Seeds to maturity: Growing a better root system on shade trees

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Web site: google Ed Gilman

Book: Illustrated Guide to Pruning, third edition, 2012

38 per section

Roots are complicated!

I dug my first tree roots up in 1977 and I am still learning!

I routinely kill perfectly healthy trees (Gilman et al. 2010)

That's how we learn about roots (Gilman 2007)

I will show you

- Natural vs. nursery-grown root systems
- Source and consequences of root defects
- How to grow quality root systems in containers and field nurseries
- Removing root defects at landscape planting
- Tree stability after planting

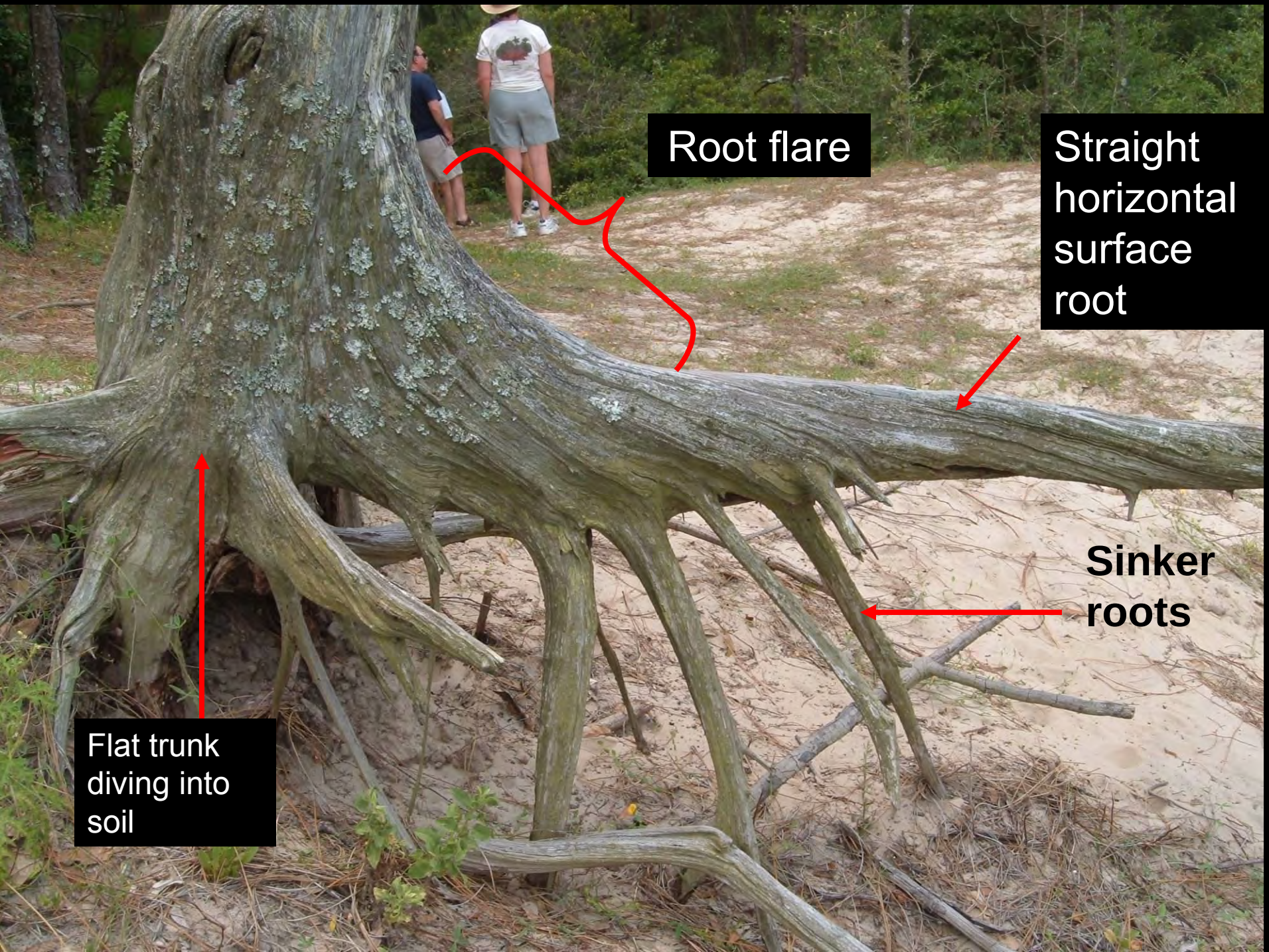
Outline for today

- Current situation
- Growing systems
- Planting issues

In nature, slow-impact root shift occurs

Deep roots dominate early, shallow roots later

Roots grow down and out in drained soil


Root flare
Straight horizontal surface root
Sinker roots
Flat trunk diving into soil

Roots graft to roots of like species


Small tree
Large trees

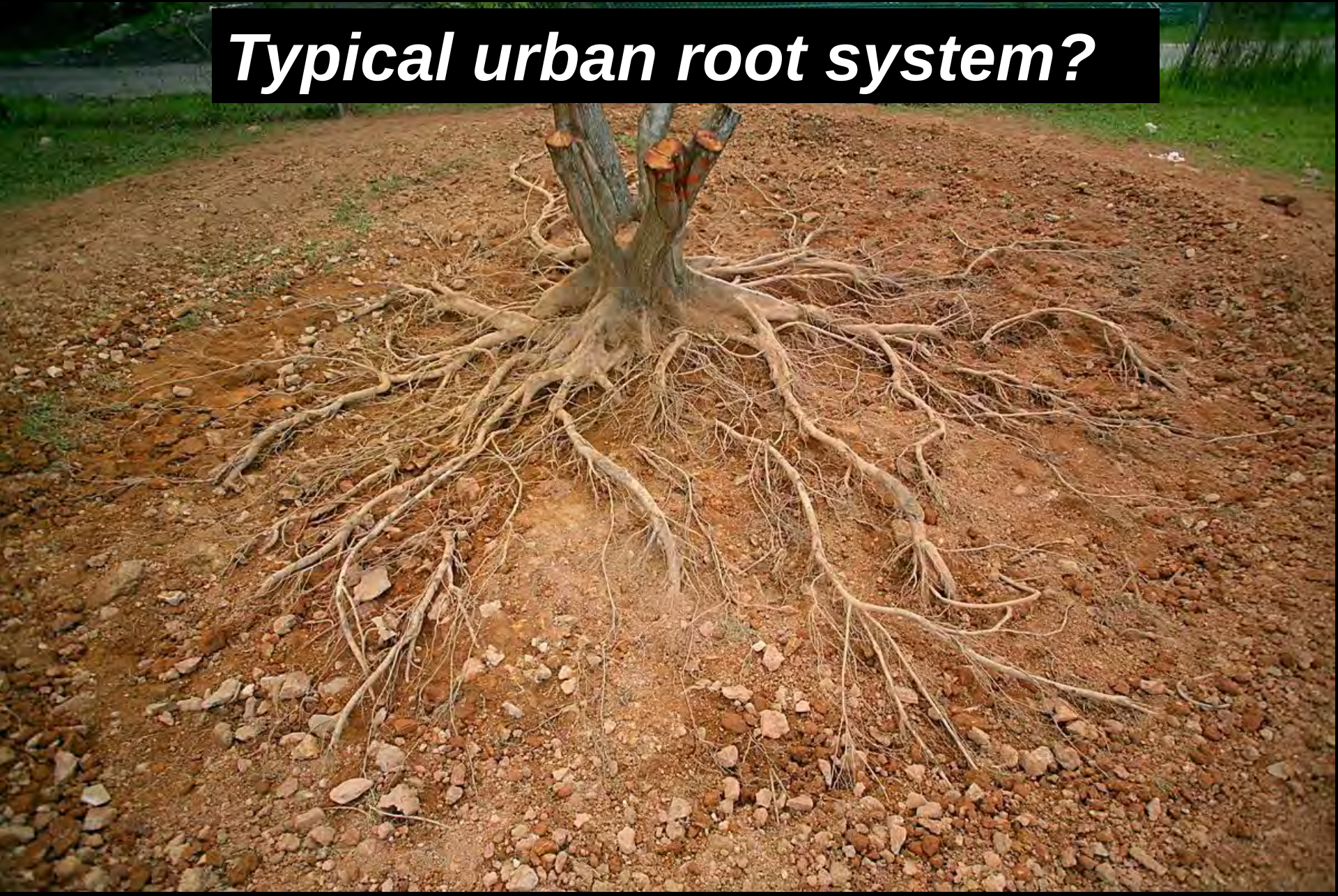

Large trees – visible root flares


Small tree – suppressed root flare, inclusion around trunk

Root defects (Gilman et. al 2010)

Stem-girdling roots also lead to poor anchorage

The challenge

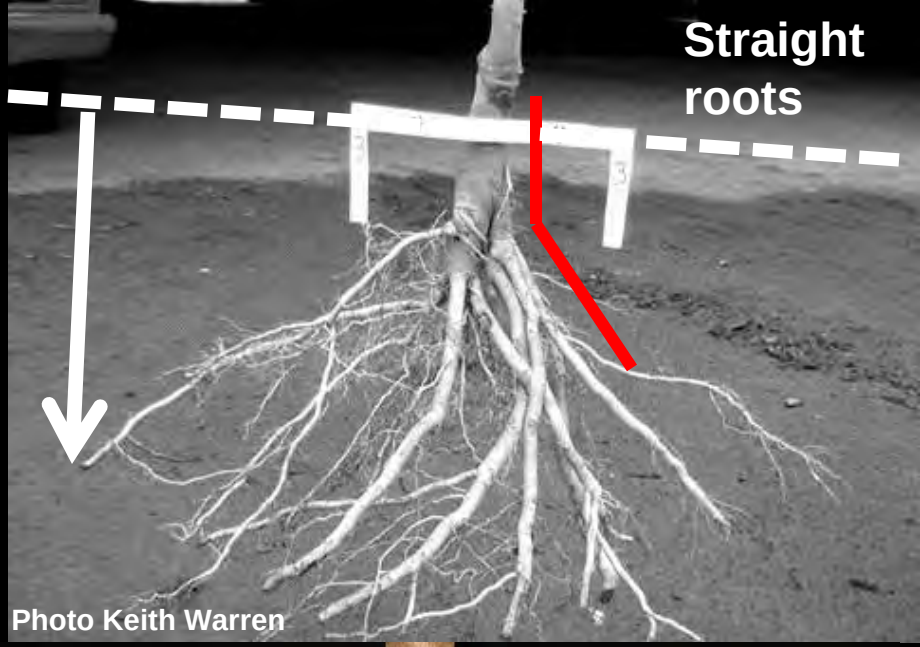

Typical urban root system?

