PFR SPTS No. 21159

Report of Plant & Food research projects conducted in the Marlborough Research Centre Tunnel House 2020–21

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1 Grape marc nitrogen mineralisation study

Output from the project:

A full report on this project was supplied to the Marlborough Research Centre Trust at the end of January 2021.

Agnew R, McNally S, Jenkins H, Wallace D, Deppe L, Tregurtha R, Gosden P. January 2021. Grape marc nitrogen mineralisation study. A Plant & Food Research report prepared for: Marlborough Research Centre Trust. Milestone No. 88279. Contract No. 37727. Job Code: P/413003/06. PFR SPTS No. 20408.

Overview of the project:

This grape marc nitrogen (N) mineralisation study was conducted in pots in the tunnel house between late-June and mid-October 2020 to determine the N supply from Sauvignon blanc grape marc. The experiment was conducted to compare the N release from two rates of grape marc (equivalent to 100 and 300 kg N/ha) and two grape marc incorporation treatments (surface applied or incorporated in the soil). A control treatment was also included, with no grape marc addition, in order to compare the N supply from the soil organic matter to the N supplied by the grape marc.

The key findings from this research project were as follows:

After the application of marc to the soil, there is a period whereby immobilisation of N within the soil N pool occurs. This is likely due to the relatively high carbon to N ratio of the grape marc (C:N=23) compared with the soil (C:N=10.3). In order for microbial activity to break down the grape marc, thereby releasing N to the soil, an amount of mineral N will be required. If the C:N ratio is too high, then this demand of N is higher, resulting in net immobilisation of N from the soil pool, as observed in this experiment.

In general, the incorporation of grape marc to soil resulted in more immobilisation of soil N in the short term compared with the surface-applied marc. Therefore, how the marc is applied may affect the N supply dynamics and should be further explored in the field.

Increasing the rate of grape marc applied from an equivalent of 100 kg N/ha to 300 kg N/ha increased the net N supply to the soil after 16 weeks. However, the proportion of N that was released from the marc over this period was similar between the two rates, particularly in the surface-applied treatments (8–10% of N released).

The immobilisation of N, observed following addition of marc to soil, will need to be carefully considered if marc is applied for the purpose of supplying N to a crop. Immobilisation of N will remove N from the plant-available pool, leading to potential N deficiencies. If the N supply is too slow (due to a period of immobilisation) then the time where N is supplied to soil may be at a period where plant uptake is slower, or at a time of year where losses due to leaching (i.e. winter/high rainfall) are greater. However, the immobilisation of N in the short term, immediately after application, may prevent losses of N during high-risk periods (e.g. winter) but the long-term nitrogen supply needs to be explored. The year-on-year dynamics of marc application also need to be explored given the yearly generation of marc material.

2 Trunk disease studies

Two studies from The New Zealand Institute for Plant and Food Research Limited (PFR) were conducted by Dion Mundy this season in the tunnel house. One study, using older vines, looked at a range of trunk diseases in mature vines and investigated the physiological responses to infection at a whole vine level. Measurements of vine leaves were conducted on naturally infected and inoculated vines to see if leaves could be used to detect disease before other symptoms were expressed. In the second PFR experiment, small cutting plants that had been surface sterilised were inoculated and grown to investigate plant response to a range of trunk disease pathogens. Results from both these PFR-funded experiments are due to be reported in September 2021 to PFR, as part of a wider project to understand the basic biology of the common grape vine trunk disease pathogens present in Marlborough.

Dion also supervised a Nelson Marlborough Institute of Technology (NMIT) student project on trunk disease. This project investigated a native New Zealand white rot fungi, which has been detected in vineyards, to see if it was pathogenic in a small model system (plants grown from cuttings). This project will not conclusively prove if the white rot fungi is a pathogen but it provides some of the ground work that will build our understanding in the area of white rots as part of the esca complex, and whether we have a unique New Zealand esca complex with a native component. The NMIT project builds on the continued research by PFR to understand the Marlborough and New Zealand context for grapevine trunk disease.

3 Understanding potential rootstock influence on soil drying (drought) responses in Sauvignon blanc – an initial pilot study

Overview of the project

This pilot study was conducted by Julian Theobald and Sue Neal. It arose following the availability of 18-month-old potted vines of mass selected (MS) Sauvignon blanc on a variety of different rootstocks (Riparia Gloire de Montpellier, Schwarzmann, 3309 Couderc, 101/14, Telek 5C, Gravesac, SO4 and 1103 Paulsen), being representative of the majority of rootstocks currently used by the New Zealand grape-wine industry. Based largely on anecdotal grower observations, these rootstocks are believed to confer different degrees of drought tolerance, with the main perceived mechanism being through variable depth of rooting. However, to date, “helpful data [scientific] on the performance of rootstocks in New Zealand is scarce or non-existent” (Hoskins, 2020). Given increasing industry concern around potential impacts of climate change and the need to conserve water and increase vine water use efficiency, further research and understanding of different rootstock performance is necessary. Thus the objectives of this initial pilot study were to:

