

From The Ground Up: Root Fundamentals For Water And Nutrient Uptake

David Eissenstat
Penn State University



Crop load effects on roots

Palmer 1992. *Tree Physiology*.

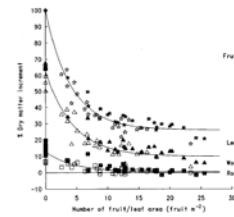
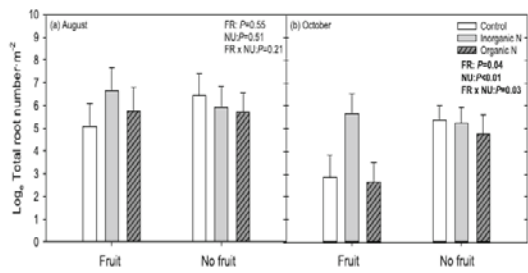


Figure 4. Partitioning of annual total dry matter production per tree of individual "Crispin" M.27 into fruit, leaves, stem and roots in relation to fruit number per unit leaf area. ○, ● = roots, □, ■ = roots and stem, ▲, △ = roots, stem and leaves. Open symbols 1982, closed symbols 1983.

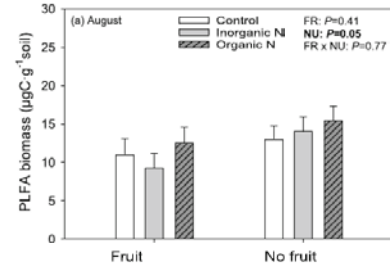
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Fruit removal in Golden Delicious/M9



Lavelly et al. 2018. *Plant and Soil*

Fruit removal on mycorrhizas



Lavelly et al. 2018. *Plant and Soil*

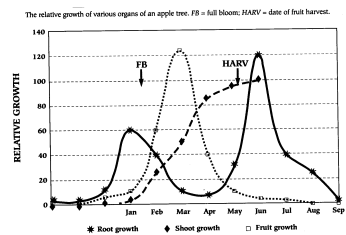
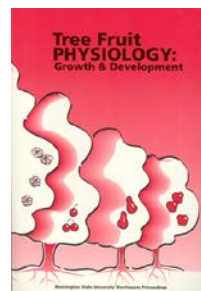
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Conclusion 1

- Fruit production comes at the expense of vegetative growth including root growth and to a lesser extent, mycorrhizal colonization

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Root Growth in Apple: Historical Perspective



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Seasonal timing of root growth

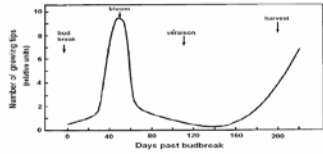
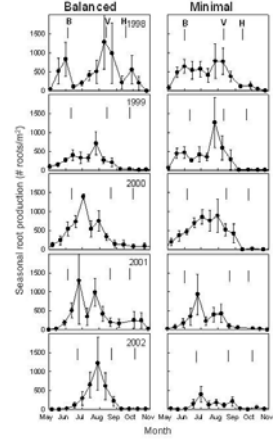


Fig. 1. Seasonal pattern of root growth in grape as typically described in text books. Data adapted from Mullins et al. (1992).

Concord Root Phenology

- No evidence that roots are mainly produced in spring and fall.
- Lack of root production around harvest.
- High annual variability but often root production is mainly between bloom and veraison.



Radville et al. 2016 *Am J Bot.*

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Root phenology in apple

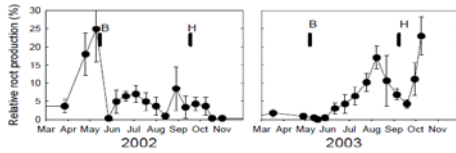


Fig. 4. Patterns of root birth (\pm SE) over the growing season of Gala/M9 apple trees in Summerland, British Columbia. Data calculated as in Fig. 2. Trees were fully irrigated (100% daily ET) on two sides of the tree. Only trees that were not mulched are shown. Thick vertical bars indicate timing of full bloom (B) and harvest (H) each year.

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Conclusion 2

- Timing of root growth can be quite variable from year to year and in not necessarily greatest in spring and fall.

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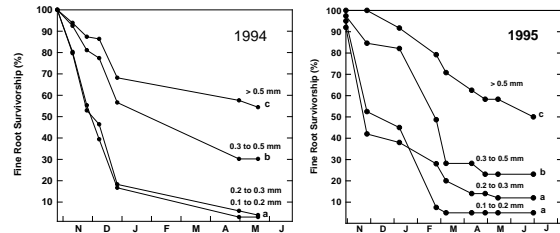
Roots with Multiple Functions



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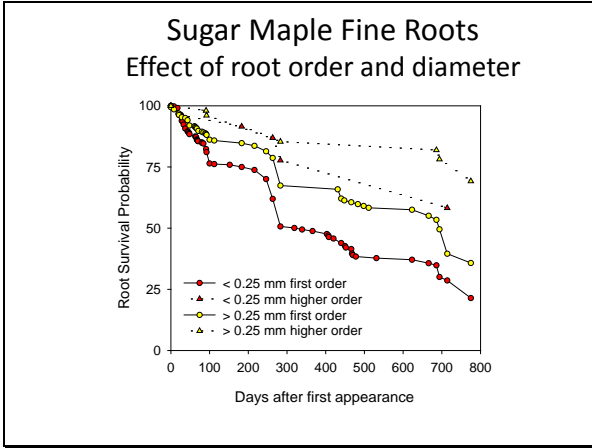
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Apple Root Survivorship



Wells and Eissenstat (2001) *Ecology*.