Want this?

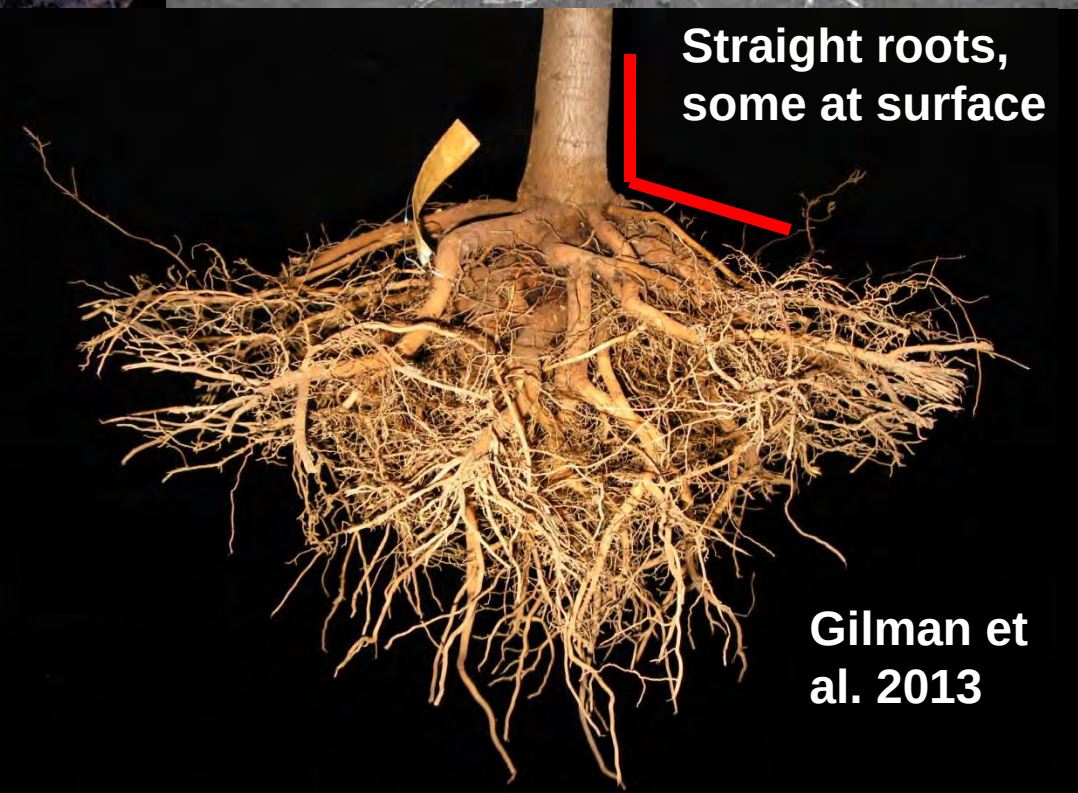
or this?

Want this?

or this?



Which root ball is best suited for planting



How does this happen?

