on ornamentals	C
1B	Omethoate	Folimat	Aphids on ornamentals	S
3A	Beta-cyfluthrin	Baythroid advanced	Aphids on ornamentals	C
3A	Bifenthrin	Talstar	Aphids on ornamentals	C
3A	Esfenvalerate	Amgrow Caterpillar and insect spray	Aphids on ornamentals	C
3A	Permethrin	Bug gun	Aphids in home garden	C
3A	Pyrethrins + piperonyl butoxide	Garden basics pyrethrum insect spray	Aphids on ornamentals	C
4A	Acetamiprid	Maxguard	Aphids on ornamentals	S
4A	Imidacloprid	Confidor	Aphids on ornamentals	S

MODE OF ACTION	ACTIVE INGREDIENT	PRODUCT NAME (e.g.)	REGISTRATION INFORMATION	Mobility
4A	Thiamethoxam	Resolva	Aphids on ornamentals	S
6+4A	Abamectin + thiamethoxam	Brunnings triple action bug guard	Aphids on ornamentals	T+S
NA	Azadirachtin	Eco-Neem	Aphids on ornamentals	C
NA	Botanical, petroleum and paraffin oils	Eco-Oil, white oil etc	Aphids on ornamentals	C
NA	Fatty acids of potassium salts	Natrasoap	Aphids on ornamentals	C

6 Pest risk ratings and potential impacts

6.1 Entry potential

Black bean aphids could enter the country as hitchhikers on plant material, vehicles, equipment, containers or on clothing. Given the increase in international travel and movement of goods between countries there is a potential of black bean aphids entering Australia.

The entry potential of black bean aphid can be considered **Medium**.

6.2 Establishment potential

The black bean aphid has a wide host range (Table 1) and has an almost worldwide distribution (Table 2), therefore it has the ability to adapt to Australia's environment. It is known to survive temperatures between -20°C (O'Doherty 1986) and 40°C (Halgren & Taylor 1986) so could survive over much of the continent. The plants that it requires for sexual reproduction (i.e. *Euonymus europaeus*, *Viburnum opulus* and *Philadelphus coronarius* (Vantaux *et al.* 2011)) occur in Australia. Mock orange (*P. coronarius*) is widely planted as a garden plant, which would allow black bean aphid to sexually reproduce and overwinter as eggs. However, it is likely that it would not reproduce sexually except in very cold climates in the south of Australia.

The insect is able to reproduce at 11.5°C (Tsitsipis & Mittler 1976) and requires temperatures of >13°C for flight (Cockbain 1961a), suggesting that large areas of Australia are suitable for the reproduction and spread of this pest for much of the year.

Based on the availability of suitable hosts and climatic conditions the establishment potential of black bean aphid can be considered **High**.

6.3 Spread potential

The black bean aphid can be spread between areas as a hitchhiker on plants, machinery, equipment, vehicles and clothing. The insect also has both winged and wingless morphs, meaning that it can fly short distances or be dispersed by the wind. Before it can fly it requires temperatures of greater than 13°C (Cockbain 1961a), therefore, spring and summer temperatures are likely to be high enough for the flight of this insect. The black bean aphid has been found to fly continuously for 5 to 8 hours in tethered flight experiments (Cockbain 1961b) suggesting that this aphid is a strong flier and could disperse over long distances.

The spread potential of black bean aphid can be considered **High**.

6.4 Economic impact

The black bean aphid has been associated with losses of 6-14% when aphid populations reached 0.2-85 aphids/faba bean plant, while losses of 100% have been reported when the population of aphids reached 6920 aphids/plant (Way 1967). *Aphis fabae* is also a vector of at least 42 plant viruses (Stoetzel & Miller 2001), although it is a relatively poor vector of plant viruses, compared with other economically-important aphids such as Green peach aphid (Potatoes NZ: https://potatoesnz.co.nz/updates/biosecurity-updates/biosecurity-update-black-bean-aphid/). However, even a poor vector can still cause massive problems.

It is therefore considered that this aphid might have a significant economic impact on several industries including: production nursery, various horticulture crops, grains (particularly leguminous grains such as faba beans (Way 1967; Larocca *et al.* 2011)), common beans (Ogenga-Latigo *et al.* 1993; Larocca *et al.* 2011) and soybeans (Summerfield *et al.* 1998).

The economic impact of black bean aphid can be considered **Medium.**

6.5 Environmental impact

Very few Australian native species are known hosts of black bean aphid. While some might be more strongly impacted than others, naturally occurring predators are likely to assist in natural environments being relatively resilient to damage.

