Scale insect and mealybug pests - applying new technologies to long-standing problems

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Until recently, scale insects have not been considered a widespread problem in Australian vineyards. Knowledge about their biology and ecology in vineyards has, therefore, been somewhat limited. With the growing interest in these insects, AWRI researchers recently applied metagenomics to identify the species of scale and mealybug present in South Australian vineyards.

BACKGROUND

Scale insects and mealybugs are sap-sucking pests that draw nutrients from plants and excrete honeydew, a sugary liquid that encourages the growth of sooty mould. These insects are common in Australian vineyards but do not cause significant damage when populations are small. In some cases, however, the population can reach a level where intervention is required to avoid fruit being downgraded or rejected by a winery. Scale and mealybug also act as vectors of grapevine viruses (Hommay *et al*. 2008, Fuchs *et al*. 2009, Bahder *et al*. 2013). In the past, scale insects have not been considered a widespread problem in Australian viticulture, so knowledge about their biology and ecology in vineyards has been somewhat limited. That has changed in recent years as interest in these insects has increased. AWRI researchers have recently applied the technique of metagenomics to identify the species of scale and mealybug present in South Australian vineyards.

DIFFERENT SPECIES, DIFFERENT CONTROL MEASURES

Different species of scale and mealybug are known to have different life cycles, for example, some have just one generation of offspring each year while others can have multiple generations per year. These differences can have a major impact on how effective control measures are and when they should be applied. For example, for species that have a single generation per year, one appropriately timed insecticide application early in the growing season can be very effective as this targets the juvenile crawler stage, which is the only life stage that can be controlled with non-systemic insecticides. Taking the same action for a species that has multiple generations of offspring each year would be much less effective as there are likely to be insects at different growth stages in a vineyard throughout the year.

PREVIOUS KNOWLEDGE OF SPECIES IN AUSTRALIAN VINEYARDS

Identification of scale and mealybug insects in the vineyard can be challenging as different species can appear visually very similar. Historically, the main scale insects thought to have been present in Australian vineyards have been grapevine scale (*Parthenolecanium persicae*) and frosted scale (*Parthenolecanium pruinosum*), both of which generally have a single generation per year and overwinter under bark. Frosted scale derives its name from the white waxy covering that females excrete, which appears as patches of white 'frost' on the surface of infested vines. This is used as the main distinguishing feature in the vineyard; however, variability between individuals can result in differing levels of 'frost' being produced, making it difficult to distinguish this species from grapevine scale in some conditions.

A visual taxonomic survey of scale insect pests carried out between 2005 and 2008 (Rakimov *et al*. 2013) found that the majority of vineyards across Australia were affected by either grapevine scale or frosted scale, with other scale insects such as long brown scale (*Coccus longulus*), soft brown scale (*Coccus hesperidum*) and black scale (*Parasaissetia nigra*) infrequently found on vines in South Australia, New South Wales and Victoria. In addition to taxonomic assessment, the 2008 survey also sequenced DNA from each scale insect to accompany the visual species assignment. However, due to technological limitations of the time, only a single small region (called a 'DNA barcode') was assessed, which provided limited genetic information on the identity of the insects. While this confirmed species assignments for nearly all the isolated scale insects, two specimens collected from Gumeracha, South Australia, exhibited unusual visual and behavioural characteristics, in addition to a varied DNA barcode that suggested that they may not represent the accepted typical species.

