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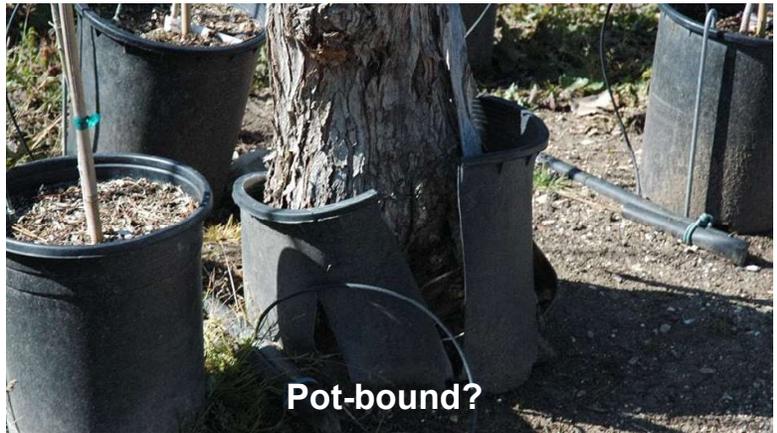
Getting to the Root of the problem with Container-grown trees

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Why container trees?

- Container production is increasing (USDA, 2014)
- Efficient in nursery
- Easier handling
- Longer planting window



Containers affect root development

- Poor root architecture from black plastic containers is often seen as the cause of later root defects and tree failure
- (Amoroso et al., 2010; Gilman et al., 1996, 2010; Gilman et al., 2010; O'Connor, 2014)



Photo: Fine Gardening, Jeff Gilman



What to do with roots of container-grown trees at planting?



Image: Friends of Grand Rapids Parks



Commonly recommended techniques for dealing with circling roots

- Teasing
- Butterflying
- Vertical-slicing
- Shaving
- Root-washing



Photos: New Garden



Root slicing



Photo: New Garden

Common practice

Can disrupt circling roots and improve root egress into backfill soil (Ellyard, 1984; Gilman et al. 2009; Gilman & Wiese, 2012)

But other systematic studies report no differences in root growth compared to control (Weicherding et al., 2007)



Teasing roots



Photo: New Garden

Common with small plants

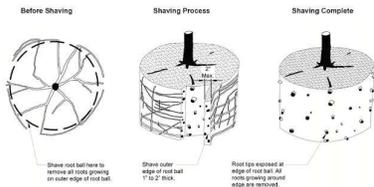
Time consuming (Ellyard, 1984)

Systematic studies report no differences in root growth compared to control (Weicherding et al., 2007)



Shaving

Shaving root balls of container-grown trees at planting increases new root growth and reduces circling roots (Gilman and Wiese, 2012; Gregg and Ellison, 2018).



Source: 2015 Florida Grades and Standards for Nursery Plants





Root-washing/Bare-rooting



Photos: Fine Gardening



Bare-rooting

Bare-rooting is the only means to reveal and remediate root defects

(Appleton and Flott, 2009; Chalker-Scott and Stout, 2009)

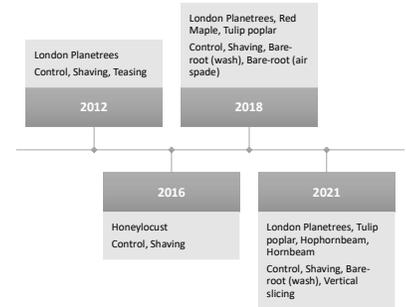


Key Questions

- Do root modifications improve root quality after planting?
 - i.e., reduce or eliminate circling roots and other defects
- Do root modifications improve root egress?
- Does pruning roots at planting (e.g., shaving, bare-rooting) increase tree water stress after planting?



MSU Root Modification Studies



Root excavation & assessment 2024



Root excavation & assessment 2024





Root excavation & assessment 2024



Assessments

- % Circling
- Root quality
 - Girdling
 - Kinked
 - Unbalanced symmetry
 - Under tree
 - Ascending



Root assessment: Root egress



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Growth and establishment of container-grown London planetrees in response to mulch, root-ball treatment and fertilization

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Research in real time

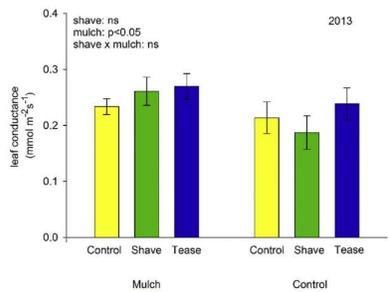
It's been a busy spring around the Cregg lab. In many ways, it feels more like mid-summer than mid-May. One of the items my students and I have been with is installation of the Social Media Designed Tree Transplant Study (SoMedTreeS). As loyal Garden Professor blog readers will recall, we conducted a Survey Monkey poll last fall to help develop a study plan to investigate tree transplanting practices of container-grown trees. Based on the results of the survey we designed a study to look the effects of root-ball manipulation and post-transplant fertilization on 96 planetrees.