The environmental impact in Australia is considered **Low**.

6.6 Overall risk

Based on the above individual ratings the combined overall risk is considered to be **Medium**.

7 Surveillance and collection of samples

7.1 Surveillance

7.1.1 Survey priorities and considerations

Surveys are required to delimit the extent of the outbreak, ensuring that appropriate quarantine zones are established and that areas free of the pest retain market access.

Initial surveillance priorities include:

- 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.

When establishing delimiting surveys for any exotic pests the following should be considered:

- The size of the survey area will depend on the size of the infested area and the severity of the infestation, as well as potential movement of plant material during the period prior to detection. It is recommended delimiting surveys should comprise local surveys around the area of initial detection.
- A high intensity of field sampling is needed for a high degree of confidence.

- All potential host species of the pest should be surveyed, with particular attention paid to the species on which the pest was initially detected. However, given the large host range and potential species that *A. fabae* may not have previously encountered, it may be worth considering *any* plant as a host during initial surveys and at production nurseries.

- If the incursion is in a populated area, publication and distribution of information sheets and appeals for public assistance may be helpful.

Developing surveys for presence and spread of black bean aphid will need to consider the following:

- *Aphis fabae* has a large host range from ornamentals (mock orange, spindle, Viburnum) to horticultural crops (beans, celery, potato, cabbage, asparagus) to weeds (milkvetch, thistle, fat-hen).

- Most hosts are present in Australia, including the hosts required for sexual reproduction (mock orange, spindle, Viburnum).

- *Aphis fabae* may be found in production nurseries, gardens, and field cropping systems.

- The risk of movement of A. fabae on people, machinery, and equipment will be high.

- Most regions of Australia will have climate conditions suitable for aphid breeding and feeding.

- The black colour of the aphid should make it relatively easy to see, although they will hide on the underside of leaves etc.

- Temperature and weather conditions will affect insect movements and breeding.

- Direction of prevailing wind can impact dispersal.

- By the time an aphid incursion is detected, it may have been present for months or years for the population to reach detectable levels or to be recognised as something different usual aphid species affecting the crop.

- The presence of ants and sooty mould can indicate presence of aphids.

7.1.2 Retail and production nurseries

A minimum of 100m around the IP should be surveyed with careful observations completed on all hosts. Other plants should also be surveyed within 100m.

If black bean aphid is detected within 100m, additional surveillance should be completed to better ascertain the degree of spread. Widespread detections around IPs indicate that the aphid has probably been present for a relatively long period of time, therefore, a wider net, with less intense surveillance is recommended. Very limited detections around IPs may indicate a new introduction for which more detailed surveillance is worthwhile.

If an aphid is not detected within 100m it is recommended to assess high risk areas within 1km of the IP and survey highest risk areas first, e.g. hot spots of primary host plants, community gardens and production nurseries.

All plants listed as hosts should be surveyed as a priority. As stated above, all other plants close to known infestations also need to be monitored for the possibility that it is an unrecorded host. Any black aphids should be treated as suspicious with samples being submitted for identification.

Monitoring should include visual inspections for aphids, their damage and cast off-skins, along with plant beating. Refer to the pest description and damage and symptoms sections above.

7.1.3 Monitoring by nursery producers

Monitoring and managing aphids is part of normal production nursery business. A pest management plan for aphids has been produced for the production nursery industry and covers a range of cultural, biological and

chemical control options. In the event that a production nursery falls within a quarantine zone, it is recommended to avoid growing primary host plants of black bean aphid to reduce the risk of populations of the aphid becoming established at the nursery, at least until such a time as policies have been developed to facilitate trade of such hosts.

Monitoring records showing presence and absence of aphids and other pests will be valuable to facilitate continued trading for businesses within quarantine zones.

7.2 Collection of samples

Samples should be collected whenever aphids are observed that have dark coloured wingless individuals present (virtually all aphid species have dark winged individuals). There are a number of aphids that are quite similar in appearance that are already present in Australia, most notably the cowpea aphid, *Aphis craccivora*, but some species have a great deal of variation in colour and may sometimes be very dark, e.g. cotton aphid, *A. gossypii.*

If aphids are detected that are considered suspicious for *A. fabae* collect at least a dozen large, wingless individuals per area (e.g. bench, section of nursery, crop line of a certain age etc) into 70% ethanol and an additional dozen into 100% ethanol for potential molecular analysis. Collect such samples from each host plant species; collect more if no information is available. Collect winged individuals and smaller individuals if there are insufficient large wingless aphids, however, these are not as useful for morphological identification. If there are very few large wingless individuals present, they should be preferentially collected into 70% ethanol.