1) **Trees begin in the field**
2) Trees begin in a container

Seeds germinating in nursery field soil

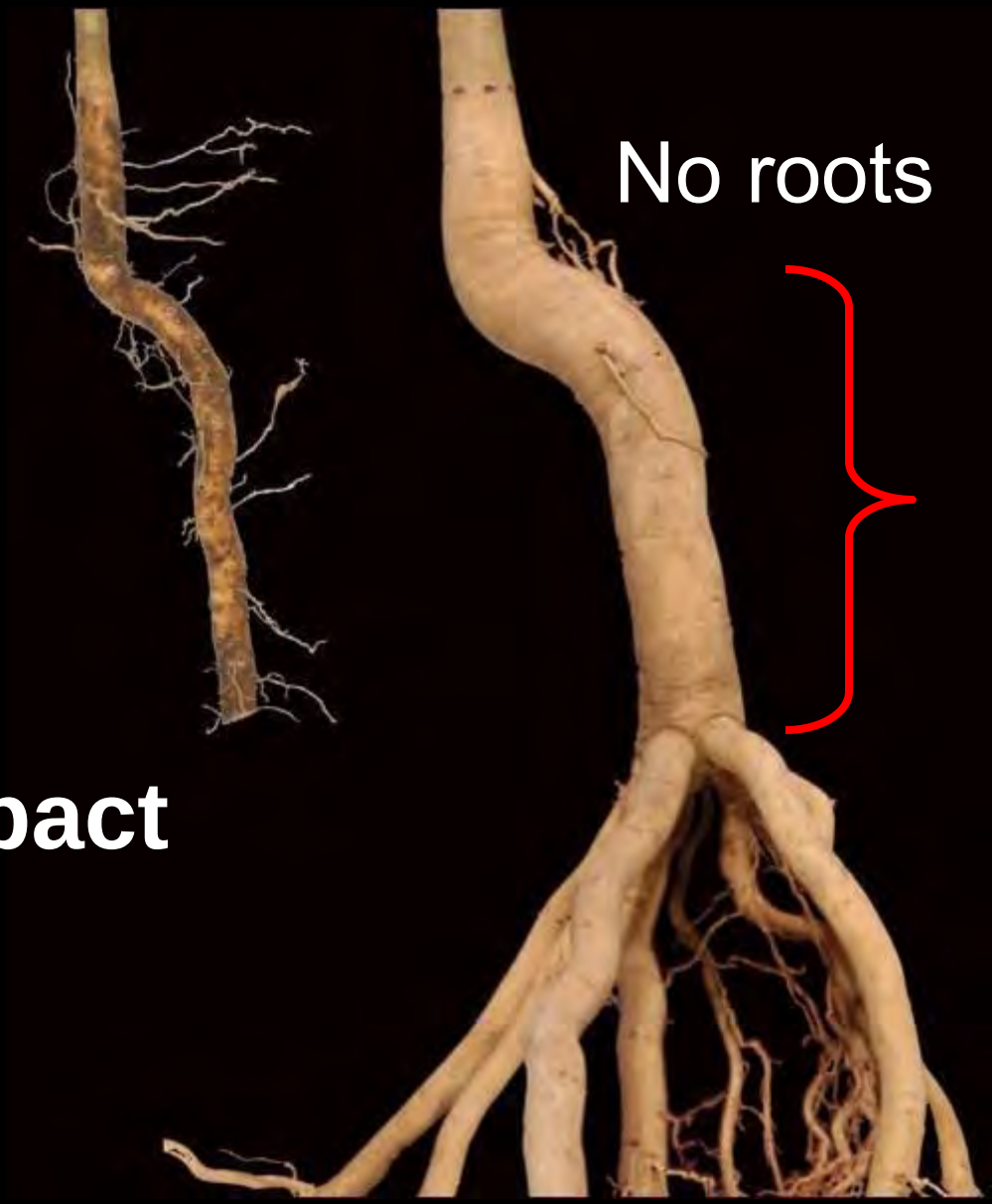
Photo: Gary Watson

Here's what's going on in the root system

Sudden impact

Photo: Gary Watson

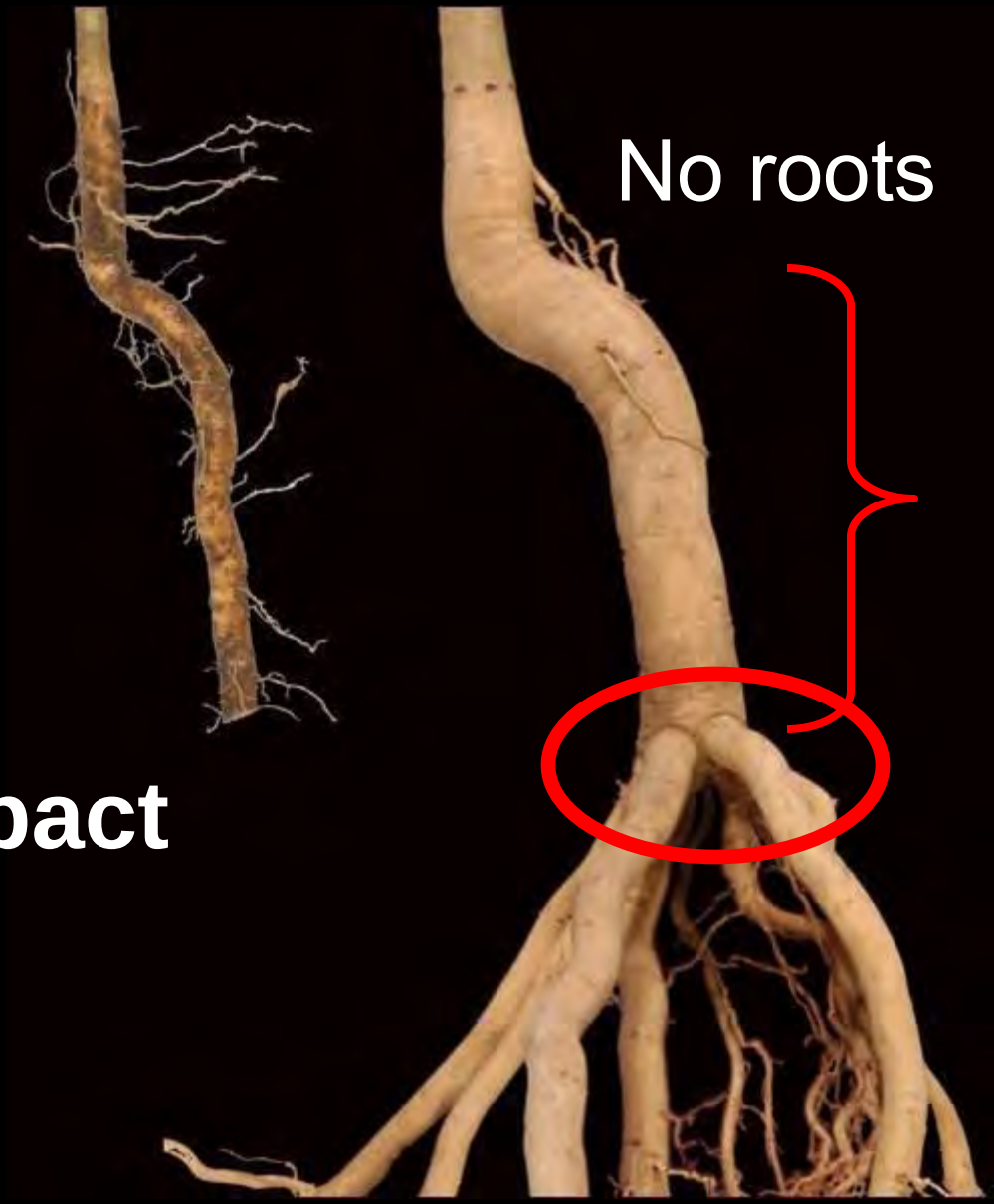
Pruning induced branching



Sudden impact

Hewitt and Watson, 2010

Pruning induced branching



Sudden impact

Hewitt and Watson, 2010

