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

Bert Cregg & Riley Johnson
Michigan State University
Department of Horticulture
Department of Forestry

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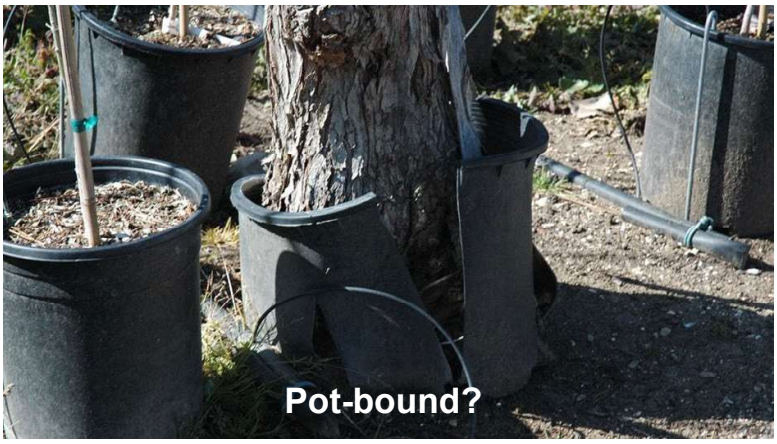
Why container trees?

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



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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)

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

Image: Friends of Grand Rapids Parks

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Commonly recommended techniques for dealing with circling roots

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

Photos: New Garden

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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)

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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)

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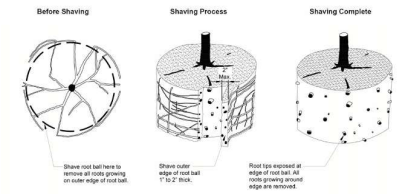
Shaving

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



Source: 2015 Florida Grades and Standards for Nursery Plants

Root-washing/Bare-rooting

Photos: Fine Gardening

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Bare-rooting

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

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

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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?

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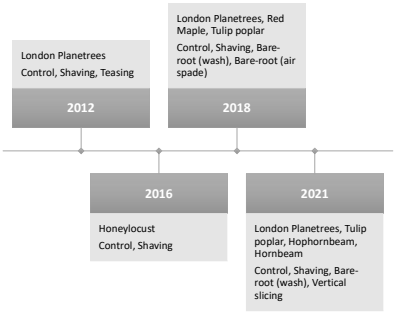
MSU Root Modification Studies



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Root excavation & assessment 2024

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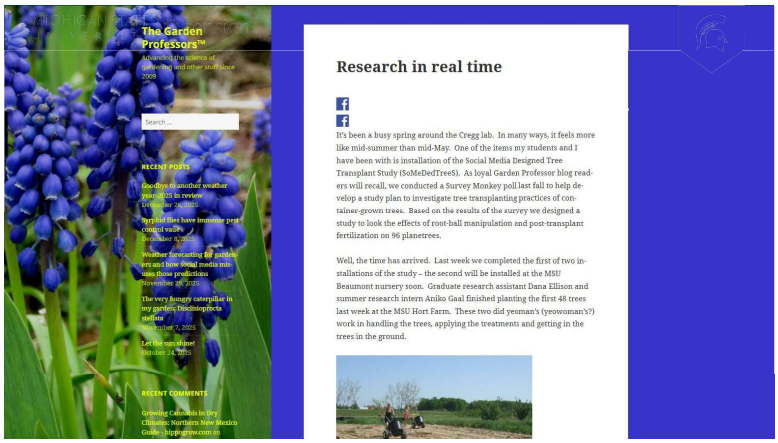
Root assessment: Root egress



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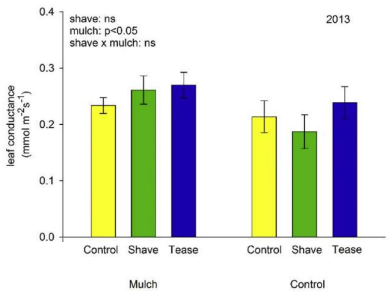
Mulch improve leaf conductance, but no effect of root treatment