IN BRIEF

- **In vineyards, scale insects and mealybugs produce sugar-rich honeydew as a by-product of feeding, leading to the growth of unsightly sooty mould on grapes.**
- **Different species of scale and mealybugs may have different life cycles and therefore require different control measures, but are difficult to distinguish visually.**
- **A pilot study demonstrated that metagenomics could be used to identify species of scale and mealybug in South Australian vineyards.**
- ***Parthenolecanium corni* (European plum scale), a species previously thought not to be a pest in Australian vineyards, was the only scale species identified in the eight vineyards sampled.**
- **This finding has implications for control strategies for these pests as this species can have multiple generations of offspring in a single year.**

NEW KNOWLEDGE FROM METAGENOMICS

A team of AWRI scientists conducted a study using metagenomics to identify the species of scale and mealybug in eight South Australian vineyards (Ward *et al*. 2023). This approach sequenced all the genetic information within mixed samples of insects that were taken from across the vine. This allowed millions of unbiased fingerprints of all species present within each sample to be collected.

European plum scale

Surprisingly, given the previous understanding of scale insect species in Australian vineyards, the European plum scale (*Parthenolecanium corni*) was the only scale insect detected on vines from the sampled sites, with this species detected in McLaren Vale, Barossa Valley, Langhorne Creek and the Adelaide Hills. While previously identified in Australia in 1976, this species was not thought to be of economic concern as a pest in Australian vineyards, despite the fact that it is a recognised pest of grapevines in other countries. Importantly, this species is known to produce multiple overlapping generations per year, have rapid developmental times and a high capacity as a virus vector (Danzig 1997, Fuchs *et al*. 2009, Comacho and Chong 2015). However, visually, European plum scale is difficult to distinguish from the other two major grapevine scale pests (grapevine scale and frosted scale) commonly found in Australian vines, especially in the field.

This finding potentially provides context to recent grower observations of harder-to-control scale infestations and that scale with multiple generations per year and rapid developmental times have been present on their vines. Although only one scale insect species was found, obscure and long tailed mealybugs were also recorded with the European plum scale detections at sites in McLaren Vale and Langhorne Creek.

LOOKING BACK AT THE DNA SAMPLES FROM 2008

A comparison of DNA fingerprints to a curated database of 'barcodes' that included those from the 2008 survey revealed that the genetics of the two unusual scale insects from Gumeracha, South Australia, could also be matched to the European plum scale. This suggests that this species could have been present, but not identified, in South Australian vineyards for at least 15 years. This evasion of detection on Australian vines is likely due to the visual similarity of European plum scale to both grapevine and frosted scale at the macroscopic and microscopic levels, as variability between European plum scale leads to some individuals producing a waxy coating that was thought to only be present on frosted scale. Comparing observations in 2008 to those carried out by the AWRI in 2022, it appears that European plum scale may have significantly increased its incidence within South Australian vineyards. This could be due to its shorter developmental time, allowing European plum scale to evade control strategies that were designed for the single-generation per year grapevine and frosted scale species. By evading control, European plum scale then benefits from reduced competition, reduced predation due to insecticide application and is left to proliferate largely uncontrolled throughout the rest of the growing season.

WHAT ABOUT BENEFICIALS?

Evidence for beneficial insects preying on European plum scale was also observed in the metagenomics study. This included two species of parasitoid wasps, one of which (*Coccophagus scutellaris)* is known to be a common beneficial whose larvae prey on many different scale insect species. However, the Barossa Valley was the only region that had detectable levels of this parasitoid, although a single site in Langhorne Creek also showed evidence of predation from a second, yet to be formally identified, parasitoid wasp species.

FUTURE APPLICATIONS OF THIS WORK

Metagenomics is a powerful tool to gain an unbiased understanding of what pest species are present in vineyards and if they are actively being targeted by beneficial insects. Holistic approaches such as this also have the ability to identify pathogenic fungal or bacterial species whose growth is promoted by scale insect and mealybug infestation. Looking towards the future, understanding which scale and mealybug insect pests are present within vineyards is an important factor for planning appropriate control strategies. Given the small sample size of the current study, broader surveys are needed across Australia's wine and table grape regions to determine if European plum scale is the major scale species in vineyards outside of South Australia. This research shows that we as an industry can benefit greatly when we adopt new technologies, such as metagenomics, to understand the issues that face viticulture in an ever-changing environment.

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