That is the origin of deep roots in root ball

1/4

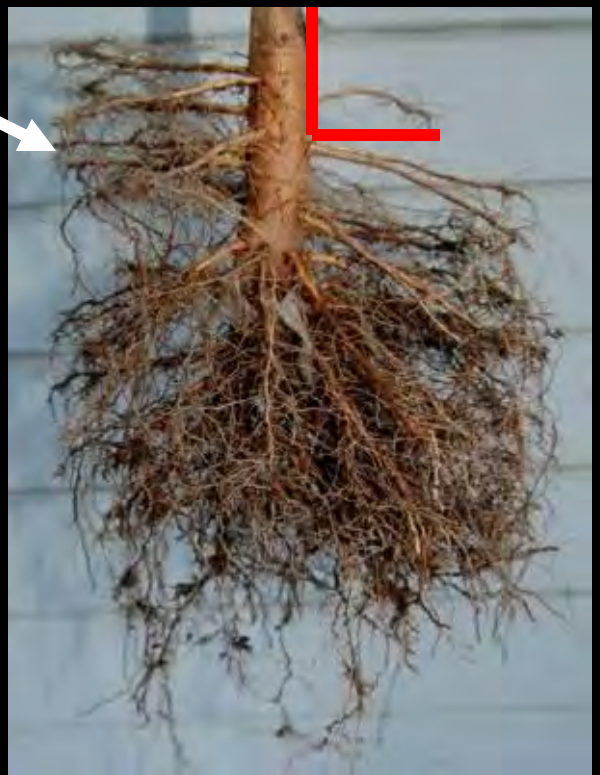
How does this happen?

1) Trees begin in the field
2) **Trees begin in a container**

Container grown

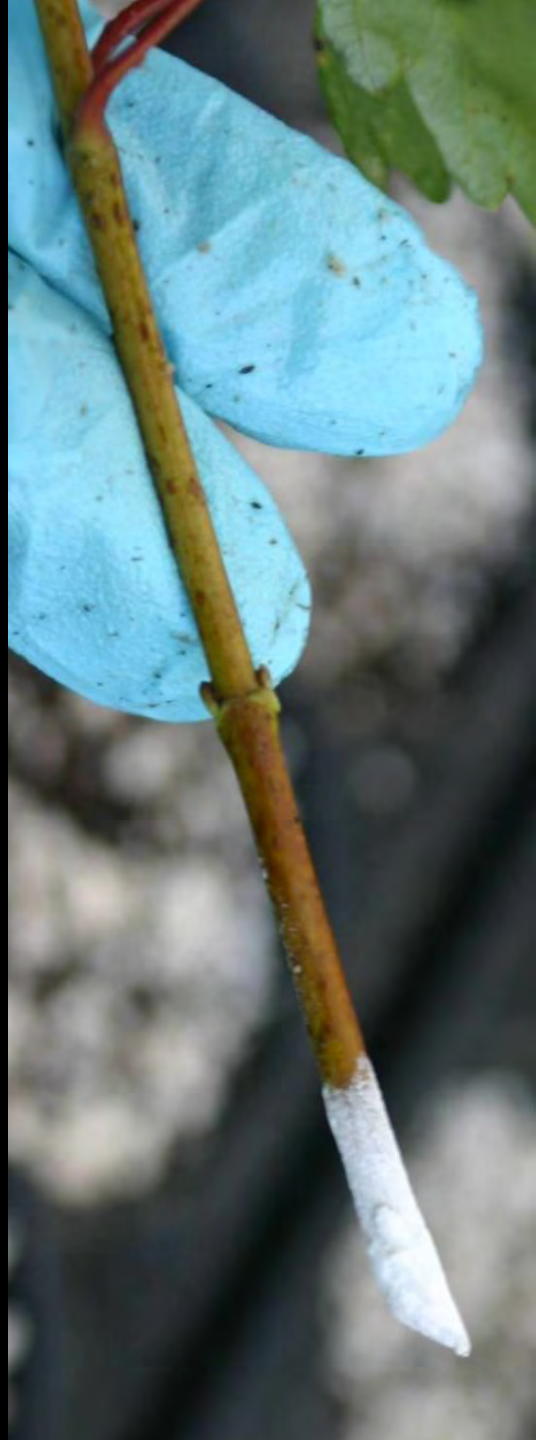
Roots grow primarily out the bottom

This has a better chance to turn into this than the other two



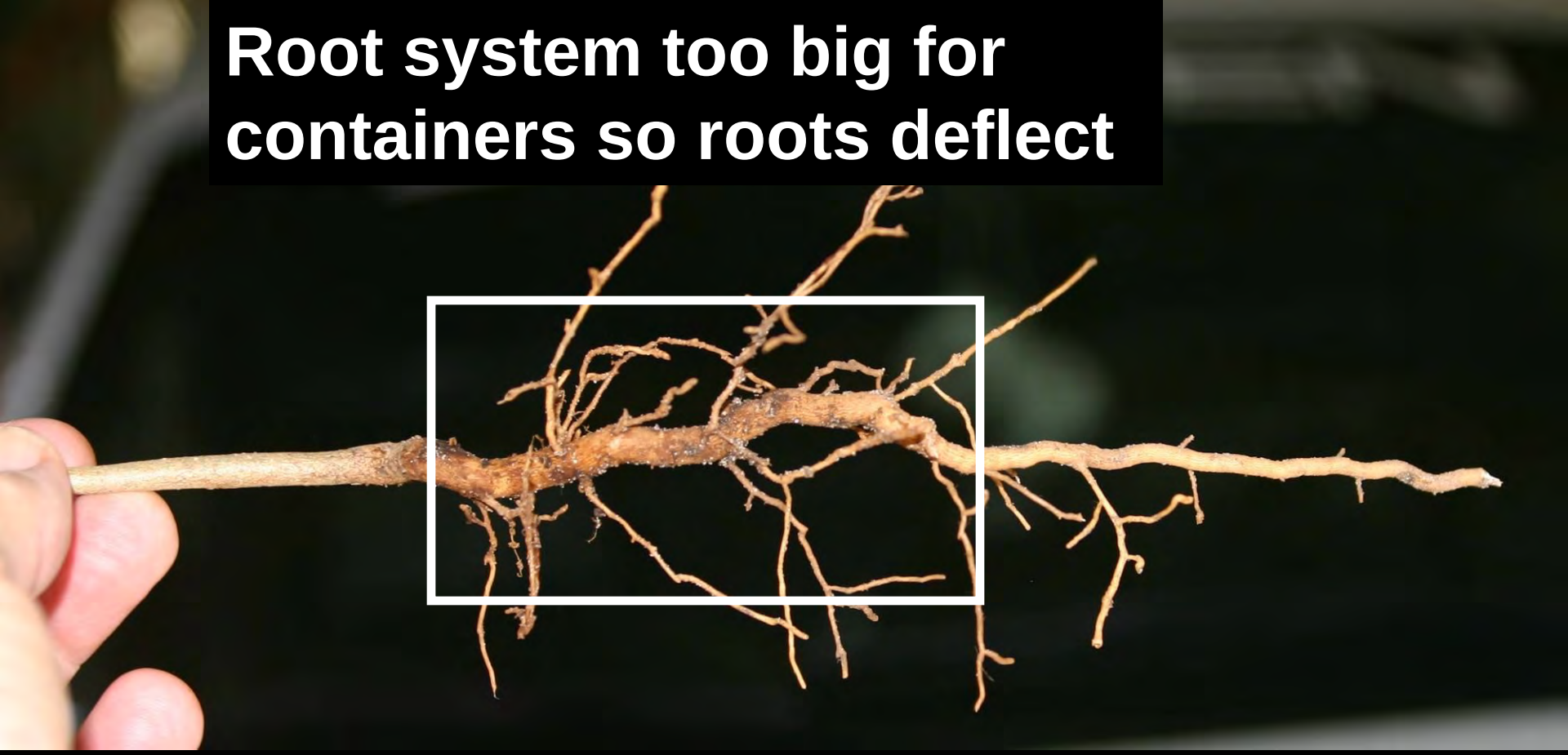
<u>Working Hypothesis:</u>
This is ideal root system

