



Mistletoe is a parasitic plant that is becoming an issue in macadamia orchards, especially in the NSW Northern Rivers, and in the Gympie, Bundaberg and Rockhampton regions in Queensland. Given its relatively recent emergence as a pest, there has been little research into mistletoe and how to manage it in macadamias. A recently finalised Hort Innovation project sheds some light.

A first step towards understanding mistletoe was taken in late 2018 through Hort Innovation project (MC18001) *Reconnaissance and recommendations for mistletoe management in macadamia orchards*. The project identified some of the key features of mistletoe, including growth habit and how it is spread, and collated grower experiences on management options. This project was led by mistletoe expert Professor Dave Watson.

While the impact of mistletoe on tree growth and production hasn't been formally quantified, the report acknowledged that there is much anecdotal evidence from growers about its ability to spread and its negative effects on tree health and yield. This is consistent with the experience of growers of other tree crops such as pecans.

REGULAR MONITORING IMPORTANT

Mistletoe, which is a native of Australia, cannot be eradicated from orchards so routine monitoring and management are vital, preferably as part of an orchard-wide or area-wide integrated pest management (IPM) program.

So far, the most effective means of management has been pruning mistletoes from infected macadamia branches.



A 14-year-old macadamia tree with an established mistletoe infection emerging from the centre of the canopy. Infected branches were pruned off 7 months earlier, but the mistletoes resprouted. Photo: David M Watson.

About mistletoe

There are 92 varieties of the parasitic plant that are native to Australia, with each region having a few dominant varieties. Based on grower feedback and orchard surveys, those causing issues in macadamia orchards are:

- in Rockhampton, smooth or orange mistletoe (*Dendrophthoe glabrecens*)
- in Bundaberg, long-flowered mistletoe (*D. vitellina*)
- in Gympie, erect mistletoe (*Amyema congener*)
- in the Northern Rivers, shiny-leaved mistletoe (*Benthamina alyxifolia*).



Smooth mistletoe, which features flowers arranged around a central stalk. This is the dominant species infecting macadamias in the Rockhampton region. Photo: Bill Higham.



Long-flowered mistletoe is the most abundant mistletoe in orchards in the Bundaberg region. Photo: Tony Rodd.



Erect mistletoe is a shrubby species that forms a simple attachment to hosts and is a frequent parasite of macadamias in the Gympie region. Photo: Murray Fagg.



Shiny-leaved mistletoe, endemic to rainforests of eastern Australia, is the main species affecting macadamias in the Northern Rivers. Photo: Black Diamond.

Mistletoe survives by using water and nutrients that would otherwise be used for tree health and nut production. Left unchecked, the plant saps the vigour of the tree and affects nut yield.

How they spread

The culprit most responsible for the spread of mistletoe is the aptly named mistletoebird (*Dicaeum hirundinaceum*). Mistletoebirds eat the berries and excrete the sticky, undigested seeds when perching. The seeds become attached to branches leading to the growth of mistletoe plants. Brown honeyeaters, figbirds, common koels and other fruit-eating songbirds also spread the seeds.

The mistletoebird prefers to eat mistletoe seeds and, because of this, is the most likely cause of plants spreading in existing infections. The other bird species may be more important in establishing infestations in new locations.

When the seeds are deposited by birds in a favourable environment, i.e. a humid or damp site that has enough light for the seed to germinate, a germinating stem (called a hypocotyl) emerges and penetrates the macadamia tree's vascular tissue. Once it is attached to the host plant's vascular system, it begins to use nutrients and grow.

A feature of mistletoes, other than erect mistletoe, is that root-like runners grow along the macadamia stem from the initial attachment point (the haustorium) and form new attachment points (epicortical runners). This means that if only the leaf-bearing shoots are removed, plants can resprout from any one of these points.



The mistletoebird is the key species involved in spreading mistletoe.



The haustorium is the initial attachment point of mistletoe to the macadamia tree branch. It penetrates the tree's vascular tissue and grows by accessing its nutrients and water supplies.

Managing mistletoe in the orchard

The experiences of growers combined with our knowledge of mistletoe biology show that there are strategies growers can apply to manage mistletoe in the orchard. These are based on integrated pest management principles, i.e. monitor regularly to detect infections and reinfections, remove existing mistletoes, adjust canopy management to reduce susceptibility and decrease likelihood of reinfection, and work with natural enemies to reduce mistletoe vigour.

