PLANT AND SOIL NEMATODES

NEMATODE PESTS OF GRAPEVINES IN AUSTRALIA

Fifty years ago, plant-parasitic nematodes were markedly reducing the yield of grapevines in several viticultural regions of Australia This fact sheet explains how that problem was overcome and then outlines the research needed to minimise future losses from nematode pests.

The Australian grape and wine industry

Most of Australia's viticulture is located in ten major grape-growing regions. The dominant production zones are the inland irrigation areas of the Murray-Darling basin, with most of the remaining production being scattered in numerous locations across the southern half of the country. About 90% of the grapes are used for wine, with the remainder dried or sold as table grapes.

Plant-parasitic nematodes: distribution and economic importance

Root-knot nematode (primarily *Meloidogyne javanica* but also *M. incognita* and *M. arenaria*), is the most damaging nematode pest of grapevines in Australia. Yield losses of 20-40% often occur when own-rooted grapevines are grown in the sandy and sandy loam soils of the Sunraysia region of Victoria and NSW; the Riverland, Barossa Valley, central and south-east districts of South Australia; the Granite Belt region of Queensland; and most viticultural regions in Western Australia.

Citrus nematode (*Tylenchulus semipenetrans*), an important pest of both citrus and grapevines, is widespread in the Murray-Darling basin and some other regions where citrus is grown. Root-knot and citrus nematodes often co-exist in these regions and collectively they cause major losses on grapes. However, in situations where *T. semipenetrans* is the dominant plant parasite, yield increases of 10-30% have been obtained with nematicides.

Fourteen species of root-lesion nematode (*Pratylenchus* spp.) have been recorded in Australian vineyards. *P. jordanensis* (now considered a junior synonym *P. zeae*) is the most widely distributed *Pratylenchus* species in South Australia and it is pathogenic to grapes. However, the relative importance of other relatively common species (*P. vulnus*, *P. coffeae*, *P. neglectus* and *P. crenatus*) is not known. Given the relatively high populations observed in some vineyards and their widespread distribution across all soil types, including soils with high clay contents, root-lesion nematodes are likely to be a significant factor limiting grape production.

Ectoparasitic nematodes are also commonly found in vineyards, with the most widespread being dagger nematodes (*Xiphinema americanum* and X. *index*), ring nematodes (*Mesocriconema* and *Criconemella* spp.), and stubby root nematodes (*Paratrichodorus* spp.). These genera certainly cause some damage to root systems but their economic importance is not known, as research has focused on the endoparasites discussed above.

Although nematodes have the capacity to damage the roots of grapevine, they can also cause crop losses by interacting with other root pathogens. For example, *Xiphinema index* is a vector of grape fan leaf virus, while root-knot and root-lesion nematodes appear to be a component of root disease complexes involving *Pythium* and fungal pathogens such as *Rhizoctonia solani* and *Fusarium oxysporum*.

Nematode management practices

<u>Hot water treatment</u>

Grape rootlings are often grown in soil that is infested with plant-parasitic nematodes rather than in sterilised potting media, and so root-knot and root-lesion nematodes are often found in the roots of the planting material that is produced. Hot water treatment (48°C for 20 minutes) is commonly used to eliminate the nematodes but several studies have shown that it is not always completely effective.

<u>Nematicides</u>

Although nematicides have been used to demonstrate that plant-parasitic nematodes are important pests of grapevines, they have never been widely used as a nematode control tactic. Fumigants such as 1, 3 - dichloropropene are expensive and eliminate beneficial soil organisms as well as pests, while non-volatile nematicides are ineffective in non-irrigated situations, provide only temporary control, and sometimes fail due to enhanced biodegradation.

<u>Nematode-resistant rootstocks</u>

Rootstocks with resistance to plant-parasitic nematodes (particularly *Meloidogyne* spp.) were introduced into Australia in the 1960s and are now the primary means of reducing losses from nematodes. However, 70-80% of current wine grape plantings in most areas are on their own roots. Rootstocks are mainly used in situations where root-knot nematodes commonly cause heavy losses (e.g. sandy and sandy loam soils that have a clay content <15%). In 1989 and 1990, two rootstocks that are highly resistant to root-knot nematode (Ramsey and Schwartzman) comprised 75% of the rootstock sales in Victoria and South Australia. Although the predominant rootstocks changed in the next 20 years, Ramsey was still the most widely used rootstock in 2007 and 2008, but other highly resistant rootstocks (101-14 and 140 Ruggeri) were also being used (Walker and Clingeleffer, 2009).

When the grape industry began using nematode-resistant rootstocks, it was soon recognised that rootstocks affected vine performance and wine quality in many ways. For example, vines on the relatively vigorous Ramsey rootstock had a deeper root system and this provided some drought tolerance. However, the scions produced much more aboveground biomass than own-rooted vines and this had undesirable effects on wine quality. Consequently, many factors are now considered when rootstocks are being selected. Rootstocks play a vital role in overcoming root-knot nematode problems but are also used to counteract a range of soil and environmental constraints (Table 1).