It is also recommended to take note of any virus symptoms. If possible, collect whole plants with virus symptoms. However, if suspect black bean aphids are present on plants they will need to be treated with great caution or killed prior to collection, e.g. with 70% ethanol spray. If whole plants cannot be collected, collect symptomatic stems including the growing tips.

If possible, apply an appropriate translaminar or systemic insecticide after samples have been collected to limit spread of the population. Obviously, if the infestation is very large this may need to be completed in collaboration with the land or production manager.

Protocols for the collection, transport and diagnosis of suspect Emergency Plant Pests (EPPs) must follow PLANTPLAN (Plant Health Australia 2014).

The total number of samples collected 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 and detection method. If possible, collect information on movements of plants, people and equipment on the property, climatic events (e.g. storms and prevailing wind directions) and farm management (e.g. irrigation methods, spray regime) as these may assist in tracing.

8 Course of action – immediate response to a detection

For a range of specifically designed procedures for the emergency response to a pest incursion and a general communication strategy refer to PLANTPLAN (Plant Health Australia 2014).

8.1 Tracing

Detection and delimiting surveys are required to determine the extent of the outbreak, ensuring areas free of the pest retain market access and appropriate quarantine zones are established. Since aphids can be moved considerable distances via wind and movement of plants and low level populations can be difficult to detect, high risk sites in the greater area should be surveyed within a 10-20km distance from Infested Premises (IPs). High risk sites include:

- All production and retail nurseries within the area.
- Backyard ‘nurseries’ trading at local markets

- Cut flower producers, particularly those growing, importing and reselling roses
- Community and botanic gardens
- Commercial producers growing plants listed as known hosts

Forward tracing should focus on:

- movement of host plants from the origin of the incursion via nursery trading
- plant material infested with aphids that may have been moved as part of normal business, e.g. roses, tomatoes, corn and other host products that may have had BBA present.
- potential natural spread to susceptible hosts on the infested property and neighbouring properties, consider prevailing winds and storms that may have occurred recently.
- hitchhiking from the initial infestation source on people, equipment and machinery.

For trace-backs, focus should include:

- movement of host plants, particularly recent importation of plant material
- review of available site monitoring records to consider if the initial infestation could have occurred on another host plant and then colonised other plants. It is important to keep an open mind as to the type of material that could have initiated a population. All suppliers of plants to the business or region should be considered within a relevant time frame given the level of infestation
- movements of anything on which an aphid could hitchhike
- prevailing winds

8.2 Quarantine and movement controls

If black bean aphid is found to be present in a very localised area and not present on environmental plants or in urban areas, a quarantine zone of at least 500m should be considered. If the aphid is found greater than 500m away at a site that has no direct link to IPs it seems likely that it is widespread and eradication unlikely.

- Plant material at the site of infestation to be subject to movement restrictions as such it could potentially spread the pest to new areas. Area freedom should be established prior to movement of plants or plant products.
- Broad acre crops that are infested with black bean aphid need to be considered carefully. If these products are to be harvested and dried in the field, winged aphids may disperse and spread the infestation. Therefore, work with the grower to come to a solution to eradicate the infestation prior to harvest.
- Machinery, equipment, vehicles and people in contact with infested plant material or soil must be controlled by decontamination or disposal, as a general protocol to reduce spread of soil borne pests and diseases.

8.3 Treatment strategy

It is recommended to apply an appropriate translaminar or systemic pesticide as soon as plants are suspected to be infested with black bean aphid (and after a sample has been collected). Manage resistance by applying the same pesticide 2-3 times each about 5-7 days apart. If aphids are still present, apply a pesticide from a different mode of action group 2-3 times, about 5-7 days apart. Use this same approach using different products as much as possible. This approach will limit pesticide resistance. If products are noted to be ineffective, discontinue their use. Plants should be carefully monitored after every 7 and 14 days and used to inform if pesticides are required.

These recommendations should be modified depending on the exact situation. It is recommended to complete an evaluation of detection rates of the aphid using both direct observation and plant beating on a variety of plants. Modify the method of follow-up surveillance based on these results. Sticky traps may also assist in trapping if a molecular identification method on winged aphids can be developed to detect black bean aphid.

8.4 Containment strategies

For some exotic pest incursions where eradication is considered impractical, containment of the pest may be attempted to prevent or slow its spread and to limit its impact on other parts of the state or country. The decision on whether to eradicate or contain the pest will be made by the National Management Group, based on scientific and economic advice.