#1 Monitor. It is crucial to regularly monitor the orchard for signs of mistletoe as part of your orchard-wide or, preferably, area-wide integrated pest management strategy. Regular monitoring will enable you to identify young infestations before they become a widespread problem. There are two ways to do this:

- Having orchard workers flag (digitally or physically) where they find an infestation that can be followed up by a removal team once a threshold is reached.
- Using a drone to detect infestations from above. Mistletoe are easily detected in tree canopies using infrared imagery.

#2 Remove. While it is labour intensive, physically removing mistletoes by pruning infected branches is currently the most effective way of controlling them in the orchard. With the species that have epicortical runners, it is essential that the runners be removed too. While one option is to remove the whole branch, growers report that another option is to remove the infected branch below the initial attachment point (the haustorium) and cut into the macadamia bark at the site of each attachment and strip away the mistletoe vascular tissue.

Removal needs to be thorough, regular and coordinated. This will involve accessing canopies to remove mistletoe foliage and then following up to remove any new growth, particularly from epicortical runners.

#3 Chip and compost or mulch. After they are removed, it is best to chip and compost plants and branches or chip them in the orchard and spread them under trees as mistletoe contains good levels of nutrients.

Predisposing factors to infection

The report identifies some factors that could predispose macadamias to mistletoe infection. These are as follows.

- **Water status.** Because mistletoe derive much of their water from the host plant, they are very sensitive to water stress the host may suffer. Research on other species has shown that trees with more reliable access to moisture are more likely to allow mistletoe to grow to maturity. This means it could be possible to manipulate the growth of mistletoe in irrigated orchards by pausing irrigation schedules. This has not been researched in macadamia.
- **Nutrients.** As a parasitic plant, mistletoes rely on the host plant for all their nutrient needs. Research has shown that they prefer hosts with more nutrients, opening the possibility of manipulating fertiliser strategies to manage growth. This has not been researched in macadamia.
- **Canopy preference.** Mistletoe seeds are more likely to germinate in trees with more open canopies. Current canopy management strategies could therefore favour mistletoes as growers are encouraged to prune inner branches to open the tree to more light. It also means that some more open-canopied varieties are more likely to become infested. There may be other reasons why some varieties become infested more readily than others. In Bundaberg, 816 and A16 are the varieties most likely to become infested first.
- **Location in the row.** Trees growing at the end of rows are more susceptible to mistletoe infection. This is partly explained by bird foraging behaviour, which shows that birds are more likely to visit these trees and thus deposit more seeds in them.
- **Proximity to mistletoe in bushland.** Macadamia trees near bushland that is heavily infested with the species of mistletoe which affect macadamias are more likely to become infested.

For the future

No chemicals are registered to control mistletoe in macadamias, although it is an area that could be researched as part of an IPM program. As the stomata on mistletoe don't close and are always open, spraying with Ethrel or other such dessicants on a hot day has been found to burn the mistletoe without severe burning of the tree.

Because mistletoes support their own unique range of insects, research into biological control and IPM is an option.

While other approaches to control such as flame throwers, controlled burning and plant breeding for mistletoe resistance have been trialled (mostly in the USA) none have shown potential for control in macadamias.

Facts about mistletoe and mistletoebirds

- Research has shown the movement and breeding activity of mistletoebirds is determined mainly by mistletoe availability.
- Mistletoe seeds can move very quickly through the gut of a mistletoebird, i.e. average gut retention time is 14 minutes
- All native birds, including mistletoebirds, are protected by legislation in both Queensland and New South Wales.
- Mammals and insects are the natural enemies of mistletoes. Research in eucalypts has shown that common brushtail and common ringtail possums prefer mistletoe foliage, and mistletoes support their own unique range of insects. Many of these insects specialise in the plant, e.g. the larvae of butterflies such as jezebels (Pieridae) and azures (Lycaenidae) feed exclusively on mistletoe.

Information



The project Reconnaissance and recommendations for mistletoe management in macadamia orchards has been funded by Hort Innovation, using the macadamia research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

You can download the final report from the Hort Innovation website www.horticulture.com.au



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