Well, the time has arrived. Last week we completed the first of two installations of the study - the second will be installed at the MSU Beaumont nursery soon. Graduate research assistant Dana Ellison and summer research intern Aniko Gaal finished planting the first 48 trees last week at the MSU Hort Farm. These two did yeoman's (yeswoman's?) work in handling the trees, applying the treatments and getting in the trees in the ground.



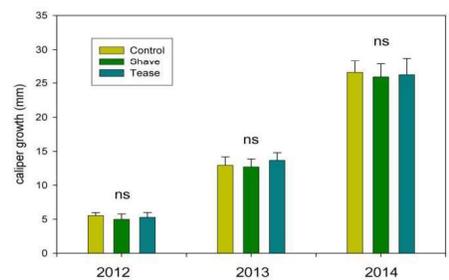


Mulch improve leaf conductance, but no effect of root treatment



Cregg and Ellison, 2018

Root-ball manipulation had no effect on tree growth after three years



Cregg and Ellison, 2018



Root treatments decreased % of circling roots

• 4 y after planting

Treatment	Experiment 1	Experiment 2
Control	87.5a	76.3a
Tease	12.5b	2.5b
Shave	0b	0b

Root biomass outside original rootball

• 4 y after planting

Treatment	Total biomass outside	Outside as % of total
Control	1225.9a	56.3a
Tease	1788.0ab	67.7b
Shave	2050.2b	74.6b



Root systems – 12 years after planting



2012 - Control



2012 - Tease

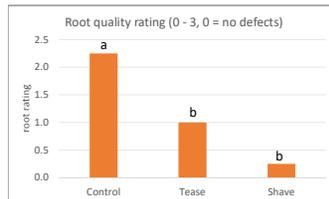
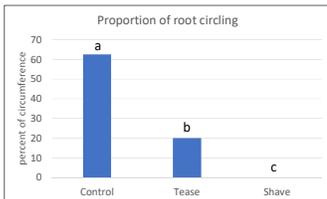


2012 - Shave



Shaving and teasing reduced circling and improved root quality

2024 assessment



2018 Study

Plant Materials

- #25 (100L) containers
- October Glory Red maple (*Acer rubrum*)
- Columnar tulip tree (*Liriodendron tulipifera*)
- 'Bloodgood' London Planetree (*Platanus x acerifolia*)

Spring – May 2018 (96 trees)

Summer – July 2018 (27 trees)





Control aka 'Pop and drop'



Shave



Bare-root - Wash



Bare-root - Airspade



Mudding-in Root-washed trees



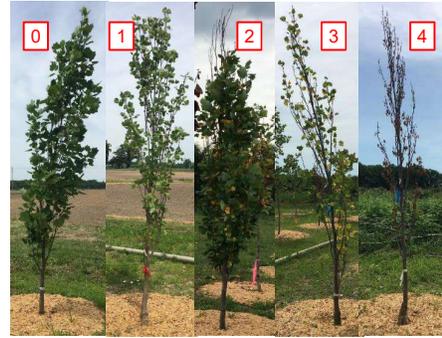


Root treatments required additional time at planting

Root modification	Total root treatment and planting time (min)		
	<i>A. rubrum</i>	<i>L. tulipifera</i>	<i>P. x acerifolia</i>
Control	6.8a	4.7a	5.7a
Shave	17.1a	12.1a	11.4ab
BR-Airspade	43.3b	24.6b	23.5b
BR-Wash	71.7c	48.0c	44.5c

Means within a column with the same letter are not significantly different ($\alpha=0.05$, Tukey's HSD)

