

Deciphering Uptake and Vascular Movement of Solutions in Grafted Citrus Trees

To optimize delivery of systemic compounds

INTRODUCTION

- *Trunk injection*: delivers therapeutic compounds directly into tree xylem
- *Benefits*: optimizes the availability of compounds and minimizes the risk of drift or damage to nontarget organisms
- *Knowledge gaps*: uptake and distribution of compounds needs to be investigated more thoroughly in citrus to adapt the method for commercial orchard systems

METHODS

- *Plant material*: greenhouse-grown 3-year-old Valencia sweet orange trees
- *Treatments*: 0.1% Acid Fuchsin, 0.1% Safranin O, and 0.1% Rhodamine B
- *Dye application methods*: no-pressure injection into the trunk compared to a complete drench of the cleaned root system. A pipette tip attached with latex tubing to a 20 mL plastic syringe was used for injection. The pipette tip is placed into a 1.6 mm drilled hole.
- *Analysis*: height of dye uptake and imaging of cross sections taken after 24 hours of passive dye application

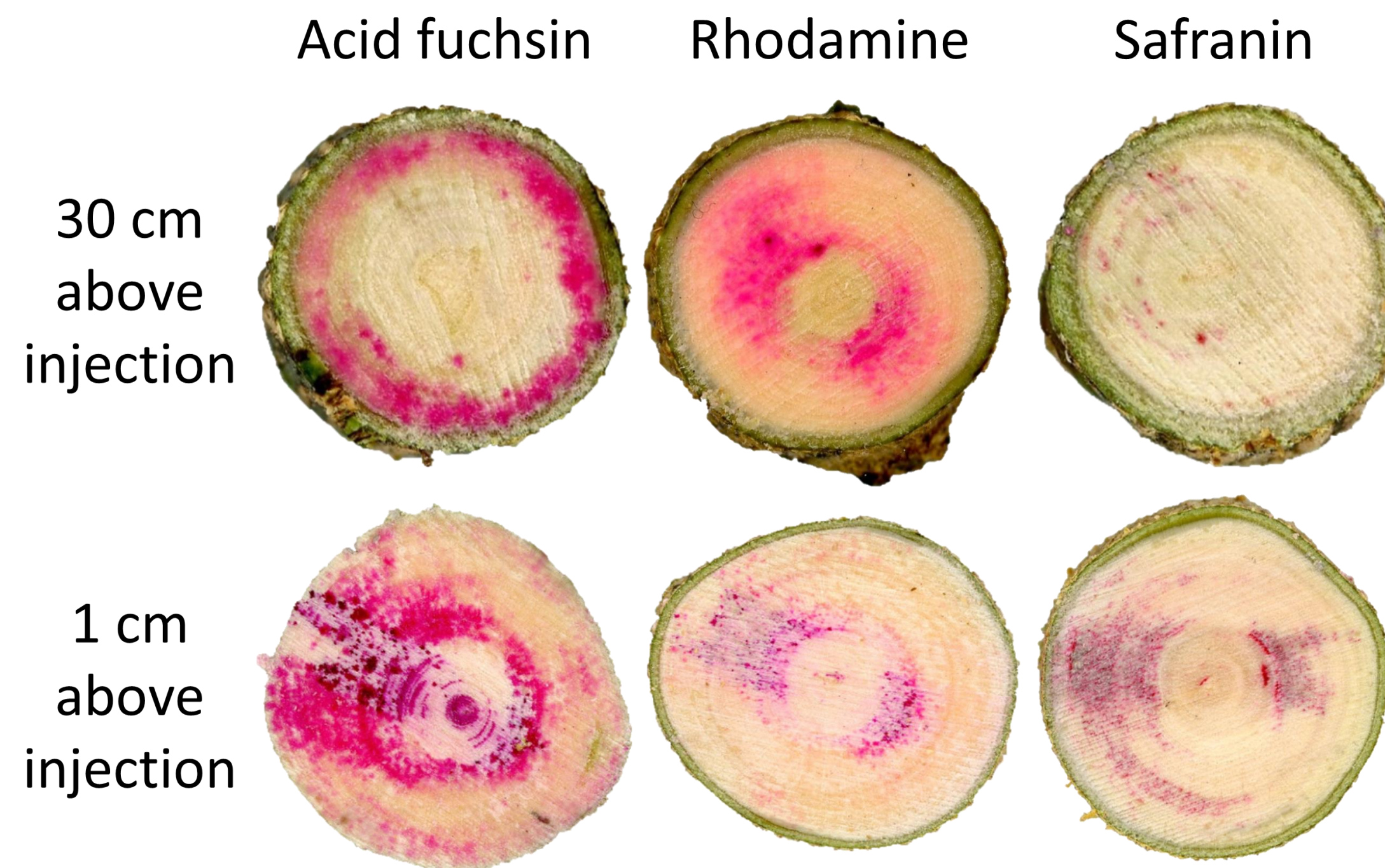
References and Acknowledgments

Pegg, K.G. 1990. Australasian Plant Path. 19(4):142-143
 Peterson, C.A. 1989. Acta Hort. 239:43-54
 Pfautsch, S., T. Holttá, M. Mencuccini. 2015. Tree Phys. 35(7):706-722
 Sanchez Zamora, M.A. and R. Fernandez Escobar. 2000. Scientia Horticult. 84(1-2):163-177

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No-pressure injection system: syringe-based device for the direct application of compounds into the xylem.