8.5 Stakeholder engagement/public awareness

High risk stakeholders include those that move host plants, including landscapers, production and retail nurseries, local councils, relevant community groups, local market groups etc

On-line or app reporting tools such as MyPestGuide should be established and promoted to allow submission of reports of suspected black bean aphid detections.

Factsheets can provide information on the pest, symptoms, impacts and reporting mechanisms (note that a general nursery factsheet is available, along with a specific Black bean aphid factsheet)

Media releases will describe the impact of the pest, surveillance programs and activities within the response program.

Advise the public not to treat plants themselves and not to take samples. Advise the public to report any suspicious aphids.

9 Technical debrief and analysis for stand down

Refer to PLANTPLAN (Plant Health Australia, 2016) 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. This should be strongly considered if black bean aphid is detected in natural environments in substantial numbers.

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Appendix 1: Important nursery industry contacts

The nursery industry is probably the most widely distributed industry in the country. Therefore it is recommended to contact the state and national body to get the most current information. General contact details provided below.

Australia and NT Website: https://www.greenlifeindustry.com.au/ Email: info@greenlifeindustry.com.au	**Western Australia** Website: https://www.ngiwa.com.au/ Email: reception@ngiwa.com.au
South Australia Website: https://ngisa.com.au/ Email: admin@ngisa.com.au	**NSW and ACT** Web: https://www.ngina.com.au/ Email: info@ngina.com.au
Queensland Website: https://www.ngiq.asn.au/ Email: info@ngiq.asn.au	**Victoria** Website: https://www.ngiv.com.au/ Email: ngiv@ngiv.com.au
Tasmania Website: https://www.ngitas.com.au/ Email: admin@ngitas.com.au	

Appendix 2: Resources and facilities – diagnostic service facilities in Australia

The diagnostic facilities below should be contacted prior to sending any samples to ensure the availability of all necessary equipment and reagents to complete the tests required.

Crop Health Services	VIC	AgriBio Specimen Reception Main Loading Dock, 5 Ring Road La Trobe University, Bundoora VIC 3083 Ph: 03 9032 7515; Fax: 03 9032 7064
DPI New South Wales – Elizabeth Macarthur Agricultural Institute	NSW	Woodbridge Road Menangle NSW 2568 PMB 8 Camden NSW 2570 Ph: 02 4640 6327; Fax: 02 4640 6428
SARDI Plant Research Centre – Waite Main Building, Waite Research Precinct	SA	Hartley Grove Urrbrae SA 5064 Ph: 08 8303 9400; Fax: 08 8303 9403
Biosecurity Queensland, Department of Agriculture and Fisheries (DAF)	QLD	Ecosciences Precinct Dutton Park Q 4102 Ph: 07 3404 6999; Fax: 07 3844 4529
Department of Agriculture and Food, Western Australia (AGWEST) Plant Laboratories	WA	3 Baron-Hay Court South Perth WA 6151 Ph: 08 9368 3721; Fax: 08 9474 2658
Department of Primary Industry and Resources	NT	Plant Industries Division BAL Building, Berrimah Farm, Makagon Road, Berrimah NT 0828 Ph: 08 8999 2261; Fax: 08 8999 2312
Department of Primary Industries, Parks, Water and Environment	TAS	GPO Box 44 Hobart Tasmania 7001 Ph: 1300 368 550

Appendix 3: Viruses vectored by black bean aphid

Information collected from the sources below. Assume that this table will be outdated with taxonomic inaccuracies (both virus and plant nomenclature)

Plant Viruses Online: Descriptions and Lists from the VIDE Database 1996 https://web.archive.org/web/20061022025235/http://image.fs.uidaho.edu/vide/descr068.htm

Chan CK, Forbes AR, Raworth DA (1991) Aphid-transmitted viruses and their vectors of the world. Agric. Canada Res. Branch Tech. Bull. 1991- 3E, 216 pp.

