Nursery levy at work: **Building resilience and biosecurity capacity**

Gall producing insects

Background

The most common gall inducing insect groups in Australia include aphids, midge flies and gall wasps. There are a variety of other groups that also sometimes produce galls, in particular thrips (Order Thysanoptera), psyllids (family Psyllidae) and scale insects. However there are also some moths, sawflies, beetles, whiteflies and other insects that may occasionally produce galls. Some galls are produced by other organisms, most notably erinose mites and some fungal pathogens. The most common groups of gall-inducing insects will be discussed in this factsheet, including some examples of the types of galls they may produce. Non-insect gall-inducing organisms are not covered in this factsheet, however, erinose mites and examples of the galls they produce are covered in the mite pest management plan available at the NGIA website.

There are about 13,000 known species of insects that produce galls on plants around the world. Gall -inducing insects tend to be specialist plant feeders, only feeding on one, or a small number of closely related host plant species. The interaction between the host plant and gall-inducing insect is very complex. Each species produces a very specific type of gall, which can sometimes be used to identify the causal insect. However, sometimes more than one species can produce galls of similar appearance on the same plant.

The gall is a by-product of insect feeding, caused when the feeding insect injects saliva into the plant that contains particular chemicals or hormones. This causes the plant to change its normal growth habit; i.e. the plant grows the gall as a consequence of insect feeding, not because of the damage caused by feeding itself. Galls may increase in size as the insect develops. Galls are often ornate and could even be described as beautiful in certain cases. In other cases, galls can cause a great deal of damage and the plant may not be saleable as a result of feeding from very few individuals.

Fig. 1. Severe damage from the cordyline gall midge fly and larvae in galls underneath the leaf sheath (insert)

Gall midge flies (family Cecidomyiidae)

Gall midge flies are small, delicate flies that are similar in appearance to fungus gnats. Their bodies

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are generally only 2-3mm long, have relatively long antennae and hairy legs (if observed under a microscope). Adults do not feed. Eggs are laid in plant tissue and the resulting larvae are tiny (<1mm). They begin feeding and immediately start to change the growth structure of the plant tissue. Larvae are often orange in colour, but may also be yellow or cream. As larvae develop they will grow to no more than about 5mm in length, depending on their age and the exact species, but are often only 2-3mm long. Larvae either pupate on the plant in their gall, on the soil surface or under the soil a short distance. Larvae of certain genera can jump 10-15cm by flicking their body when searching for a place to pupate. Pupation in the soil versus on the plant has management implications. Adults will often emerge after 7-14 days.

Different gall midge flies will be active at different times of the year. Many species only have one or two generations per year, normally over summer. Other species will have a number of generations between spring and autumn, but may not be active over winter. Some species will remain active all year round in tropical regions or in protected cropping environment.

Galls range in appearance from relatively large ovoid growths to ornate projections or small non-descript, circular galls. Some species from this family may feed on plants but not produce galls, other species are predators or feed on fungi.

Gall midge fly larvae are extremely difficult to manage with insecticides. In addition to being encased within plant structures, they are naturally resistant to most pesticides. Effective long term control relies on breaking the lifecycle of pest species found in production nurseries. Refer to the management section below for more information.

Gall wasps (various families, e.g. Cynipidae, Eurytomidae and others)

Gall wasps are small insects generally between 2-8mm in length. They are often dark in colour with a constriction forming a 'waist' in the abdomen. The abdomen beyond the constriction is typical bulbous in shaped, but some species may be very difficult to distinguish from parasitic wasps. There are perhaps thousands of species of gall wasps known worldwide. Each wasp tends to be specific to a small number of plant species or closely related genera. The citrus gall wasp, *Bruchophagus fellis*) is probably the most widespread and important species affecting the production nursery industry. Many common native plants may be affected by gall wasps, e.g. *Eucalyptus* spp., *Banksia* spp., *Acacia* spp., etc.

Citrus gall wasps lay their eggs in plant stems, larvae develop and cause the stems to enlarge. Severe infestations can cause plants to have greatly reduced foliage, fruit load and significant plant

Fig. 2. Damage resulting from dianella gall midge fly (above) and a close up of their larvae under the leaf sheath (insert); Erythrina gall wasp (an exotic species) exit holes (middle - photo by Albert Mayfield, USDA Forest Service, Bugwood.org); severe leaf curl galls caused by aphids on *Abelia* (below).

dieback. While all citrus can act as a host, some species are more susceptible than others.