Quercus seeds into containers, *Acer* cutting into container



Roots are confined to container

Root system too big for containers so roots deflect



Root defects in containers

- Circling
- Diving
- Ascending
- Kinks

Diving

Lets wash this container out

Few lateral roots

New roots primarily coming out bottom of liner pot

Natural branching

Container branching


Ascending

Gilman et. al 2011

Question: Can we develop a root system that resembles a natural root system? YES

Outline for today

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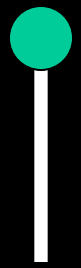
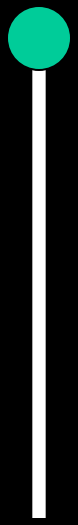
3” wide

Model of how a great root system develops

3” wide



3” wide



Air pruning

3” wide

Air pruning

Air pruning

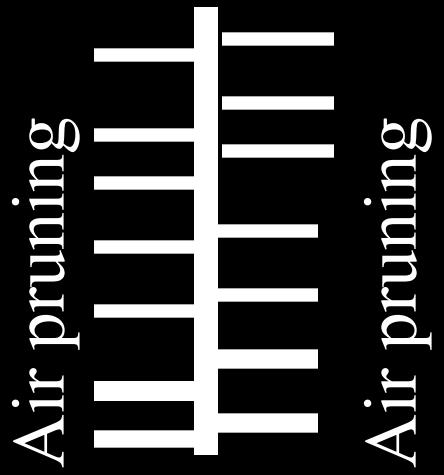
3” wide

3” wide

3” wide

Ready

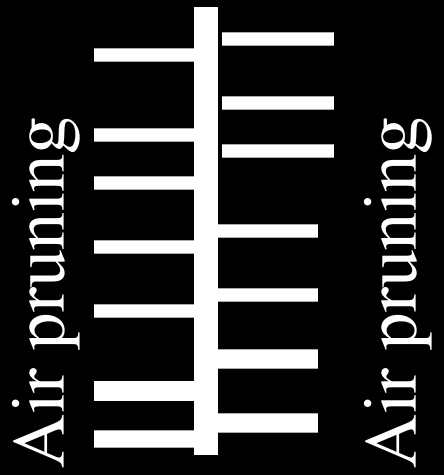
3” wide



Shift to a
3 gallon

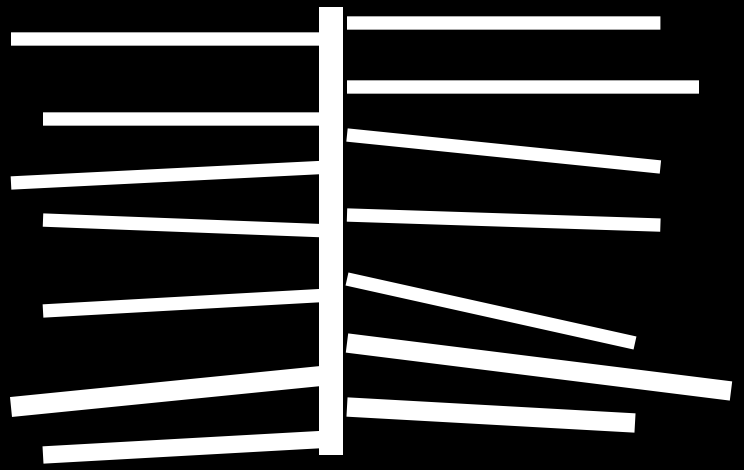
Ready

3” wide



Ready

3 gallon container



That retards root growth at the bottom

Photos: Brian Kempf

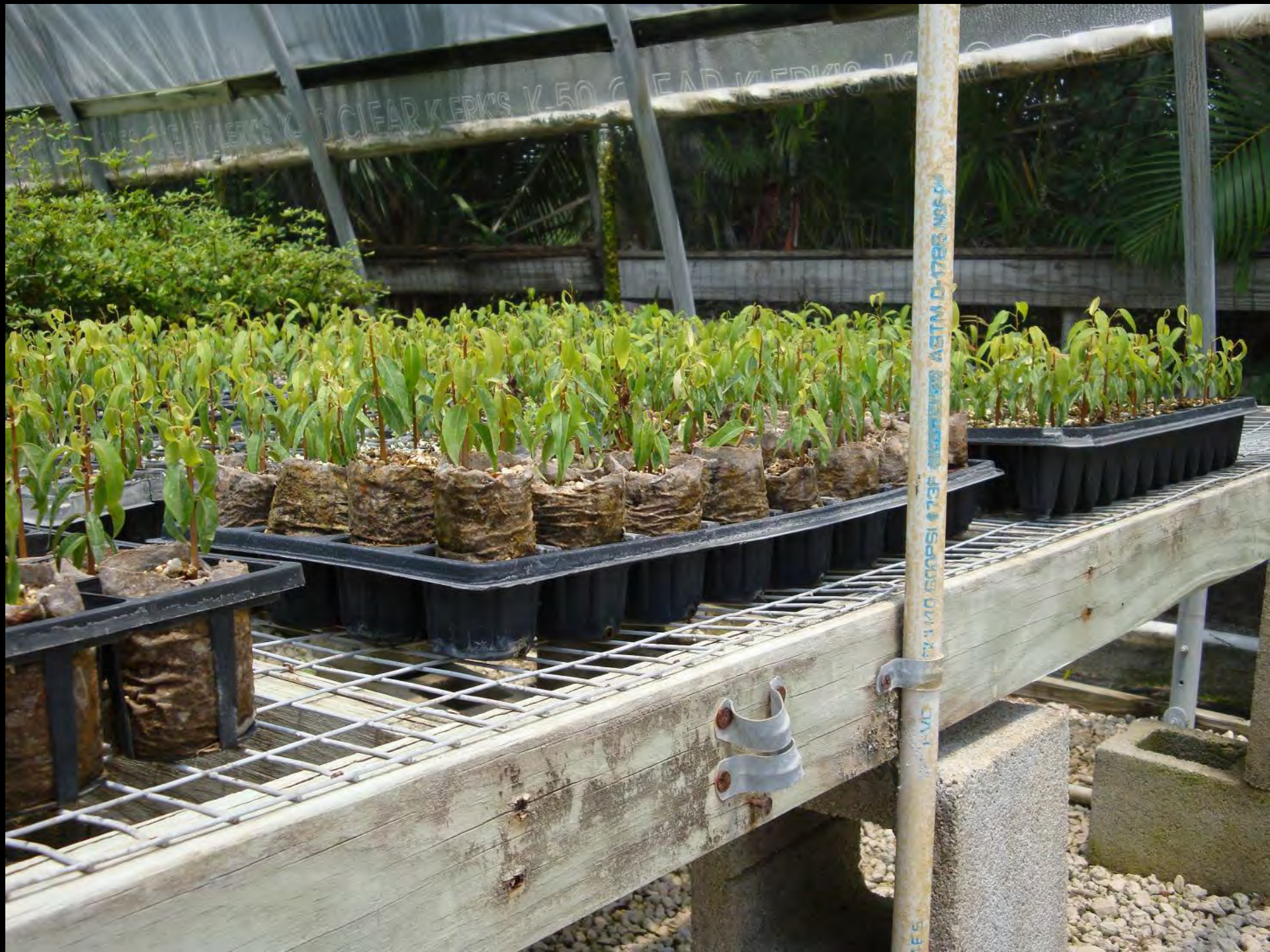
Air pruning container

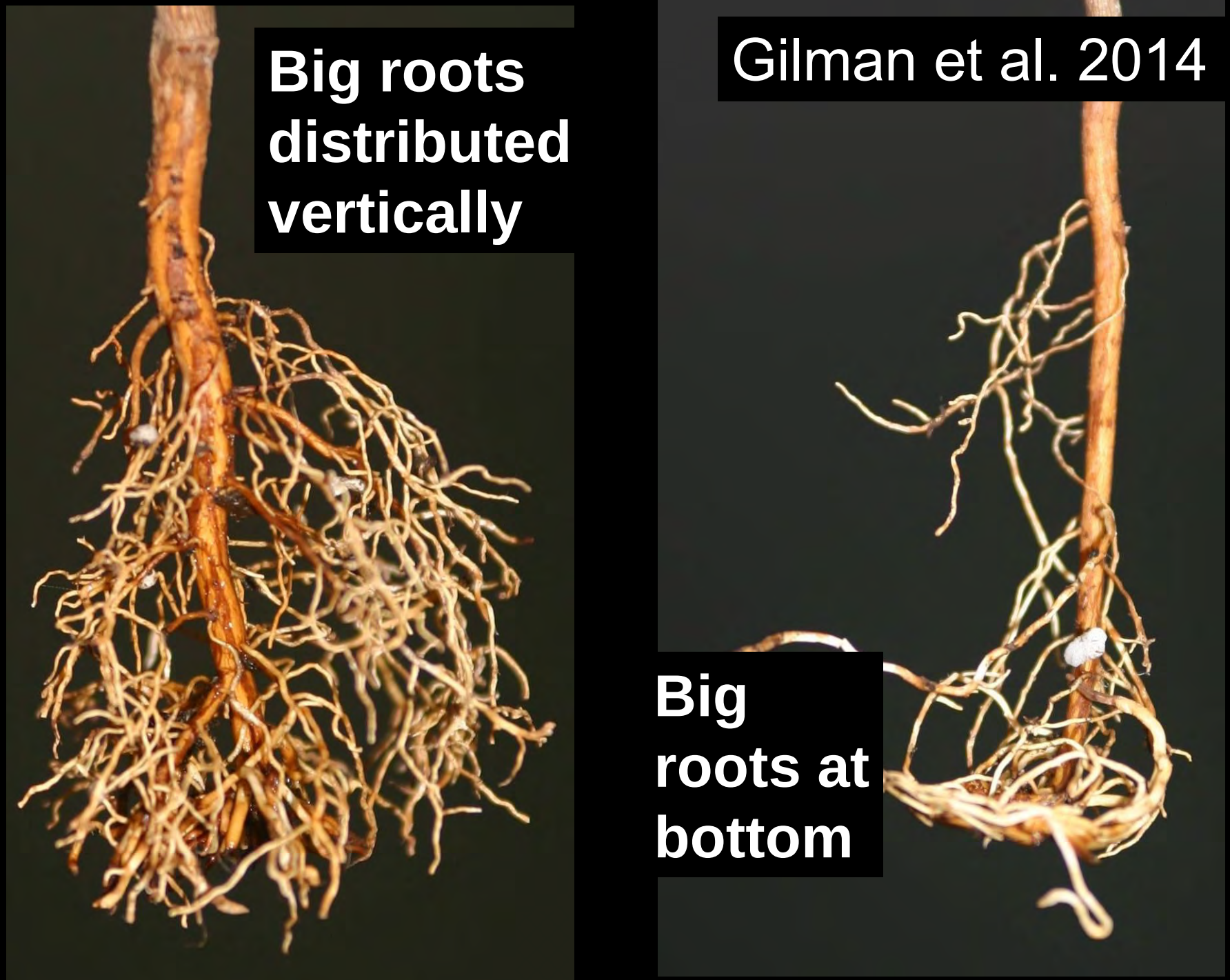
Pioneer pot
Air pot?
Fabric pot?
Jiffy pot
Ellepot

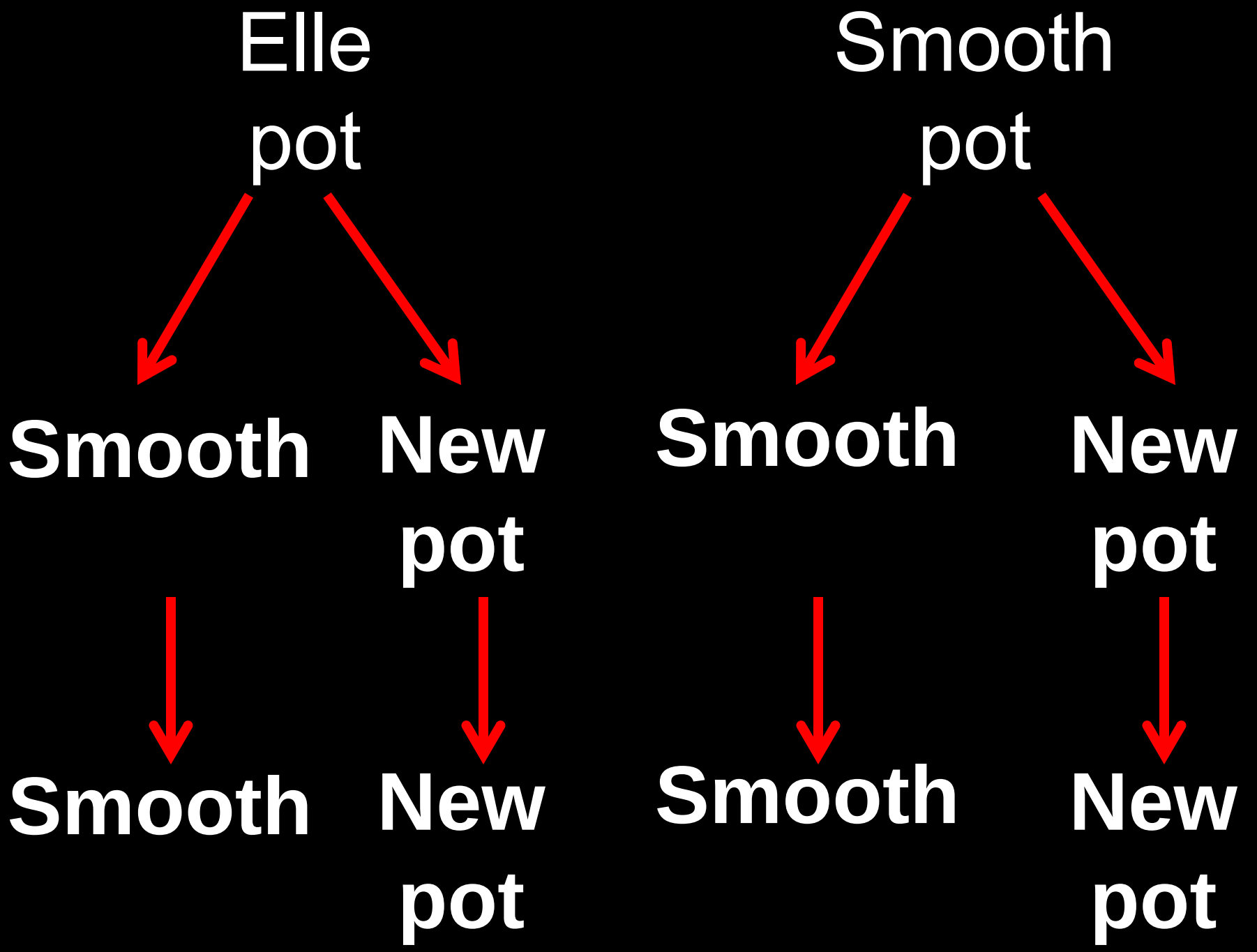
Air pruned at bottom

So, yes we can grow a better root system

So want this instead of this?