Rouse and Clegg, 2021



Bare-rooting increased extreme scorch

% with extreme scorch (rating ≥ 3)			
	<i>A. rubrum</i>	<i>L. tulipifera</i>	<i>P. x acerifolia</i>
June 14			
Control	0.0a	0.0a	0.0a
Shave	0.0a	37.5ab	0.0a
BR-Airspade	25.0a	75.0b	25.0ab
BR-Wash	37.5a	50.0b	50.0b
Sept. 21			
Control	12.5a	0.0a	0.0a
Shave	0.0a	37.5ab	0.0a
BR-Airspade	37.5a	87.5c	0.0a
BR-Wash	25.0a	62.5bc	0.0a

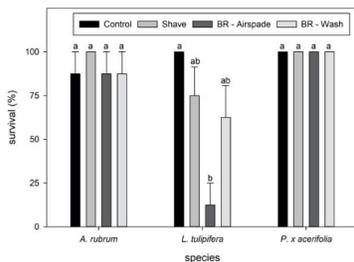
Means within species x date with the same letter are not significantly different ($\alpha=0.05$, Tukey's HSD)

- Bare-rooting resulted in more trees displaying extreme leaf scorch following transplant
- Species varied in response
- Some trees recovered, some continued to decline

Rouse and Clegg, 2021



Mortality in response to root treatments varied by species

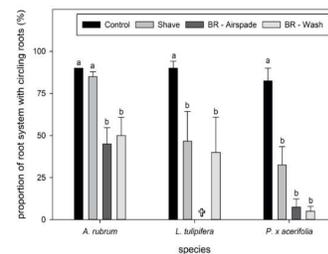


Means within species with the same letter are not significantly different ($\alpha=0.01$, Tukey's HSD)

Rouse and Clegg, 2021



Root modification can decrease circling

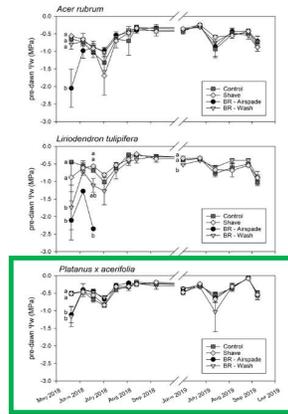


Means within species with the same letter are not significantly different ($\alpha=0.01$, Tukey's HSD)

Rouse and Clegg, 2021



Plant water potential



Getting through initial moisture stress is crucial:

- Bare-rooting increased moisture stress immediately following planting
- *L. tulipifera* trees in the BR-Airspade treatment were not measured after July 2018 due to mortality
- Trees can recover following initial moisture stress

Rouse and Clegg, 2021



Root systems – 6 years after planting



Red maple



Tulip poplar

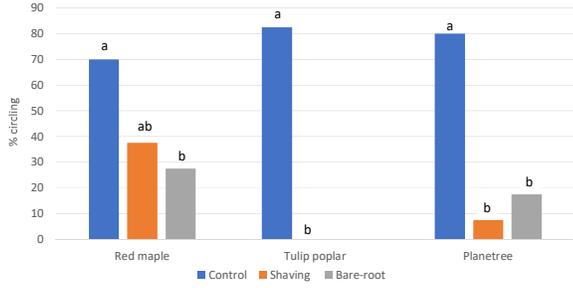


Planetree

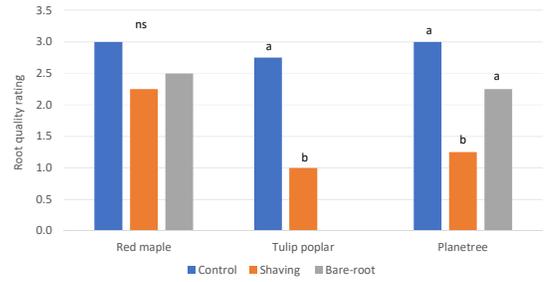




Shaving reduced circling for all species



Shaving improved root quality rating for tulip poplar and planetree



2021 Root modification trial

- Plant materials
 - London planetree *Platanus x acerifolia* 'Bloodgood'
 - Tulip tree *Liriodendron tulipifera*
 - Hornbeam *Carpinus caroliniana*
 - Hophornbeam *Ostrya virginiana*
- 1 1/2 - 2" liners
- Grown in 25 gal. containers at MSU Pot-in-Pot nursery for 2 years
- Standard nursery culture
 - 80/20 (v/v) pine bark/peat
 - Daily irrigation
 - CRF fertilization
- 5-6 reps per trt x spp