https://archive.org/details/aphidtransmitted19913chan

Virus	**Susceptible Hosts (both natural and experimental hosts)**	**In Aus**
Alfalfa mosaic virus/alfamovirus	*Apium graveolens, Apium graveolens var. rapaceum, Capsicum annum, Caryopteris incana, Cicer arietinum, Lactuca sativa, Lupinus sp., Lycopersicon lycopersicum, Malva parviflora, Medicago sativa, Nicotiana tabacum, Phaseolus vulgaris, Philadelphus sp., Pisum sativum, Solanum tuberosum, Trifolium incarnatum, Trifolium repens, Viburnum opulus, Vigna radiate, Vigna unguiculata*	Yes
Bean common mosaic virus/serotype B/potyvirus	*Cajanus cajan, Cassia tora, Chenopodium amaranticolor, Chenopodium quinoa, Cicer arietinum, Crotalaria spectabilis, Cyamopsis tetragonoloba, Glycine max, Gomphrena globose, Lens culinaris, Lupinus albus, Lupinus angustifolius, Macroptilium lathyroides, Melilotus albus, Nicotiana benthamiana, Nicotiana clevelandii, Phaseolus coccineus, Phaseolus lunatus, Phaseolus vulgaris, Pisum sativum, Sesbania exaltata, Tetragonia tetragonioides, Trifolium incarnatum, Trifolium subterraneum, Vicia faba, Vicia sativa, Vicia villosa, Vigna angularis, Vigna radiate, Vigna unguiculata*	Yes
Bean leaf roll virus/luteovirus	*Arachis hypogaea, Astragalus sinicus, Cicer arietinum, Glycine max, Lathyrus odoratus, Lens culinaris, Lupinus cosentinii, Medicago hispida, Medicago sativa, Phaseolus vulgaris, Pisum sativum, Trifolium dubium, Trifolium hybridum, Trifolium incarnatum, Trifolium pratense, Trifolium repens, Trifolium subterraneum, Vicia faba, Vicia sativa, Vigna unguiculata*	Yes
Bean yellow mosaic virus/potyvirus	*Amaranthus caudatus, Arachis hypogaea, Cajanus cajan, Canna, Chenopodium album, Chenopodium amaranticolor, Chenopodium quinoa, Cicer arietinum, Crotalaria retusa, Crotalaria spectabilis, Cucurbita maxima, Cyamopsis tetragonoloba, Eustoma russellianum, Freesia, Gladiolus, Glycine max, Gomphrena globose, Lathyrus odoratus, Lens culinaris, Lupinus albus, Lupinus angustifolius, Lupinus luteus, Macrotyloma uniflorum, Medicago sativa, Melilotus albus, Nicotiana clevelandii, Nicotiana debneyi, Nicotiana glutinosa, Nicotiana rustica, Nicotiana sylvestris, Nicotiana tabacum, Papaver somniferum, Petunia × hybrid, Phaseolus lunatus, Phaseolus vulgaris, Physalis floridana, Phytolacca Americana, Pisum sativum, Robinia pseudoacacia, Spinacia oleracea, Stellaria media, Tetragonia tetragonioides, Trifolium hybridum, Trifolium incarnatum, Trifolium pratense, Trifolium repens, Trifolium subterraneum, Trifolium vesiculosum, Trigonella foenum-graecum, Vicia faba, Vicia sativa, Vicia villosa, Vigna angularis, Vigna radiate, Vigna unguiculata, Zinnia elegans*	Yes