Some gall wasp species may lay eggs into leaves or flowers and, like other galling insects, the shape and colour of the gall produced is characteristic of the species and may assist in accurate identification. Larvae living within the galls are maggot-like, often cream in colour and legless but with chewing mouthparts.

Gall wasps are attacked by a range of parasitic wasps that lay eggs on the gall wasps, ultimately killing them. Gall wasps on native plants are more likely to have parasitoids.

Thrips (various families in order Thysanoptera)

Thrips are relatively small, sausage-shaped insects that generally 0.5-3mm length, but sometimes up to 14mm. Details on their biology and management can be found in the thrips pest management plan, therefore the following information is in relation to their gall forming habit. World-wide there are about 300 thrips species that form galls. Most thrips that form galls cause leaves to become curled in a specific way. However, some thrips may cause hornlike projections, bubble-like growths, bladder-like projections or tumour-like galls more typical of gall wasps. Similar to other gall forming insects, thrips that form galls have a specific relationship with their host plants; only a small number of plant species are attractive to each thrips species.

Many plant species can be affected by gall forming thrips including *Acacia*, *Myoporum*, *Ficus*, *Dianella*, *Schefflera*, *Casuarina*, *Pittosporum* and many others.

Aphids (Family Aphidae)

Similar to thrips, most gall forming aphids cause leaf curl and distortion. The insects are present on the external surface of the leaf, feeding on the new growth and altering the leaf growth habit as it expands. A relatively small number of aphids produce galls similar to that made by gall midge flies and thrips; enlarged areas of various shapes within which the aphids feed and reproduce. The biology of aphids is complex and described in detail in a separate factsheet devoted to this group.

Psyllids (family Psyllidae)

Psyllids, including lerps, are small sap sucking insects, many of which produce galls. Adults resemble leafhoppers that are generally only a few millimetres (2-5mm) in length. Adults may be green, yellow, red or a pattern of brown, grey or black. Psyllids hold their wings tent-like over their abdomen similar to leafhoppers. Psyllid wings are often transparent. The head and thorax of psyllids are also relatively soft and bulbous compared to leafhoppers, which are relatively smooth and sclerotised.

Eggs are generally laid in a plants growing tips and are typically orange or yellow in colour (often bright orange). Newly hatched nymphs are less than a millimetre in length and are often a similar colour to the eggs. Relatively small nymphs are often very flat, relatively wide, and orange to yellow in colour. Larger nymphs may be less flattened and may have body shape and colouration more similar to adults.

Fig. 3. Severe damage caused by galling psyllids on *Dodonaea* spp. (above) and a close up of nymphs (below).

All nymphs produce honeydew. However, some psyllids produce honeydew in a characteristic hard white wax-like substance. It is this waxy substance that forms the covering of lerps, some of which may be gall producing, and may act to protect the insect underneath. The wax may be long and curly or even appear similar to powdery mildew. There is significant variability amongst gall forming psyllid body shape. Psyllids producing cup shaped galls (e.g. in *Syzygium*) have bodies that extends into the cup, but the back of the insect is flat and contiguous with the leaf surface.

Management

Production nurseries tend to provide ideal environments for the development of gall forming species. Plants are often actively growing for relatively long periods of time and produce soft, lush growth. Gall forming species often lay their eggs (nymphs in the case of aphids) on new, unexpanded developing foliage. As a result a small number of individual insects can infest the growing tip and cause damage that makes plants unsaleable within 1-2 weeks. Detecting these initial pest populations is often difficult and relies on careful, regular plant inspections. Such inspection may not be cost effective unless targeted appropriately during the critical stages in the lifecycle of both the pest and plant.

Correct identification of gall forming pests is essential to effective management. Many gall forming pests are only reproductively active during discrete periods of the growing season. This allows a plant managers the opportunity to protect new growth during these high risk times. This can be achieved by growing plants in an insect proof structure or by using pesticides. Gall forming pests that are present throughout much of the year may be more difficult to control, particularly if they are very cryptic in nature.