1. Explore physiological responses of Sauvignon blanc on different rootstocks to an episode of soil drying under the semi-controlled environment conditions of the relocated Marlborough Research Centre (MRC) Plastic Tunnel House (PTH), with the added advantage of removing potential rainfall interference.
2. Given vines were established in a fixed soil rooting volume and therefore the ability for deeper rooting was restricted, observe whether different scion x rootstock combinations conferred any other soil drying/drought tolerance adaptations or advantages.
3. Develop a standardised approach to growing and managing potted vines within the PTH as a means by which scion-rootstock combinations may be ‘screened’ for beneficial traits in the future.

Forty-eight potted vines (Sauvignon blanc mass selected scion x 8 rootstock combinations x 6 replicates) were transferred to the PTH in late September 2020, and arranged in a 2x3 randomised block design across three rows orientated north to south and running the width of the tunnel house (Figure 1). Vines had previously been established in 40-L black polythene pots containing 35 L of a bark-based potting compost mix to a total depth of 280 mm. An automated drip irrigation system was established delivering 1 L per day to each vine, and controlled by Autogrow Software and solenoids installed during the MRC’s refurbishment of the PTH.

Figure 1. (Top) grafted vines established in 2x3 randomised block design (mid-October 2020); (Bottom right) pots with automated irrigation drip-lines established; and (Bottom left) measurement of leaf gas exchange (photosynthesis and water loss) on selected leaves of vines during a 2-week period of soil-drying (January 2021).

Vines were trained to three vertical shoots supported by individual bamboo canes, and to 10 leaf nodes per shoot, after which any additional leaf and lateral shoot growth was routinely removed. In January (at approximately berries pea-sized), four vines each of the MS x Ripaira Gloire and MS x 1103 Paulsen (with rootstocks anecdotally considered ‘drought sensitive’ and ‘drought tolerant’, respectively), had irrigation withheld (drippers removed), whilst two control vines of each combination continued to receive daily irrigation. Volumetric soil water content was measured routinely in each pot at a depth of 120 mm and 220 mm below the surface, using a Greenlight-Redlight Soil Moisture Reader (Dataflow Systems, Christchurch, NZ). Leaf gas exchange (photosynthesis, transpiration, stomatal conductance) were routinely measured at leaf node 8 of shoot 2, using a portable infra-red gas analyser (CIRAS 2, PP Systems, Amesbury, USA) and leaf cuvette (PP Systems, LCA2) enclosing a leaf area of 250 mm^2. Following the approximate 2-week soil drying deficit irrigation (DI) period, all vines were returned to a fully irrigated or well-watered (WW) situation. In early February, leaves were individually detached, and leaf area measured using a transparent belt leaf area meter (LI-3100C, LI-COR Biosciences, Nebraska, USA).

The key findings from this initial pilot study were as follows:

Following an initial saturation of all pots with water at experimental day 0, volumetric soil water content between well-watered (WW) control treatment and soil-drying deficit irrigated (DI) treatment vines started to diverge after 2 days, WW treatments stabilising at approximately 50% volumetric soil water content and DI treatments steadily drying to 20% volumetric soil water by experimental day 17 (Figure 2, A). There was no apparent rootstock effect on volumetric soil water content.

