Effect of soil properties on Pinot Noir vine vigour and root distribution in Tasmanian vineyards

Samuel Rees[A] and Richard Doyle[B]

[A]School of Agricultural Science, University of Tasmania, Hobart, TAS, Australia, Email Samuel.Rees@utas.edu.au
[B]Tasmanian Institute of Agricultural Research, University of Tasmania, Hobart, TAS, Australia, Email Richard.Doyle@utas.edu.au

Abstract
Root distribution of *Vitis vinifera* cv Pinot Noir was described growing in 16 different soil variants within three vineyards in Tasmania, Australia.

Soil type was shown to affect the distribution of vine roots, with soil physical properties having the greatest influence. Roots responded to zones of soil weakness (such as cracks, sand in-fills and old root pathways), especially in coarsely structured soil conditions. In the absence of these features, high soil strength hindered root growth with 2000 kPa being a key threshold. The presence and frequency of these structures had a greater influence on root distribution than the overall soil strength. Soil chemical differences were less limiting and only caused restrictions to root growth at extreme levels.

Low vigour vines had a lower rooting depth (< 60 cm), and low total root numbers. Vines with high vigour had a considerable proportion of roots below 60 cm. High vine vigour did not always relate to high total root numbers suggesting that root efficiency and function is also important. Root distribution also generally followed water movement pathways, highlighting the importance of appropriate water management.

Key Words
Root distribution, soil, vine, *Vitis vinifera*, soil structure

Introduction
Pinot Noir is an increasingly important grape variety for cool climate wine production in Tasmania. The state has a very wide array of soil types used for production ranging from highly alkaline to acidic reaction trends and from reactive clay soils to loose sandy profiles. Soil depth, substrate conditions and water table heights are also highly variable. It has been noted that grapevine vigour and yield is highly varied both within and between vineyards. This study aimed to understand the soil component of vineyard variability. Investigations of vine root distribution were undertaken in different soil types and related to vine vigour and yield.

The findings of the study have implications for the expansion of the viticultural industry in Tasmania by identifying the most favorable soil conditions for high quality Pinot Noir production. The results also offer some useful insights for managing water and nutrient supply to vine root systems.

Methods
A total of 25 plots consisting of 12 vines each were established across three vineyards in Tasmania, Australia. These plots mainly consisted of *Vitis vinifera* cv Pinot Noir and covered 16 different soil variants.

Root distribution was recorded using the profile wall method outlined in Bohm (1979). Trenches were excavated to expose soil profiles and vine root distribution across two vines within each plot. Penetration resistance and root size frequency was recorded across the soil face using a 5 cm x 5 cm grid. The soil profile was described and sampled for chemical, physical and mineralogical analysis.

Vine parameters of bunch number, bunch weight, cane number and average cane weight were also recorded over three consecutive seasons to help derive overall yield and vigour characteristics for each plot.

Results
Soil type was shown to influence the distribution of vine roots, with differences in soil physical properties having the greatest affect. Soil chemical differences (salinity, exchange cations, pH and available P) were less limiting and only caused restrictions to root growth at extreme levels.

The total number of roots observed varied across the study, with high root numbers generally associated with high vine vigour. However, some vines had high vigour with relatively low total root numbers (Figure 1b). This suggests that root function and root efficiency has a greater influence on vine growth than total root number. It is assumed that water retention characteristics of each soil type play an important role, with soils that allowed easy access to moisture having high vine vigour with smaller root systems.