Most gall forming insects are specific to a small group of plant species. Assess plant species and varieties available and consider their susceptibility or resistance to key pests, e.g. psyllid resistant varieties of *Syzygium* are readily available. Consider only growing resistant or tolerant varieties. If gall damage is attractive on a native plant then it can be marketed as such and moderate damage may be tolerated. If minor damage can be sustained, conserve natural enemies that can sometimes become very abundant in production nurseries and assist in reducing pest populations.

Once plant damage has occurred, it will remain on or in the plant unless pruned. Once damaged foliage is removed it must be disposed of hygienically. Insects may still be present within galls and may emerge and fly back into the crop. Plant material should be disposed of carefully in a manner that causes the death of any pest insects present. The exact method may vary with the pest. Bagging plant material and leaving it in the sun for an hour or two on a hot day may be sufficient for some situations. Pasteurisation or physical removal of infested plant material from the nursery (preferably deep buried) are other options. Keep in mind that some species may pupate in the soil, e.g. some gall midge flies and thrips. Therefore reinfestation may occur if suitable plant material is available and regular pesticide application may be necessary for a period of time. In some cases it may be necessary to remove all host plants to break the lifecycle in the nursery.

Refer to infopest or the APVMA or product registrations and minor use permits. There is also a webinar available on the NGIA YouTube channel on how to use these sites effectively. For those groups that are resistant to pesticides, e.g. gall midge flies, management must rely on growing plants that are resistant or tolerant and excluding the pest from the nursery. This may be possible if the plant is grown during a period of the year for which the pest is not active.

Native gall forming species

There are a surprising number of insects that are native to Australia and have not yet been described, i.e. they have not been given a species name. This can readily occur when native plants are initially only first cultivated in a production nursery environment. It can also occur on native plants that have been cultivated for a long time, but for which the pest has not been identified. Alternatively, it may only be an occasional pest, but if there is a very good season for the pest it may become a larger problem locally. If infested plants are then sent to regions in which it was not previously present (and are climatically suitable), the problem can then become more widespread. Sometimes specialist taxonomists are aware that there is an undescribed species on a plant because of the unique gall formed. If sufficient numbers of individuals are unable to be collected, formal description may not be possible.

There are also a number of very serious exotic pests that form galls on introduced plants, e.g. citrus psyllids. **If you see anything unusual call the Exotic Plant Hotline on 1800 084 881.**

This document was written by Andrew Manners (Agri-science Queensland, Department of Agriculture and Fisheries, Ecosciences Precinct, GPO Box 267, Brisbane QLD 4001) as part of NY15002 Building the resilience and on-farm biosecurity capacity of the Australian production nursery industry in 2016. Thanks go to David Carey and John Duff for helpful comments on previous versions of this factsheet. Photographs in this factsheet have been taken by DAF staff unless otherwise acknowledged.

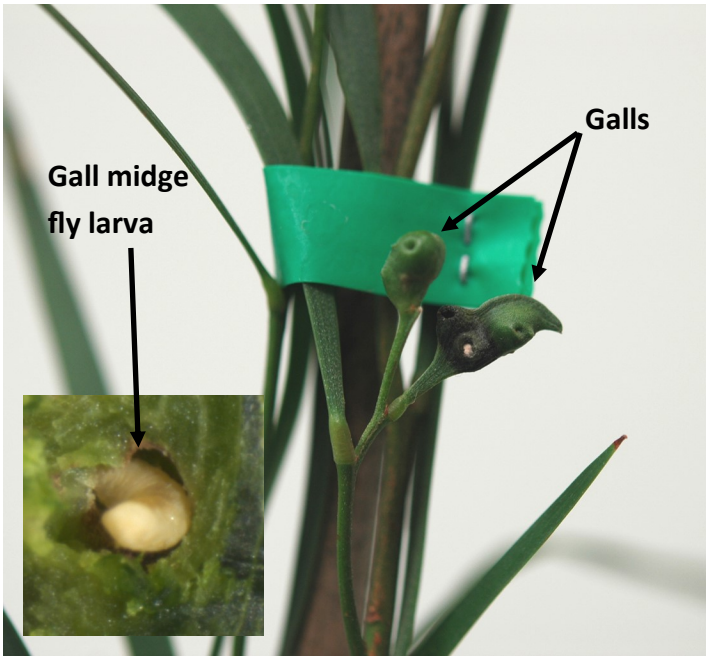

Fig. 4. A gall midge fly in brigalow (*Acacia harpophylla*) is probably undescribed.