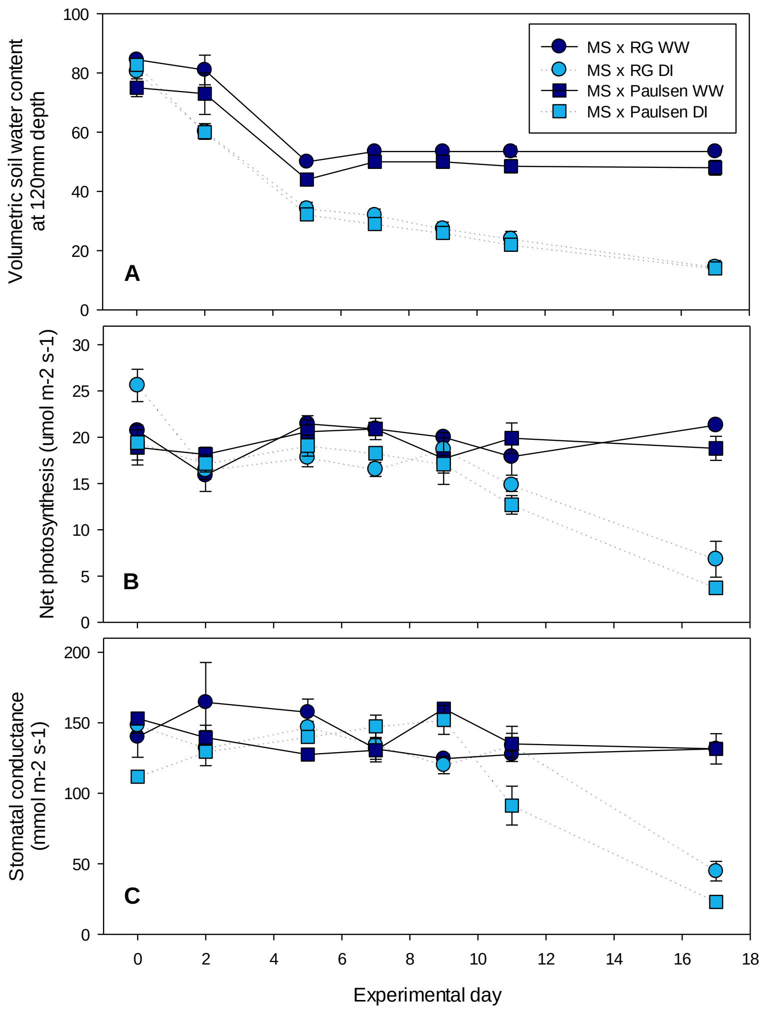

Figure 2. Response of MS Sauvignon blanc x Riparia Gloire de Montpellier (RG) and MS Sauvignon blanc x 1103 Paulsen potted vines to 17 days of well-watered (WW) or deficit irrigation (DI) treatments, with monitoring of volumetric soil water content (A), leaf net photosynthesis (B) and stomatal conductance (C). Full treatments as indicated in the key. Bars = 1 x standard error. WW n=2, DI n=4.

Despite the divergence in soil volumetric soil water content after day 2, rates of net photosynthesis were stable and did not differ between treatments until after day 9 (Figure 2, B). Thereafter, rates of net photosynthesis declined in DI treatments relative to WW, the decline being greatest in the MS x 1103 Paulsen DI treatment. Stomatal conductance (Figure 2, C) followed a similar pattern of response, with the MS x 1103 Paulsen DI treatment also showing the greatest decrease in conductance from day 11.

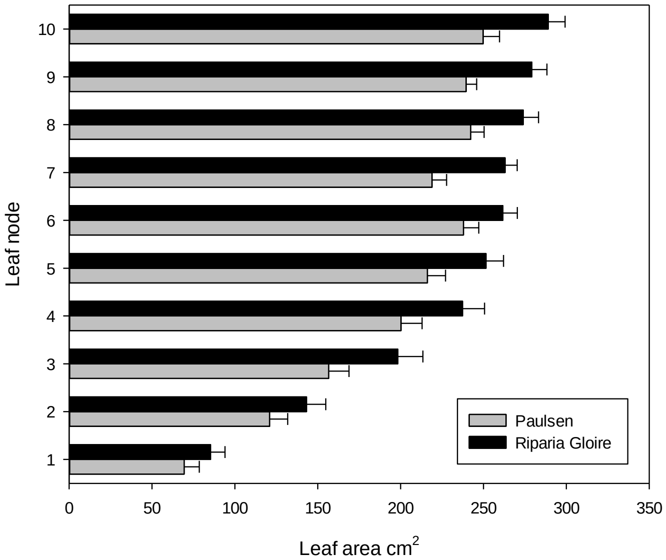

Figure 3. Leaf area versus leaf node position at harvest for MS Sauvignon blanc x Riparia Gloire de Montpellier and MS Sauvignon blanc x 1103 Paulsen potted vines. Treatments as indicated in the key. Bars = 1 x standard error, n=6.

Although leaf area for all vines had been established prior to application of the WW & DI treatments, it was still a parameter of interest. Overall, leaf area increased with increasing leaf node number (Figure 3) and, interestingly, average leaf area across all nodes was significantly lower (17%; $p<0.05$) for MS x 1103 Paulsen vines compared with MS x Riparia Gloire de Montpellier.

In summary, and although very much an initial pilot study, physiological observations suggest that the 1103 Paulsen rootstock may have a more sensitive response to soil drying (earlier stomatal closure) and therefore improved drought tolerance, than Riparia Gloire de Montpellier. Additionally, and irrespective of absolute water availability, the 1103 Paulsen rootstock would also appear to confer a decrease in leaf area (potentially mediated through rootstock-scion hormone signalling), and another potential adaptive strategy to conserve water. Thus, in addition to anecdotal evidence for deeper rooting (a factor restricted in this pilot study) as a drought tolerance mechanism in rootstocks such as 1103 Paulsen, there is also some evidence to suggest the additional involvement of physiological and other adaptive mechanisms. This merits further and more thorough investigation, and potentially in divergent soil types of relevance to the industry.

Reference

Hoskins N 2020. Drought-tolerant rootstocks: time for a reassessment? New Zealand Winegrower Magazine 123: 36–38.

Confidential report for:

Marlborough Research Centre Trust
Project #3

PUBLICATION DATA

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