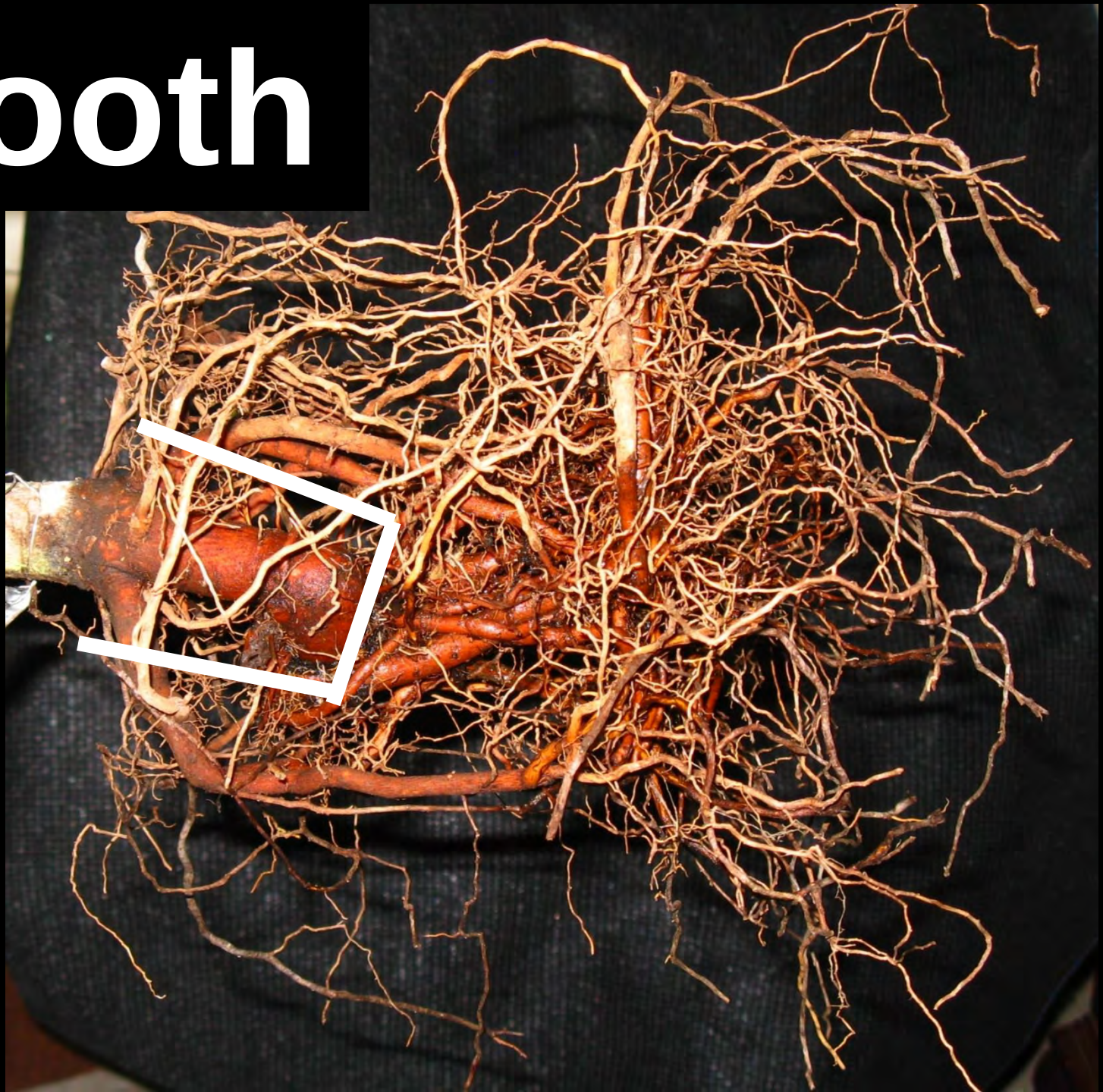

Big roots distributed vertically
Gilman et al. 2014
Big roots at bottom

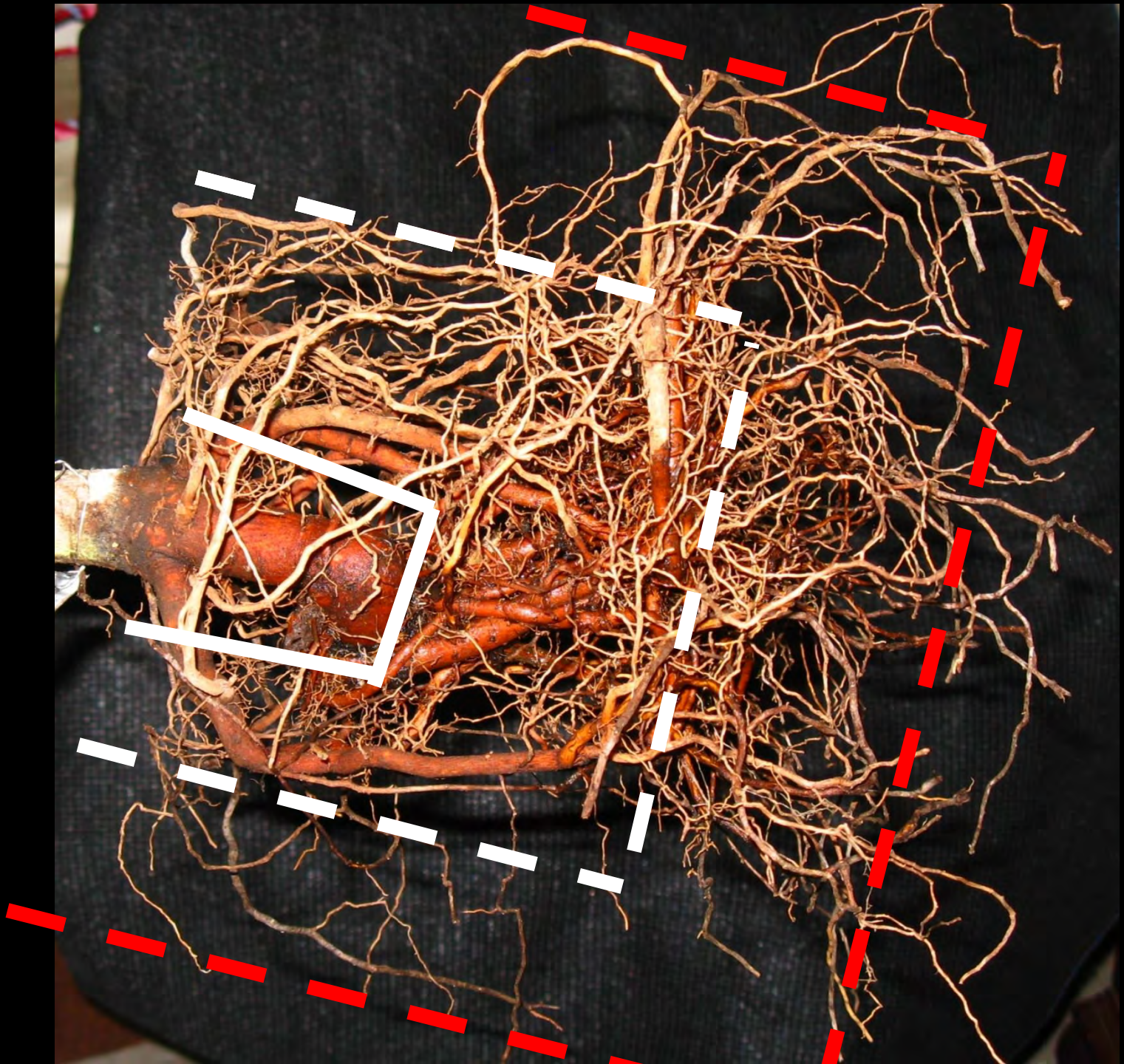

Elle pot
Smooth pot
Smooth
New pot
Smooth
New pot
Smooth
New pot
Smooth
New pot

Elle pot into smooth

Elle pot into

Smooth





1/2

Porous sides

This should make a great whip to go into a field nursery

Beautiful

40 of each went into the ground


10 months later


Winched trees to simulate about a 90 kph wind


18 degree lean


28 degree lean

18 degree lean

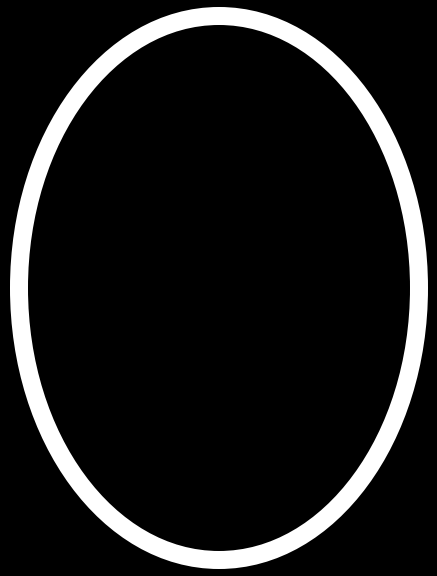
28 degree lean

18 degree lean

28 degree lean

Wood mass is more widely distributed in root system on the left

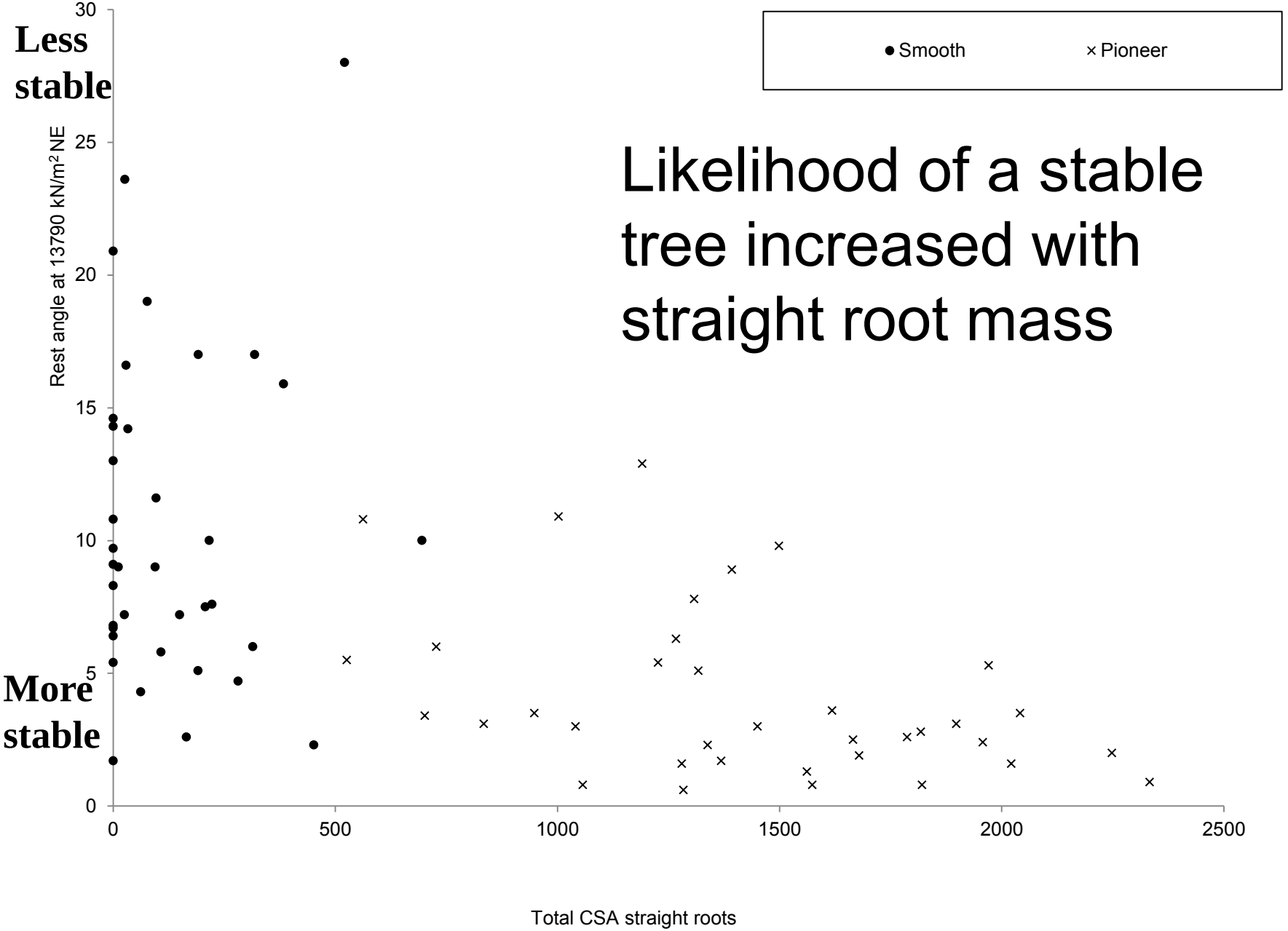
Wood orientation



18 degree lean

28 degree lean

Wood mass is more widely distributed in root system on the left



Likelihood of a stable tree increased with straight root mass

Factors correlated with anchorage

- Straighter roots = more anchorage; $r = 0.84$
- Lower imprint rating = more anchorage; $r = 0.78$

Conclusion: Superior root ball root system shown above

Conclusion: Superior root ball root system shown above

Removing the outer “shell” of roots Gilman et. al 2013


Root pruned *Acer*


No root pruning

Oct 2008