Virus	Susceptible Hosts (both natural and experimental hosts)	In Aus
Beet mosaic virus/potyvirus	*Abelmoschus esculentus, Amaranthus caudatus, Amaranthus retroflexus, Atriplex hortensis, Beta macrocarpa, Beta maritima, Beta patellaris, Beta vulgaris, Capsella bursa-pastoris, Celosia argentea, Celosia cristata, Chenopodium album, Chenopodium amaranticolor, Chenopodium capitatum, Chenopodium murale, Chenopodium quinoa, Cucurbita pepo, Dianthus barbatus, Glycine max, Gomphrena globose, Hyoscyamus niger, Melilotus indicus, Nicotiana bigelovii, Nicotiana clevelandii, Nicotiana glutinosa, Phacelia campanularia, Phytolacca Americana, Pisum sativum, Samolus parviflorus, Senecio vulgaris, Sonchus arvensis Spinacia oleracea, Stellaria media, Tetragonia tetragonioides, Trifolium incarnatum, Vicia faba, Zinnia elegans*	Yes
Beet western yellows virus/polerovirus	*Abelmoschus esculentus, Amaranthus retroflexus, Arachis hypogaea, Arctotheca calendula, Arundo donax, Beta macrocarpa, Beta patellaris Beta vulgaris, Brassica campestris ssp. Napus, Brassica campestris ssp. Pekinensis, Brassica campestris ssp. Rapa, Brassica juncea, Brassica napus var. napobrassica, Brassica nigra, Brassica oleracea var. botrytis, Brassica oleracea var. capitate, Calandrinia caulescens, Capsella bursa-pastoris, Capsicum annuum, Celosia argentea, Cheiranthus cheiri, Chenopodium capitatum, Cicer arietinum, Citrullus lanatus, Clarkia pulchella, Coronopus didymus, Crambe abyssinica, Cucumis sativus, Cucurbita moschata, Cucurbita pepo, Erodium moschatum, Euphorbia peplus, Gazania rigens, Glycine max, Gomphrena globose, Helianthus annuus, Lactuca sativa, Lactuca serriola, Lathyrus odoratus, Lens culinaris, Lupinus albus, Lupinus cosentinii, Lycopersicon esculentum, Malva parviflora, Matthiola incana, Medicago hispida, Montia perfoliata, Nicandra physalodes, Nicotiana bigelovii, Nicotiana clevelandii, Papaver rhoeas, Petroselinum crispum, Petunia × hybrid, Phlox drummondii, Physalis floridana, Pisum sativum, Raphanus sativus, Senecio vulgaris, Sinapis alba, Sinapis arvensis, Solanum tuberosum, Sonchus asper, Sonchus oleraceus, Spinacia oleracea, Stellaria media, Tetragonia tetragonioides, Trifolium incarnatum, Trifolium pratense, Trifolium repens, Trifolium subterraneum, Tropaeolum majus, Vicia faba, Vicia sativa, Vigna unguiculata, Viola cornuta, Zinnia elegans*	Yes
Beet yellows virus/closterovirus	*Atriplex hortensis, Beta vulgaris, Celosia cristata, Chenopodium album, Chenopodium amaranticolor, Chenopodium ambrosioides, Chenopodium capitatum, Chenopodium foliosum, Chenopodium hybridum, Chenopodium quinoa, Lactuca sativa, Montia perfoliata, Nicotiana clevelandii, Spinacia oleracea, Stellaria media, Tetragonia tetragonioides, Trifolium hybridum*	No
Broad bean mild mosaic virus	*Vicia faba*	No
Broad bean wilt virus/fabavirus	*Petroselinum crispum, Petunia x hybrid, Pisum sativum, Plantago lanceolate, Spinacia oleracea, Tropaeolum majus, Vicia faba*	Yes
Cauliflower mosaic virus	*Arabidopsis thaliana, Brassica oleracea, Brassica rapa, Brassica spp., Raphanus spp.*	Yes
Celery mosaic virus/potyvirus	*Anethum graveolens, Apium graveolens var. dulce, Conium maculatum, Coriandrum sativum, Daucus carota, Pastinaca sativa, Petroselinum crispum*	Yes

Virus	Susceptible Hosts (both natural and experimental hosts)	In Aus
Celery yellow spot virus/luteovirus	*Apium graveolens, Conium maculatum, Pastinaca sativa*	No
Chilli mosaic virus[1]	*Capsicum frutescens*	No
Cowpea (Moroccan) aphid-borne mosaic virus/potyvirus	*Vigna unguiculata*	No
Cucumber mosaic virus/cucumovirus/cauli movirus	*Abelmoschus esculentus, Amaranthus caudatus, Amaranthus retroflexus, Antirrhinum majus, Apium graveolens, Atriplex hortensis, Beta vulgaris, Brassica campestris ssp. Napus, Brassica campestris ssp. Pekinensis, Brassica campestris ssp. rapa, Brassica juncea, Calendula officinalis, Capsella bursa-pastoris, Capsicum annuum, Capsicum frutescens, Catharanthus roseus, Cheiranthus cheiri, Chenopodium album, Chenopodium amaranticolor, Chenopodium foetidum, Chenopodium hybridum, Chenopodium murale, Chenopodium quinoa, Chrysanthemum morifolium, Cicer arietinum Cichorium endive, Citrullus lanatus, Coriandrum sativum, Crotalaria spectabilis, Cucumis melo Cucumis sativus, Cucurbita maxima, Cucurbita moschata, Cucurbita pepo, Datura ferox, Datura metel, Datura stramonium, Datura tatula, Daucus carota, Emilia sagittata, Fagopyrum esculentum, Glycine max, Gomphrena globose, Gossypium hirsutum, Helianthus annuus, Hyoscyamus niger, Ipomoea nil, Lens culinaris, Lotus corniculatus, Lupinus albus, Lupinus angustifolius, Lycopersicon esculentum, Lycopersicon pimpinellifolium, Matthiola incana, Medicago sativa, Melilotus albus, Momordica balsamina, Nicotiana bigelovii, Nicotiana clevelandii, Nicotiana debneyi, Nicotiana glutinosa, Nicotiana megalosiphon, Nicotiana rustica, Nicotiana sylvestris, Nicotiana tabacum, Nicotiana × edwardsonii, Phaseolus lunatus, Phaseolus vulgaris, Physalis floridana, Physalis peruviana, Phytolacca Americana, Pisum sativum, Raphanus sativus, Rumex acetosa, Senecio vulgaris, Solanum demissum, Solanum melongena, Solanum nigrum, Solanum nodiflorum Solanum rostratum, Solanum tuberosum, Sonchus oleraceus, Spinacia oleracea, Tetragonia tetragonioides, Trifolium hybridum, Trifolium incarnatum, Trifolium pratense, Trifolium repens, Tropaeolum majus, Verbesina encelioides, Vicia faba, Vicia sativa, Vigna radiate, Vigna unguiculata, Vigna unguiculata ssp. sesquipedalis*	Yes
Dahlia mosaic virus/caulimovirus	*Dahlia pinnata*	Yes
Dioscorea green-banding mosaic virus(related to yam mv)/potyvirus	*Dioscorea rotundata*	No
Faba bean necrotic yellows virus/nanavirus	*Cicer arietinum, Lathyrus odoratus, Lens culinaris, Medicago hispida, Melilotus officinalis, Phaseolus vulgaris, Pisum sativum, Trifolium incarnatum, Trifolium subterraneum, Vicia faba, Vicia palaestina, Vicia sativa*	No