Table 1. Properties of some commonly used rootstocks (from White and Krstic, 2019)

Rootstock	**Resistance to root-knot nematode**	**Relative vigour**	**Lime tolerance**	**Salinity tolerance**	**Drought tolerance**	**Soil acidity tolerance**
Ramsey	High	High	Medium	Susceptible	Mod. susceptible	Poor
Schwartzmann	High	Low-medium	Medium	Mod. tolerant	Susceptible	Poor
101-14	High	Low	Medium	Mod. tolerant	Susceptible	Poor
140 Ruggeri	High	Medium-high	High	Mod. tolerant	Highly tolerant	High
5BB Kober	High	Medium-high	High	Mod. susceptible	Mod. susceptible	Poor
1103 Paulsen	Medium-high	Medium-high	High	Mod. tolerant	Tolerant	Medium
99 Richter	Medium-high	Medium-high	High	Mod. tolerant	Tolerant	Poor
SO4	Medium-high	Medium	High	Mod. susceptible	Mod. Susceptible	Poor
110 Richter	Medium	Medium	High	Mod. susceptible	Tolerant	Medium
5C Teleki	Medium	Medium	High	Mod. susceptible	Mod. susceptible	Poor
420A	Medium	Low	High	Susceptible	Susceptible	Poor
3309C	Low	Low	Medium	Susceptible	Susceptible	Poor

Future research on nematodes

The introduction of nematode-resistant rootstocks overcame the chronic nematode problems that were often seen on grapes in the 1960s and 70s. However, the success of these rootstocks has caused the Australian grape industry to become complacent about the role of nematodes in causing root disease problems. Grapes are now grown in many areas where nematological research has never been undertaken, and so nematodes are probably causing losses that are not being recognised. Thus, a comprehensive nematode research program such as the one outlined by Walker and Stirling (2008) is required. Some of the most important areas for future research are discussed below.

- When a nematode-resistant rootstock is grown for many years, resistance-breaking biotypes of the nematode will invariably develop. One such example has already been detected in Australia, as an aggressive pathotype of root-knot nematode (designated *M. javanica* pt 1103P) was found causing unthrifty growth on 1103 Paulsen rootstock in a vineyard at McLaren Vale, South Australia (Smith et al. 2016). This observation indicates that the grape industry needs to be continually alert to the possibility of new nematode pathotypes developing. The industry must also maintain a rootstock breeding program that aims to provide durable resistance against all the root-knot nematode species and pathotypes that occur in Australian vineyards.

- Resistance to root-knot nematode has been the focus of rootstock breeding and selection programs in Australia, but resistance to this nematode does not guarantee resistance to other important plant-parasitic nematodes such as root-lesion nematode and citrus nematode. Root-lesion nematode is likely to be causing damage in soils where the clay content is too high for root-knot nematode and so research is required to identify the species present in these soils, assess their population densities, and determine whether the key species are pathogenic to grapevines. Rootstocks with resistance or tolerance to the pathogenic species must then be found.
- Studies in the USA have shown that ring nematode (*Mesocriconema xenoplax*) sometimes causes yield losses of more than 30%. However, this nematode is not readily recovered by the extraction methods commonly used in Australia, and so it has been overlooked. Thus, research should be undertaken to determine whether ring nematode is causing significant damage in various viticultural regions of Australia.

Improving the health of viticultural soils and its impact on suppression of plant-parasitic nematodes

In the last two decades vignerons have increasingly recognised that constraints such as compaction, poor water infiltration, structural instability, poor drainage, propensity for soil erosion, inadequate nutrient supplies and root damage caused by soilborne pests and pathogens can be overcome by improving the biological health of the soil. Thus, practices such as minimum tillage, cover cropping, mulching, and inputs of compost, biochar, and other organic amendments are now incorporated into some viticultural production systems (White and Krstic 2019). The main benefit from these approaches is that soil organic matter levels increase and this generates a more active and diverse soil biological community that enhances nutrient mineralisation, reduces surface crusting, improves soil porosity, increases aeration, enhances water-holding capacity, facilitates root penetration, reduces loss of topsoil due to erosion, and increases the soil's suppressiveness to soilborne pests and pathogens.

From a nematode management perspective, one of the main outcomes from improving the biological health of a soil is that the regulatory services provided by soil organisms begin to operate more effectively. This means that nematode-trapping fungi, fungal egg parasites, predatory microarthropods, predatory nematodes, parasitic bacteria in the genus *Pasteuria*, and other natural enemies begin to keep pest nematode populations under control. Thus, two important components of any future soil health work in viticulture are to 1) assess the level of suppressiveness that can be achieved when various practices are integrated into a viticultural production system, and 2) understand the type of biological community that is required to maintain populations of pest nematodes at levels that do not cause significant damage.

Literature cited and further reading

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