One year later


No
pruning


No pruning

Root pruned

Root pruned


Gilman et al. 2010


TIMEX


TIMEX

Root ball shaved

Root ball shaved

Shave off the outer roots at planting


Root ball not shaved
15 gal
container


Root ball not shaved
15 gal container
3 gal container

3/4

Outline for today

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We compared tree anchorage in wind

(Gilman and Masters 2010)

- Smooth-sided 45 gallon containers
- Field-grown (B&B)

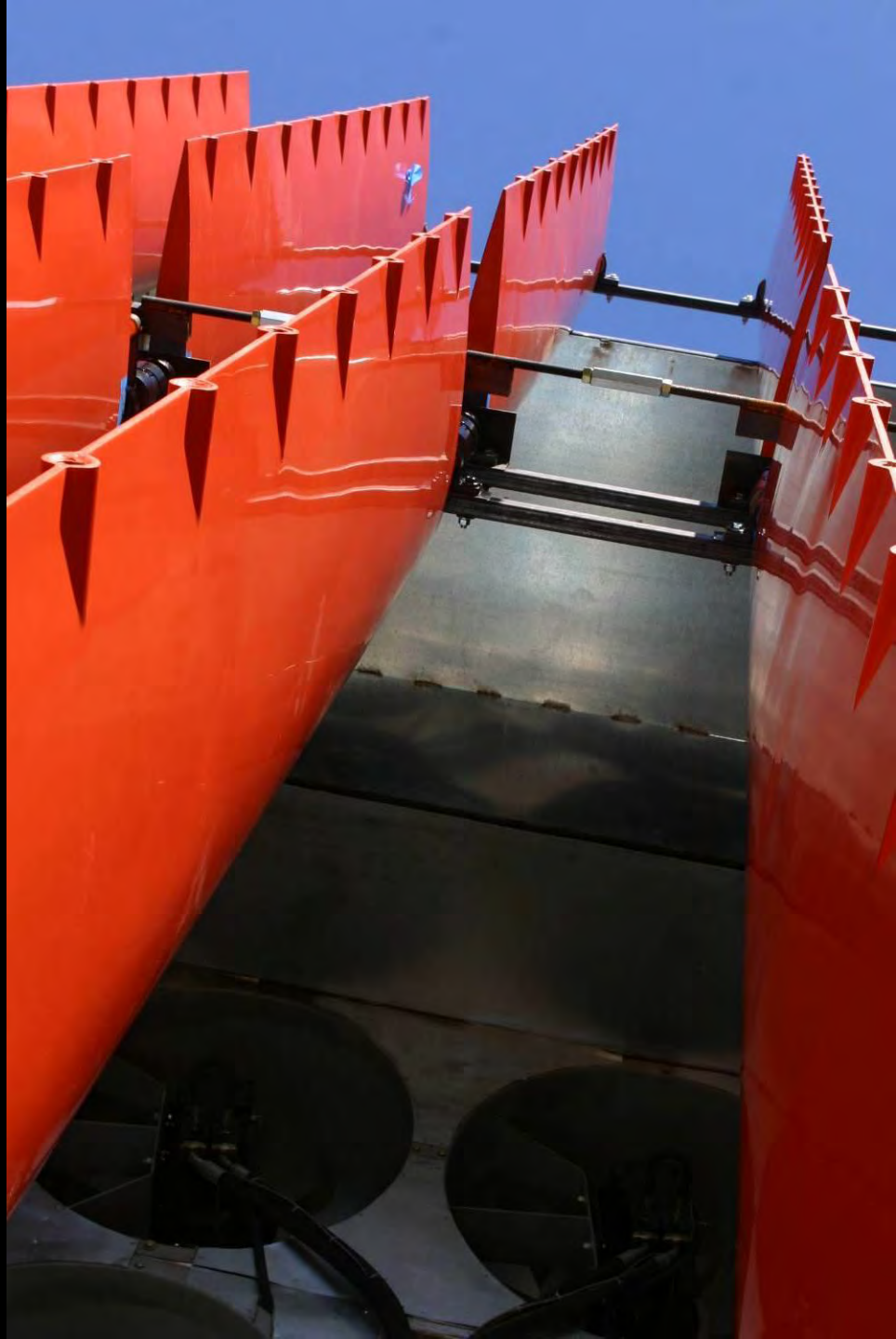
…… planted three years earlier (2005).


LA513
KUBOTA


KUBOTA

Three years later


CAUTION
HIGH WINDS
STAY CLEAR



Largest portable wind tunnel in the world
3,000+ horsepower


$500,000 machine


Roots not straight

Straight roots

- 115 roots per tree
- Root diam. 8.3mm

In the nursery, we need to start managing roots much earlier

Good

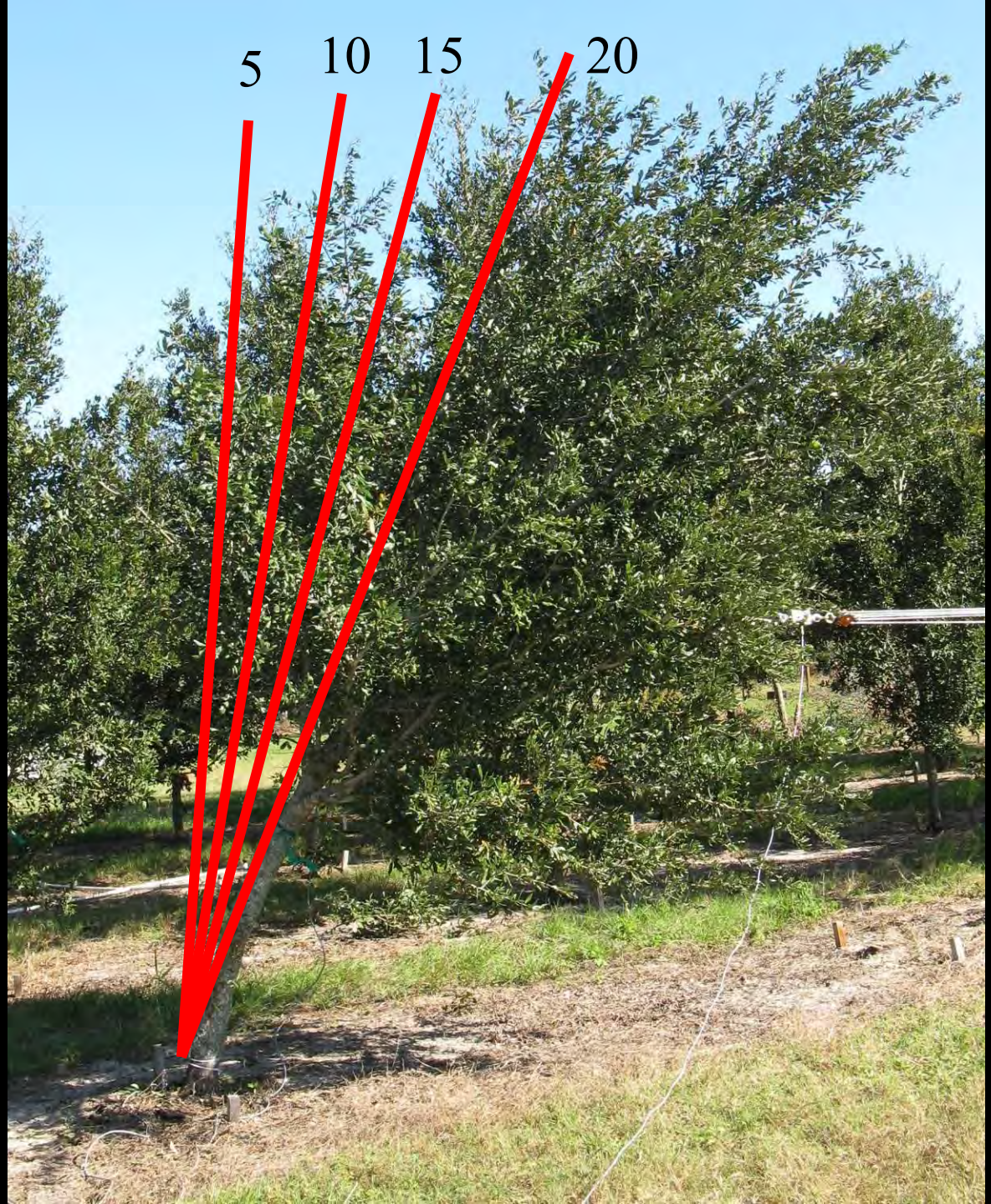
Not good

Can we increase anchorage with root ball slicing? Gilman et al. 2010

Quercus: Some sliced, some not

Root ball slicing

Three years later



Trees pulled to 25 degrees in increments of 5 degrees

Results

- Slicing root balls top to bottom did not result in more roots growing into landscape soil
- Sliced root balls were not better attached to the soil