Shaving



Root washing



Control



Vertical slice

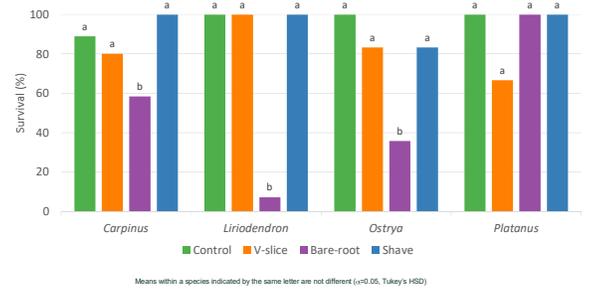


Planting May 2021





Bare-rooting reduced first year survival



Crown Die-back Rating (0 = none; 4 = dead)

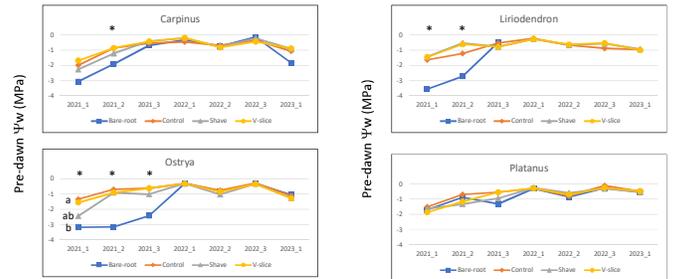


	Die-back rating			
	Carpinus	Liriodendron	Ostrya	Platanus
Control	1.1a	0.0a	0.4a	0.7a
Shave	1.5a	0.0a	0.3a	0.6a
Slice	1.0a	0.0a	0.5a	1.5a
Bare-root	3.0b	3.9b	2.1b	0.4a

Means within a species indicated by the same letter are not different ($p < 0.05$, Tukey's HSD)



Water potential: Effects of Bare-rooting were evident in season of planting



Root systems – 3 years after planting



Control – Planetree





V-slice – Planetree



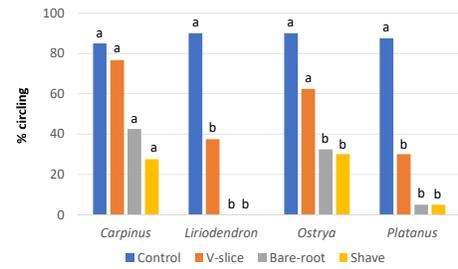
Shave – Planetree



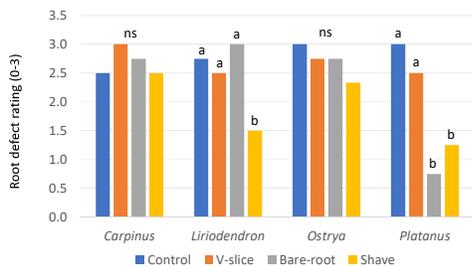
Bare-root – Planetree



Treatments reduced root circling for all species except hornbeam



Treatments were less effective in eliminating other root defects



Summary

- Shaving, teasing, and bare-rooting were effective in reducing circling roots
- Treatments were less effective at improving root defect rating
- Bare-rooting increased tree water stress after planting, resulting in reduced survival and die-back for sensitive species
- Vertical slicing reduced circling roots for 2 of 4 species but did not improve overall root quality
- These results and our related studies demonstrate shaving is the most effective approach to managing roots of container-growth trees



Thank you!

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Nursery Supplies, Inc.

Michigan Department of Agriculture and Rural Development Horticulture Fund



Questions



2016 Trial - Honeylocust



Root systems – 8 years after planting



Honeylocust Trial - Control

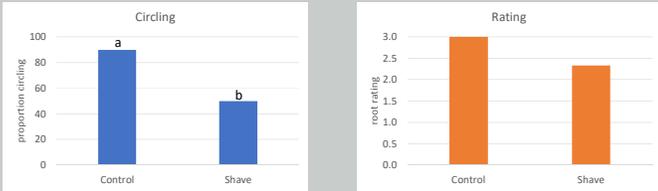


Honeylocust Trial - Shave





Shaving improved root quality of honeylocust – sort of...



The case for trees

- Ecosystem services
 - Stormwater mitigation
 - Energy savings
 - Improving air quality
 - Carbon sequestration
- Increased property values
- Other public health and societal benefits



What about alternative containers?



Photos: Ed Gilman



CSU Project



Chanticleer™ pear grown in black plastic (above) and Root Pouch® (right) 18 months after planting

Images: Allison Stoven O'Connor