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Influence of composted green waste on the population dynamics and dispersal of grapevine phylloxera *Daktulosphaira vitifoliae*

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Abstract

A field study was conducted, over three grapevine growing seasons, to assess the effect of composted green waste on the population dynamics and risk of dispersal of root-feeding grapevine phylloxera *Daktulosphaira vitifoliae* on ungrafted *Vitis vinifera* grapevines. An assessment was also made to determine the effect of compost application on grapevine vigour, grape yield and quality. Phylloxera crawler (first instar) emergence above-ground was significantly increased through the annual application of composted green waste. The implications of these results for phylloxera management on ungrafted grapevines are discussed.

Keywords: Grapevine; Phylloxera; Population dynamics; Quarantine; Compost; Dispersal

1. Introduction

Grapevine phylloxera is distributed in most major viticulture regions of the world with the exception of Chile (CAB International, 1998) and the Australian states of South Australia and Western Australia. In most grape-growing countries, phylloxera is managed by planting of European *Vitis vinifera* L. grapevines, which are susceptible to root-feeding phylloxera populations, grafted onto root systems of resistant rootstocks, which are hybrids of American *Vitis* spp. However, despite the relative world-wide success and usage of rootstocks, as the main phylloxera management option, the insect remains a serious threat to sustainable viticulture due to the industries reliance on a single management option. A diverse range of phylloxera genotypes can survive on some widely used rootstocks (Corrie et al., 2003; Powell, 2003) and rootstock planting material represents a higher cost to the grower. In some countries the availability of some rootstock hybrids is restricted. In California widespread plantings of the rootstock AxR#1 (Ganzin 1) succumbed to a resistant 'biotype' of phylloxera resulting in over US$ 1billion of economic loss in the 1990s (Granett et al., 2001).

In Australia, unlike most other grape-growing countries, phylloxera's geographical distribution is restricted to quarantine zones, in the southeastern states of Victoria and New South Wales, and 85% of commercial vineyard plantings are on susceptible ungrafted *V. vinifera*. Therefore quarantine is the main management option currently being used in Australia and National Phylloxera Management Protocols have been developed (NVHSC, 2003) to reduce the risk of transfer on grape products, viticultural machinery and personnel.

In recent years, there have been reports of potential breakdown in rootstock resistance to phylloxera in Europe (Porten and Huber, 2003) and the USA (Granett et al., 2001) and therefore alternative management options, including cultural management, need to be investigated. There are

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several compost formulations that could be considered for grapevine management systems including green waste from urban areas. Composted green waste consists of a mixture of urban garden waste such as prunings, weeds and lawn clippings. However, to date no studies have been conducted to determine the influence of composted green waste on grapevine phylloxera populations and related vine damage culminating in economically damaging yield reduction and, in severe cases, vine death. The study presented was designed to assess the impact of composted green waste mulch on grapevine phylloxera population dynamics, the risk of transfer of dispersive life-stages and vine health.

2. Materials and methods

The experimental site was in a commercial vineyard located 5 km east of Cheshunt (36°5′S, 146°39′E) within the King Valley Phylloxera Infested Zone (PIZ), North-East Victoria, Australia (Department of Primary Industries, 2004). Phylloxera was first detected in the vineyard in May 1997 (Richard Carson, personal communication). The phylloxera strain at the site was characterised as genotype G4 (Corrie et al., 2003). The experiments were conducted between October 2001 and June 2004 over three consecutive grapevine growing seasons. The commercial vineyard block chosen for the study consisted of 15-year old ungrafted *V. vinifera* cv. Sauvignon Blanc vines. The row spacing was 3 m and vine spacing was 1.8 m and the experimental block consisted of ten experimental rows with a single buffer row between paired experimental rows.

A soil survey was conducted in the experimental block, as described in Powell et al. (2003), and was classified as a dystrophic brown kurosol (Isbell, 1996) which demonstrated a duplex nature with a sandy clay loam A horizon overlying the higher clay content B horizons.

Rainfall and air temperature records were obtained from the Moyhu weather station located 15 km from the experimental site. Mean monthly temperatures during the 2001 and 2003 vegetative season (October–May) were 18.5 °C and were slightly higher at 19.5 °C during the 2002 season. The mean total rainfall during the vegetative season was 17 mm but varied from 15.6 to 18.9 mm.

Mature composted green waste was prepared commercially through a windrowing process by Greenchip Recycling, Barunduda, Victoria, following Australian composting standards (Anon, 2000).

The experiment was laid out in a randomised complete block with five replicates. Within each replicate (block) there were two plots, one plot for the treatment (compost) and one for the control (no compost). Plots were randomly assigned within each block. In each plot 10 adjacent vines, with 5 vines in two adjacent rows, were selected for the treatment and ten for the control. Compost was applied to the undervine soil surface to a depth of 5 cm in October of 2001, 2002 and 2003 of each growing season prior to budburst. The control plots were set up similarly to the treatment plots but compost was not applied to the soil surface. Single uncomposted buffer vine rows were placed between experimental plots and blocks. No fertiliser or pesticide application was applied to treatment, control or buffer rows within the experimental site during the trial period.

2.1. Sampling and monitoring

In each plot two central grapevines were used as 'population monitor vines', to assess above- and below-ground abundance of phylloxera life-stages. To assess phylloxera population movement above-ground two non-destructive trap types, trunk and emergence (Powell et al., 2000), were used for each monitor vine and statistical analysis covered a period of eight fortnights for each season. In season 2001–2002 the above-ground phylloxera counts were analysed from the 13th of December 2001 to the 25th of March 2002. In season 2002–2003 the phylloxera counts were analysed from the 19th of December 2002 to the 26th March 2003. In season 2003–2004, phylloxera counts were analysed from the 17th of December 2003 to the 24th of March 2004. To assess population numbers below-ground a destructive root sampling technique was used twice per growing season in winter (October) and summer (February/March).

Root populations of grapevine phylloxera were monitored at six-monthly intervals, over three successive seasons, in October and February and March. Root samples (2–8 g dry weight) were taken from a single vine adjacent to the monitor trap vine in one row of the coupled/paired design ($n = 5$). The roots were transported under quarantine conditions to a quarantine laboratory, where they were washed and examined, under a dissecting microscope, to record the number of each phylloxera life-stage. The roots were weighed to calculate wet weight, then oven-dried at 50 °C for 48 h and reweighed to determine dry weight.

The seasonal abundance of phylloxera dispersive stages (namely first instars (crawlers) and adult winged forms (alates)) emerging from below-ground onto the soil surface was measured over three successive seasons using 'emergence traps' placed adjacent to each monitor vine. Emergence traps consisted of translucent plastic containers (4 L Décor™), 22 cm diameter × 13 cm depth, open at one end, rinsed with tap water and inverted onto the soil surface at a distance of 10 cm from the sample vine trunk. Traps were fixed flush with the soil surface using metal tent pegs. On emergence from the soil phylloxera were trapped in condensation on the sides of the trap. At fortnightly intervals insects were removed by washing the trap with 70% methanol and collected in plastic containers. Traps were then rinsed with tap water and re-positioned. Collected insects were identified and quantified using a low power binocular microscope.

Phylloxera movement up and down grapevine trunks was assessed, over three successive seasons, by collecting