Virus	Susceptible Hosts (both natural and experimental hosts)	In Aus
Hippeastrum mosaic virus/potyvirus	*Eucharis grandiflora, Hippeastrum x hybridum, Hippeastrum puniceum*	Yes
Iris (beardless) mosaic virus/potyvirus	*Belamcanda chinensis*	Yes
Iris fulva mosaic virus/potyvirus	*Iris filifolia, Iris tingitana, Iris unguicularis, Iris xiphioides, Iris xiphium*	Yes
Leek yellow stripe virus/potyvirus	*Allium ampeloprasum porosum group, Allium ascalonicum, Allium cepa*	Yes
Maize dwarf mosaic virus/potyvirus	*Arundo donax, Bromus mollis, Bromus secalinus, Bromus tectorum, Chloris gayana, Cynodon dactylon Echinochloa crus-galli, Eleusine coracana, Lagurus ovatus, Oryza sativa, Panicum capillare, Panicum maximum, Panicum miliaceum, Paspalum dilatatum, Phalaris paradoxa, Rottboellia exaltata, Saccharum officinarum, Sacciolepis indica, Setaria italic, Setaria viridis, Sorghum bicolor, Sorghum halepense, Zea mays*	No
Narcissus yellow stripe virus/potyvirus	*Narcissus jonquilla, Narcissus pseudonarcissus, Nerine bowdenii*	No
Nasturtium mosaic virus	*Tropaeolum majus*	No
Nasturtium ringspot virus	*Tropaeolum majus*	No
Onion yellow dwarf virus/potyvirus	*Allium ascalonicum, Allium cepa, Allium spp.*	Yes
Papaya ringspot (P & W) virus/potyvirus	*Carica papaya, Citrullus lanatus, Cucumis melo, Cucurbita pepo, Melothria pendula, Momordica charantia*	Yes