Cregg and Ellison, 2018

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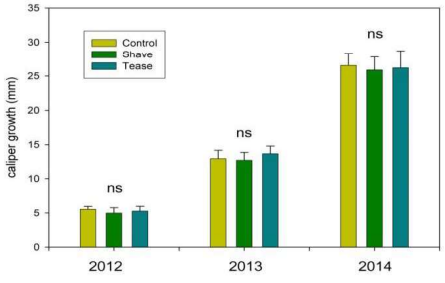
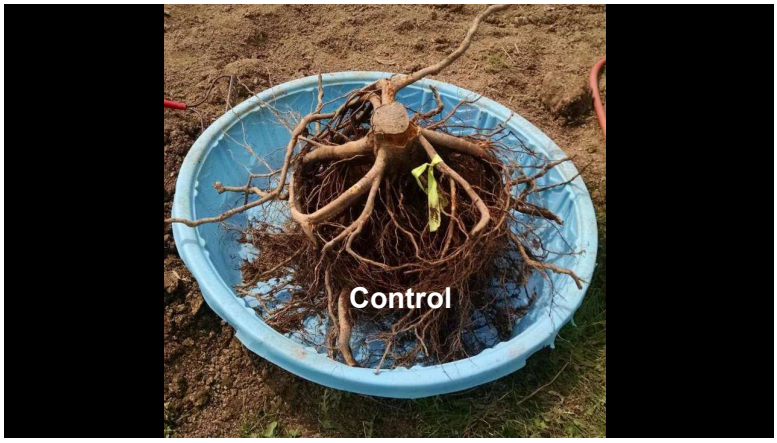
Root-ball manipulation had no effect on tree growth after three years



Cregg and Ellison, 2018



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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

Cregg and Ellison, 2018

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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

Cregg and Ellison, 2018

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Root systems – 12 years after planting

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2012 - Control

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2012 - Tease

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2012 - Shave

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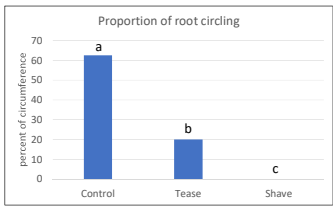
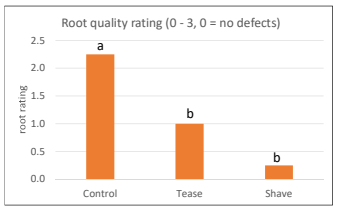
Shaving and teasing reduced circling and improved root quality

2024 assessment





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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)

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Control
aka 'Pop and drop'

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Shave

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Bare-root - Wash

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Bare-root - Airspade

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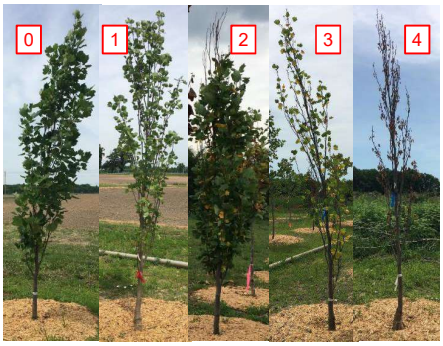
Mudding-in
Root-washed trees

Root treatments required additional time at planting

Root modification	Total root treatment and planting time (min)		
	A. rubrum	*L. tulipifera*	*P.* x *acerifolia*
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 (α=0.05, Tukey's HSD)

Rouse and Cregg, 2021



Bare-rooting increased extreme scorch

% with extreme scorch (rating ≥ 3)

June 14	*A. rubrum*	*L. tulipifera*	*P.* x *acerifolia*
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

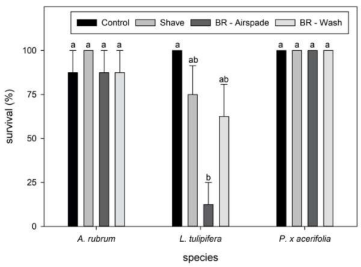
Sept. 21	*A. rubrum*	*L. tulipifera*	*P.* x *acerifolia*
Control	12.5a	0.0a	0.0a
Shave	0.0a	37.5ab	0.0a
BR-Airspade	37.5a	87.5c	0.0a
BR-Wash	25.0a	62.5bc	0.0a

Means within species x date with the same letter are not significantly different (α=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 Cregg, 2021

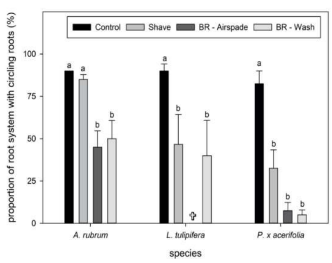
Mortality in response to root treatments varied by species



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

Rouse and Cregg, 2021

Root modification can decrease circling



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

Rouse and Cregg, 2021

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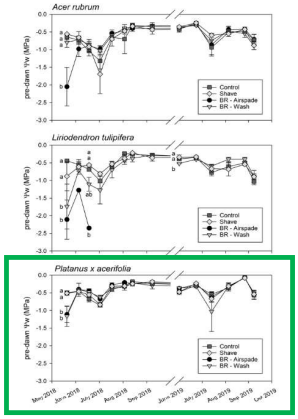
Plant water potential



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 Cregg, 2021

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Root systems – 6 years after planting