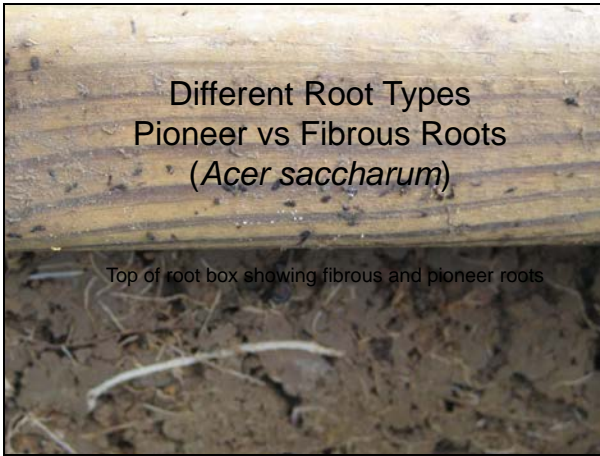
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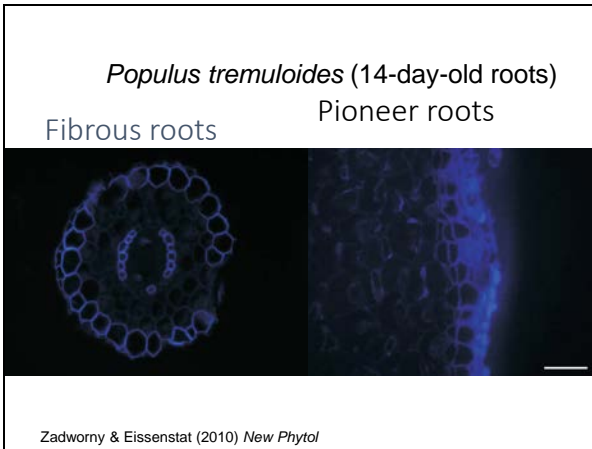
Contrasting pioneer & fibrous roots Root Morphology

Zadworny & Eissenstat (2010) *New Phytol*

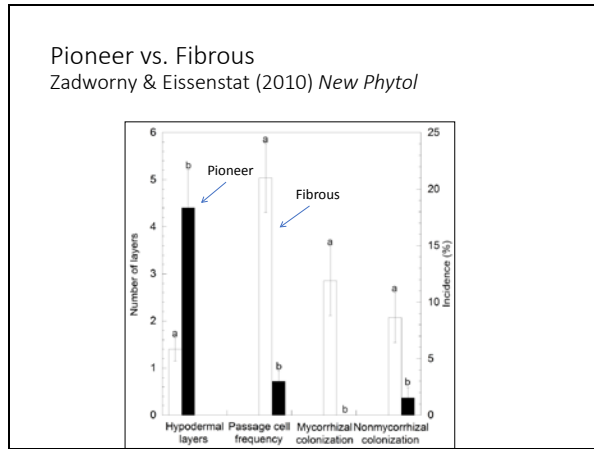
	<i>P. tremuloides</i>		<i>A. negundo</i>		<i>A. saccharum</i>		<i>J. nigra</i>		<i>L. tulipifera</i>	
	fibrous	pioneer	fibrous	pioneer	fibrous	pioneer	fibrous	pioneer	fibrous	pioneer
Root diameter (mm)	0.3	1	0.4	1.1	0.5	1	0.6	2.1	0.9	2
Specific root length (m/g)	3	1.3	1.3	0.4	1.2	0.5	1.3	0.5	0.8	0.3

Pioneer vs. Fibrous, $P < 0.01$

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Conclusion 3

- Pioneer roots that are thick when born are intended to become framework roots and are not involved directly in water and nutrient acquisition
- The small fibrous roots are the primarily roots involved in water and nutrient acquisition. They are short, high in N, metabolically active, ephemeral and often colonized by mycorrhizal fungi.

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Gala/M9 Summerland BC

In collaboration with Denise and Gerry Neilsen



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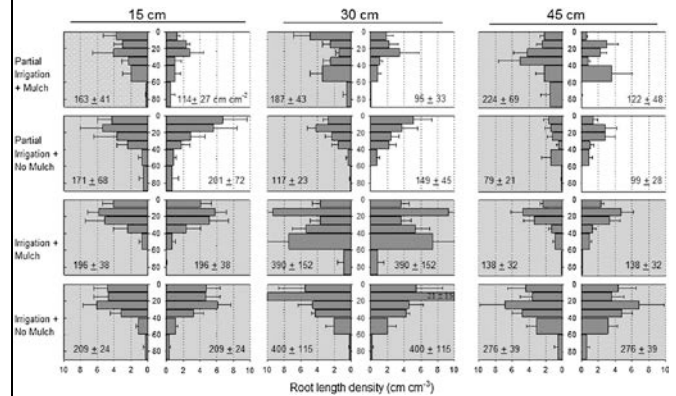
Root distribution and irrigation

- Work done in Summerland, BC in sandy soils with Gala apples on M.9 rootstock.
- Trees were either mulched or not
- Trees were irrigated only sufficient to meet 50% of daily evapotranspiration or fully irrigated

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Effects of Irrigation and Mulch on Root Distribution

Eissenstat, Neilsen, Neilsen and Adams. 2018. *Hortscience*



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Overall conclusions

- Timing of root production can vary widely from year to year
- Roots can vary widely in function with branching order, diameter and type (pioneer vs. fibrous)
- Root distribution can be affected by level of irrigation and mulching. In sandy soils, mulching may mitigate reductions in irrigation of root and fruit production.

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