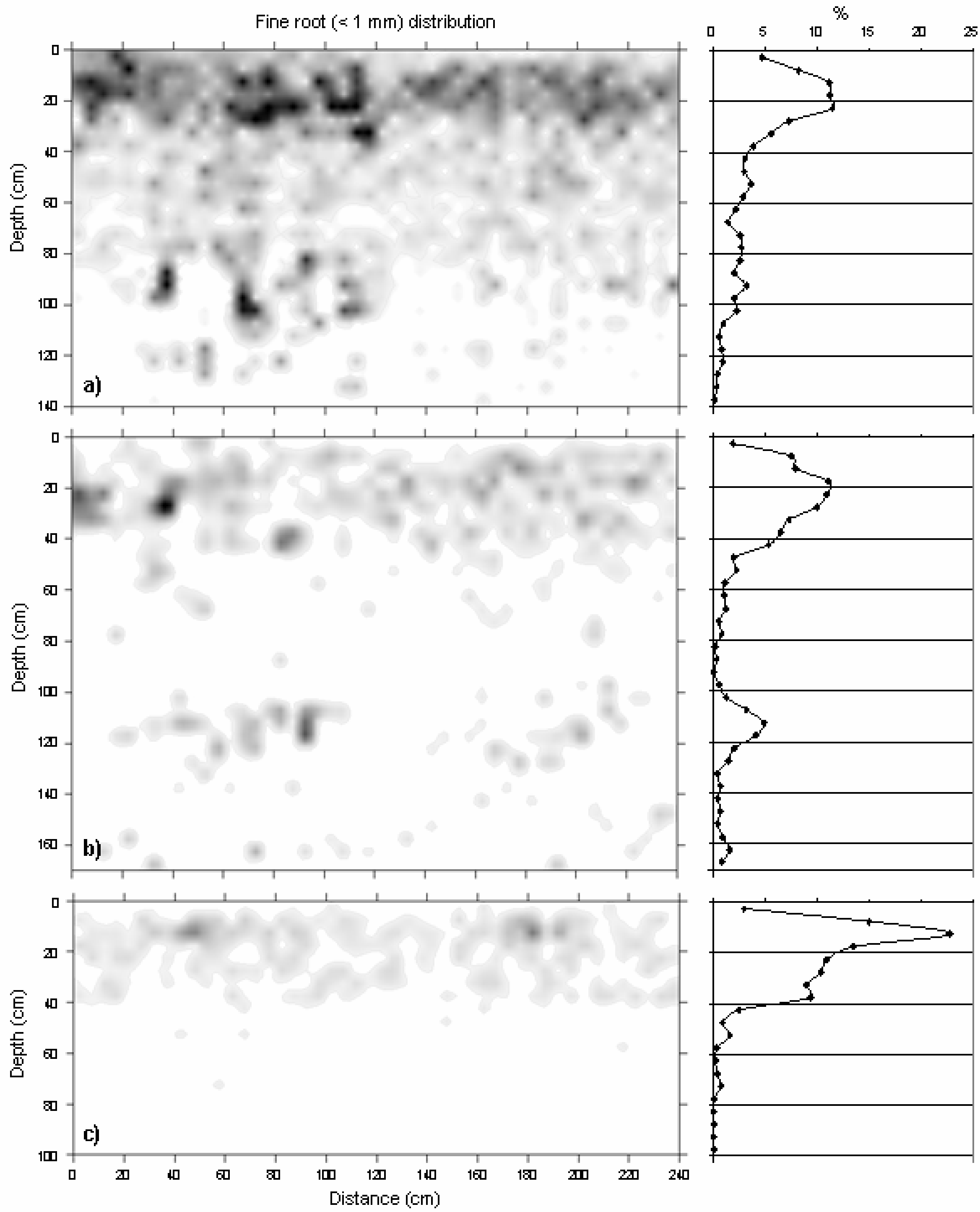

Figure 1. Examples of fine root (< 1 mm) distribution (shaded) and percentage root distribution with depth. a) extensive root distribution of high vigour vines with high root numbers. b) root distribution of high vigour vines with low root numbers and concentration of roots in subsoil. c) shallow root distribution of low vigour vines with low root numbers.

Independent of soil type, all vines had the highest percentage of root growth within 10 – 30 cm depth. Root growth was generally limited in the surface soil (0 – 10 cm) as well as at depths greater than 60 cm. Vines with high vigour had a high proportion of roots at depth (> 60 cm). Roots were either evenly spread through subsoil horizons (Figure 1a) or were concentrated at a specific depth (Figure 1b). Low vigour vines had restricted rooting depth (< 60 cm) and low total root numbers (Figure 1c). Limited rooting depth was caused by shallow depth to impermeable layers (bedrock or massive subsoil), acid soil conditions ($pH_w < 4.5$) or shallow, saline water tables.

Root growth was reduced through soil with penetration resistance values greater than 2000 kPa. However, sites with high soil strength (> 2000 kPa) were still able to have extensive root growth if roots had access to cracks, sand in-fills or old root channels (Figure 2). This suggests that it is the void architecture of soil that is critical for root growth, rather than just soil strength.

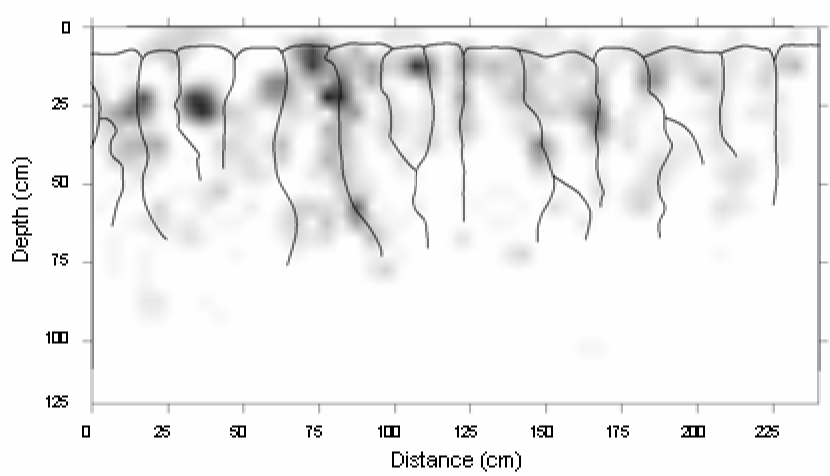

Figure 2. Fine root (< 1 mm) distribution (shaded) showing strong association with primary structure (–) in a soil with high soil strength (> 2000 kPa)

Conclusion

A wide range of root patterns and rooting depths were noted across the broad array of soil types observed. Peaks of root numbers occurred when favorable conditions were present, with soil structure having a greater influence than soil chemistry. Roots responded to cracking patterns and soil structure, especially in coarsely structured soil conditions. In the absence of cracks, high soil strength hindered root growth with 2000 kPa being a key threshold. Vigour was not always related to total root number suggesting root function is also significant. Root distribution also generally followed water movement pathways, highlighting the importance of appropriate water management.

Of the 16 soil variants observed, many showed favourable conditions for root growth with no one soil type or parent material that provides the ‘ideal’ medium for root growth. Moreover it is the physical conditions that the soil provides that have the greatest influence on root growth and vine vigour.

References

Bohm W (1979) Methods of studying root systems. Methods of studying root systems.