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Red maple

Control

Shave

Bare-root

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Tulip poplar

Control

Shave

Bare-root

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Planetree

Control

Shave

Bare-root

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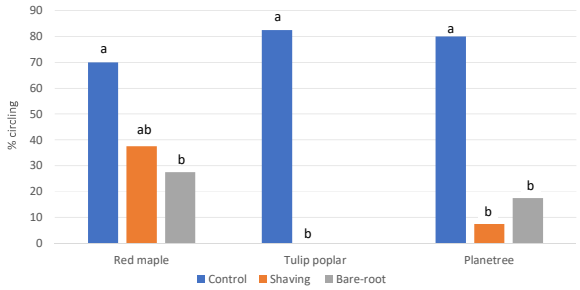
Shaving reduced circling for all species



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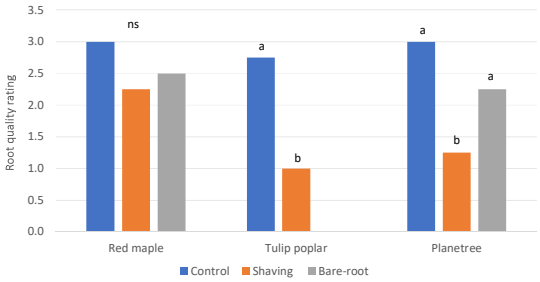
Shaving improved root quality rating for tulip poplar and planetree



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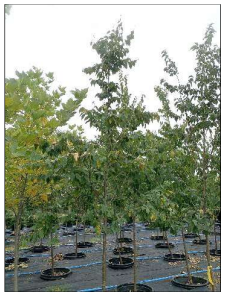
2021 Root modification trial

- Plant materials
  - London planetree *Platanus x acerifolia* 'Bloodgood'
  - Tulip tree *Liriodendron tulipifera*
  - Hornbeam *Carpinus caroliniana*
  - Hophornbeam *Ostrya virginiana*
- 1 ½ - 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



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Shaving | Root washing | Control



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Vertical slice


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Planting May 2021


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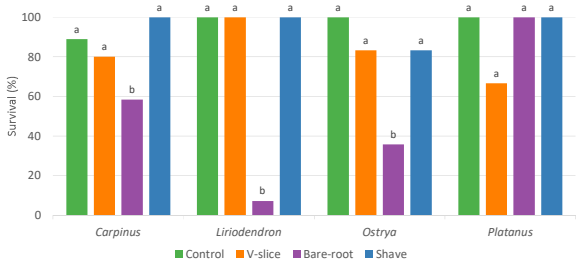
Bare-rooting reduced first year survival



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

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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 (α=0.05, Tukey's HSD)

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

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Root systems – 3 years after planting

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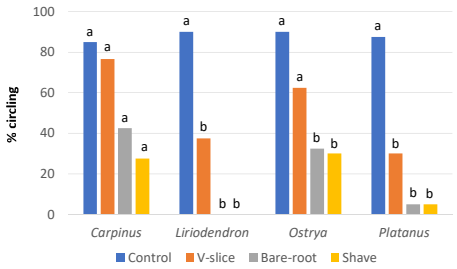
Control – Planetree

V-slice – Planetree

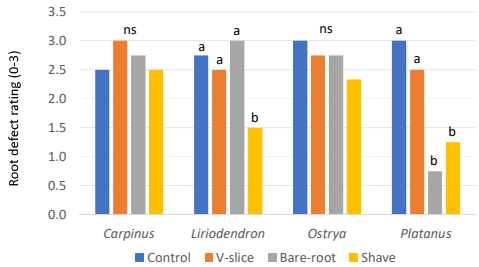

Shave – Planetree


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

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Thank you!

Mitchell Fox, Tom Fernandez, Dana Ellison-Smith, Maddy Dubelko, Amy MacLaren, Anna Dunnebacke, Noah Dressander, Claire Komarzec, Kenna Kline, Jeremy Rajter

MSU Beaumont Nursery – Jay Andrews
MSU Campus Landscape Services - Jerry Wahl

MSU Project GREEEN

J. Frank Schmidt & Son, Co.

Nursery Supplies, Inc.

Michigan Department of Agriculture and Rural Development Horticulture Fund

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2016 Trial - Honeylocust

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Root systems – 8 years after planting

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Honeylocust Trial - Control

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Honeylocust Trial - Shave

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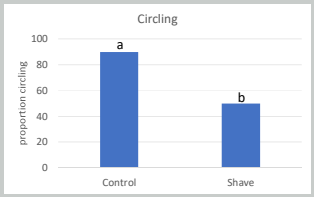
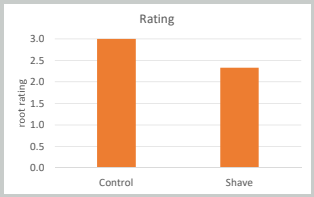
Shaving improved root quality of honeylocust – sort of…





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The case for trees

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

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What about alternative containers?

Photos: Ed Gilman

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CSU Project

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

Images: Allison Stoven O'Connor