Virus	Susceptible Hosts (both natural and experimental hosts)	In Aus
Pea seed-borne mosaic virus/pea fizzle top virus/pea leaf roll mosaic virus/potyvirus	*Beta vulgaris, Brassica campestris ssp. Pekinensis, Brassica oleracea var. capitate, Brassica oleracea var. gemmifera, Brassica oleracea var. viridis, Capsella bursa-pastoris, Catharanthus roseus, Chenopodium album, Chenopodium amaranticolor, Chenopodium capitatum, Chenopodium foetidum, Chenopodium murale, Chenopodium quinoa, Cucurbita maxima, Gomphrena globose, Lathyrus odoratus, Lens culinaris, Medicago sativa, Petunia × hybrid, Pisum sativum, Senecio vulgaris, Tetragonia tetragonioides, Vicia faba, Vicia sativa, Vicia villosa, Zinnia elegans*	Yes
Plum pox virus/potyvirus	*Capsella bursa-pastoris, Celosia argentea Chenopodium ambrosioides, Chenopodium capitatum, Chenopodium foetidum, Chenopodium foliosum, Chenopodium murale, Chenopodium quinoa, Cyamopsis tetragonoloba, Emilia sagittata, Gomphrena globose, Humulus lupulus, Hyoscyamus niger, Lupinus albus, Lycopersicon esculentum, Melilotus albus, Melilotus officinalis, Nicandra physalodes, Nicotiana acuminate, Nicotiana benthamiana, Nicotiana bigelovii, Nicotiana clevelandii, Nicotiana debneyi, Nicotiana glutinosa, Nicotiana megalosiphon, Nicotiana occidentalis, Nicotiana rustica, Nicotiana sylvestris, Nicotiana tabacum, Petunia × hybrid, Physalis floridana, Physalis peruviana, Pisum sativum, Prunus armeniaca Prunus cerasifera, Prunus domestica, Prunus glandulosa, Prunus insititia, Prunus japonica, Prunus mahaleb, Prunus maritima, Prunus persica, Prunus salicina, Prunus sibirica, Prunus spinose, Prunus tomentosa, Ranunculus arvensis, Ranunculus sardous, Senecio vulgaris, Sesbania exaltata, Sorbus domestica, Stellaria media, Trifolium pratense, Trifolium repens, Vicia sativa, Vicia villosa, Zinnia elegans*	No
Potato leaf roll virus/polerovirus	*Datura stramonium, Physalis floridana, Solanum tuberosum, Amaranthus caudatus, Celosia argentea, Gomphrena globose, Nolana lanceolate, Capsella bursa-pastoris, Monita perfoliata*	Yes
Potato virus A?/potyvirus		Yes
Potato virus S/carlavirus	*Chenopodium album, Chenopodium amaranticolor, Chenopodium quinoa, Cyamopsis tetragonoloba, Nicotiana clevelandii, Nicotiana debneyi, Solanum rostratum, Solanum tuberosum*	Yes
Potato virus Y/potyvirus	*Capsicum annuum, Capsicum frutescens, Chenopodium amaranticolor, Chenopodium quinoa, Lycium Lycopersicon esculentum, Nicotiana glutinosa, Nicotiana tabacum, Physalis floridana, Solanum chacoense, Solanum demissum, Solanum demissum × S. tuberosum, Solanum tuberosum, Tinantia erecta*	Yes
Primula mosaic virus/potyvirus	*Primula obconica*	No
Shallot latent virus/carlavirus	*Allium ampeloprasum porosum group, Allium ascalonicum, Allium cepa, Allium sativum*	No

Virus	Susceptible Hosts (both natural and experimental hosts)	In Aus
Soybean mosaic virus/potyvirus	*Antirrhinum majus, Cassia occidentalis, Chenopodium album, Chenopodium quinoa, Crotalaria spectabilis, Cyamopsis tetragonoloba, Glycine max, Glycine soja, Glycine wightii, Lablab purpureus, Lespedeza stipulacea, Lespedeza striata, Lupinus albus, Macroptilium lathyroides, Macrotyloma uniflorum, Nicandra physalodes, Nicotiana benthamiana, Nicotiana tabacum, Petunia × hybrid, Phaseolus lunatus, Phaseolus vulgaris, Pisum sativum, Sesbania exaltata, Vicia faba, Vigna unguiculata, Vigna unguiculata ssp. cylindrica*	Yes
Tobacco etch virus/potyvirus	*Amaranthus caudatus, Beta vulgaris, Capsicum annuum, Capsicum frutescens, Cassia obtusifolia, Cassia tora, Celosia argentea, Chenopodium album, Chenopodium amaranticolor, Chenopodium foetidum, Chenopodium quinoa, Datura ferox, Datura metel, Datura stramonium, Gomphrena globose, Gypsophila elegans, Hyoscyamus niger, Lycopersicon esculentum, Melilotus albus, Nicandra physalodes, Nicotiana bigelovii, Nicotiana clevelandii, Nicotiana glutinosa, Nicotiana rustica, Nicotiana sylvestris, Nicotiana tabacum, Nicotiana × edwardsonii, Petunia × hybrid, Physalis floridana, Physalis peruviana, Senecio vulgaris, Solanum melongena, Solanum nigrum, Solanum tuberosum, Tetragonia tetragonioides, Torenia fournieri, Zinnia elegans*	No
Tulip breaking virus/potyvirus	*Calochortus, Fritillaria pudica, Lilium (cvs Concorde, Sterling Star), Lilium formosanum, Lilium longiflorum Ornithogalum thyrsoides, Tulipa, Tulipa hybrids, Zigadenus fremontii*	No
Turnip mosaic virus/potyvirus	*Alliaria petiolate, Brassica nigra, Capsella bursa-pastoris, Hesperis matronalis, Stellaria media, Trifolium hybridum*	Yes
Watermelon mosaic virus/potyvirus	*Citrullus lanatus, Cucumis melo, Cucumis sativus, Cucurbita pepo*	Yes

[1] Only known to be vectored by *Aphis fabae* ssp. *solanella.*