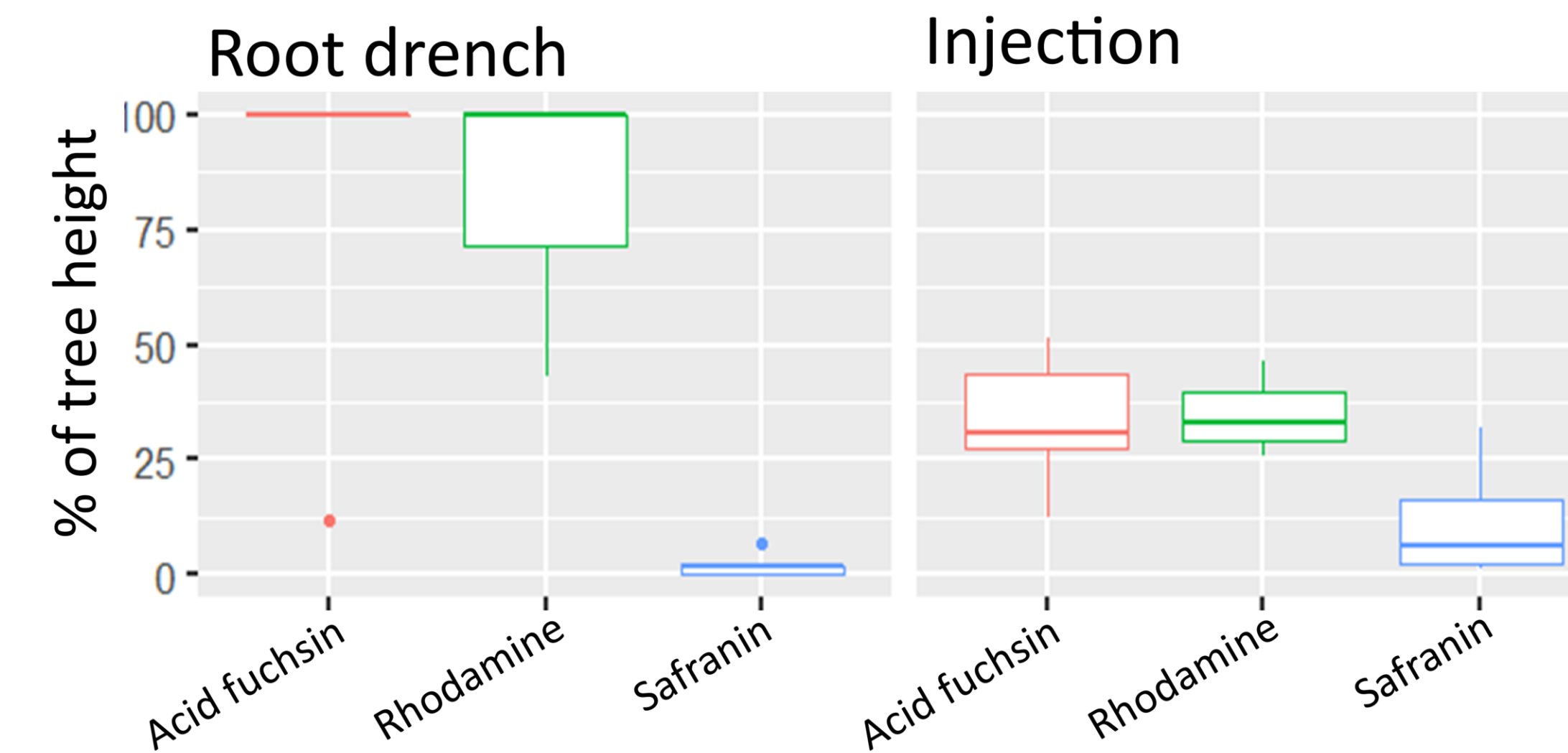
Dye distribution: vertical and lateral movement of three different water-soluble dyes after high-pressure injection.

Root drench Pressure injection



Natural uptake compared to injection: passive uptake and distribution of acid fuchsin in outer xylem rings compared to distribution after high-pressure injection in inner xylem rings

Height of dye uptake



Height of visible dye as percent of tree height: Natural uptake from root drenching contributes to greater dye distribution compared to a no-pressure injection of acid fuchsin or rhodamine.

RESULTS

- *Dye*: vertical movement of safranin O is significantly lower than that of acid fuchsin ($p=0.0001$) or rhodamine ($p=0.003$)
- Acid fuchsin moves quickly into outer xylem rings following injection, suggesting rapid lateral transfer through ray cells
- Rhodamine readily moves horizontally, though less lateral transfer is evident
- Safranin is bound to cell walls and does not move readily through xylem tissue
- *Application method*: natural uptake following a root dip significantly increases distribution compared to a no-pressure transfusion ($p=0.0002$)

CONCLUSIONS

- The molecular structure and application method of a compound influences uptake and distribution
- The degree of lateral transfer should be considered to determine whether a compound is suitable for delivery through trunk injection
- Natural root uptake tends to be restricted to outer xylem rings; while injection forces dye through inactive xylem vessels
- Efficacy of injection will vary based on whether the disease being targeted is phloem or xylem limited