Diving root that was cut generates new roots July 2007


July 2007 –
close-up

July 2009 – close-up

Summer 2013

15 gallon oaks into the landscape

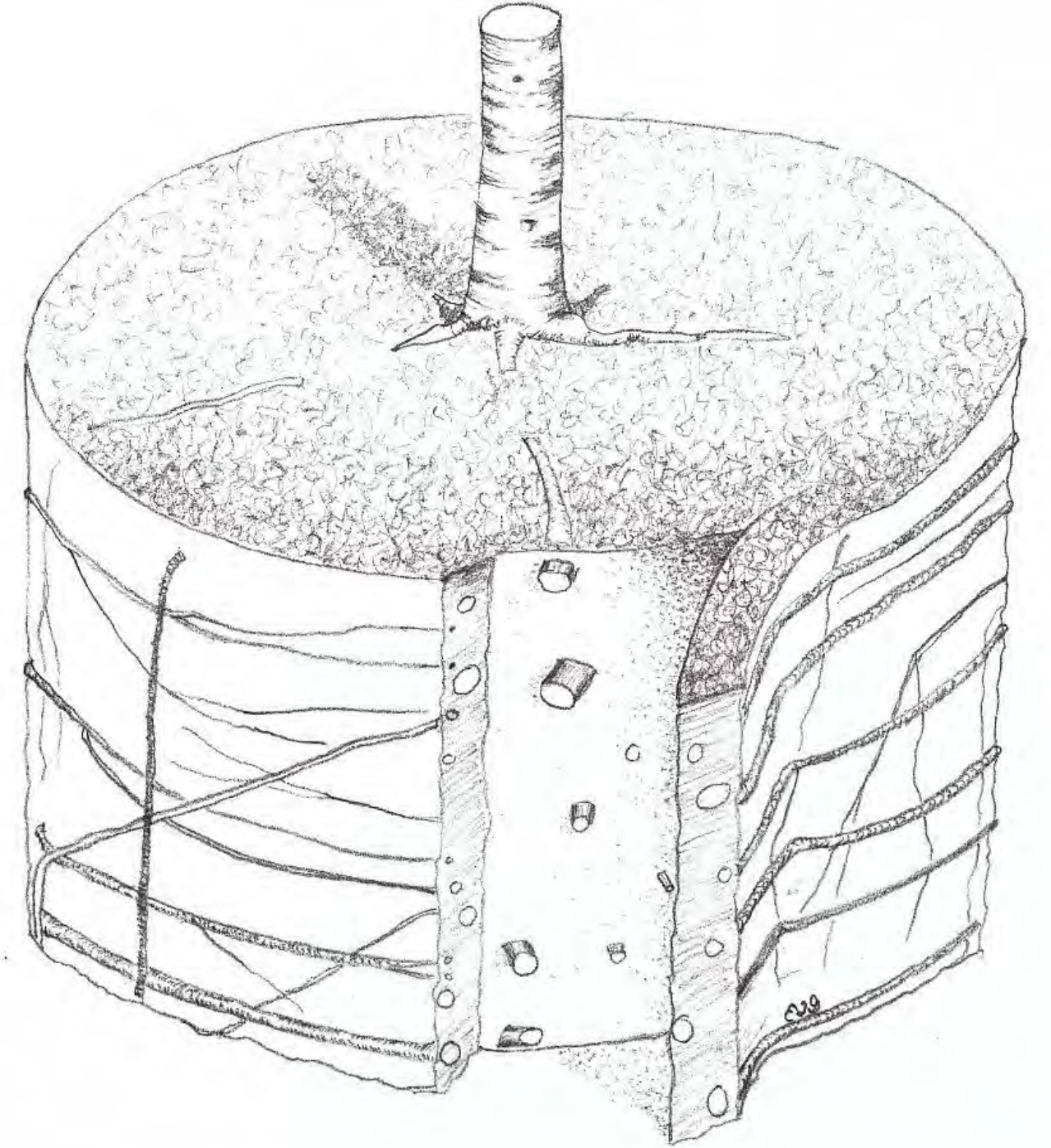
3 treatments

Gilman et al. 2011

- No root pruning
- Slicing root ball
- Shaving root ball

Slicing radially

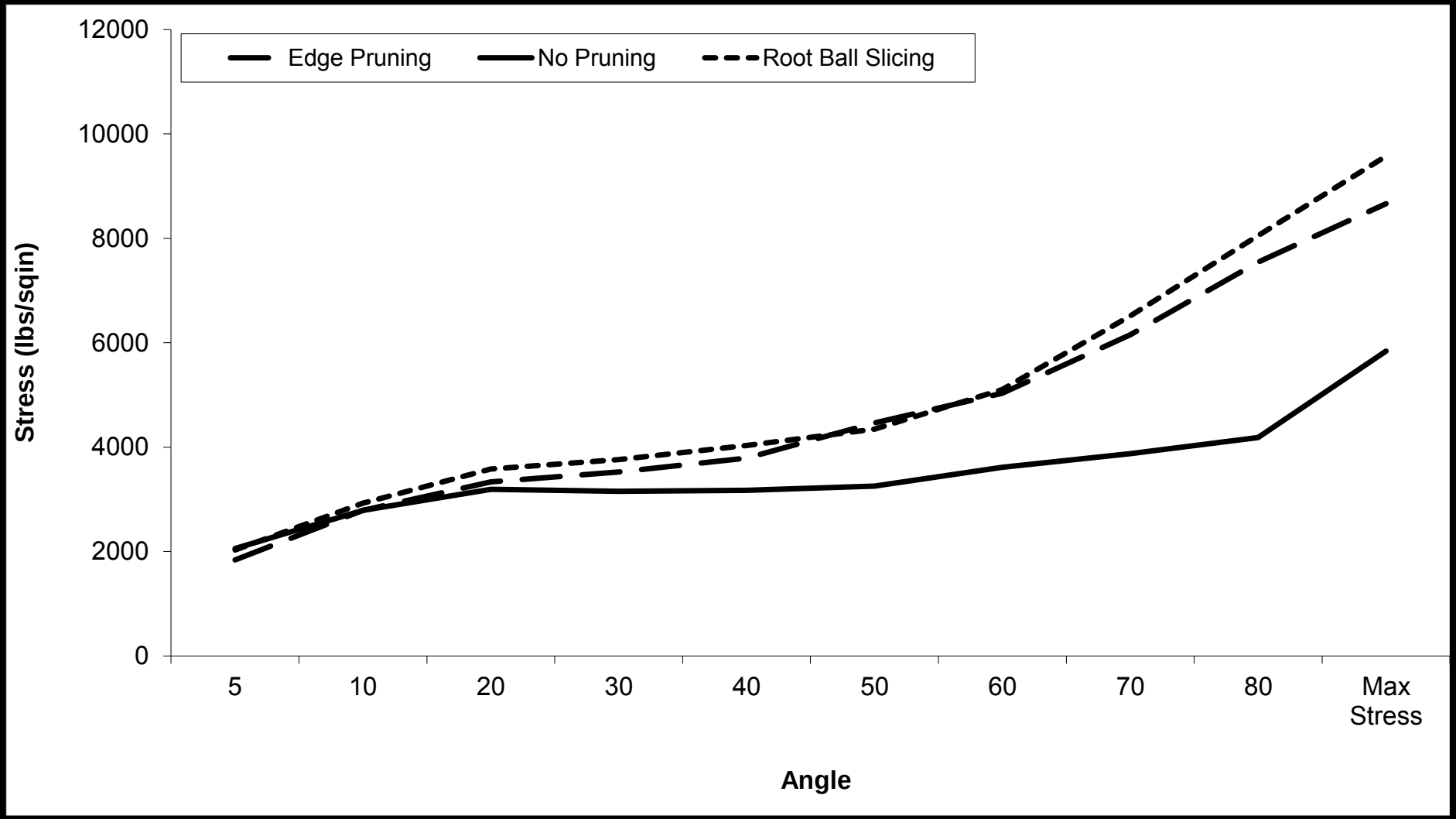
Root ball shaving accomplishes this



Shaving tangentially

Shaving

Bending stress to pull trees over



Shaved at planting

The straighter the roots, the better the anchorage

5 years after planting

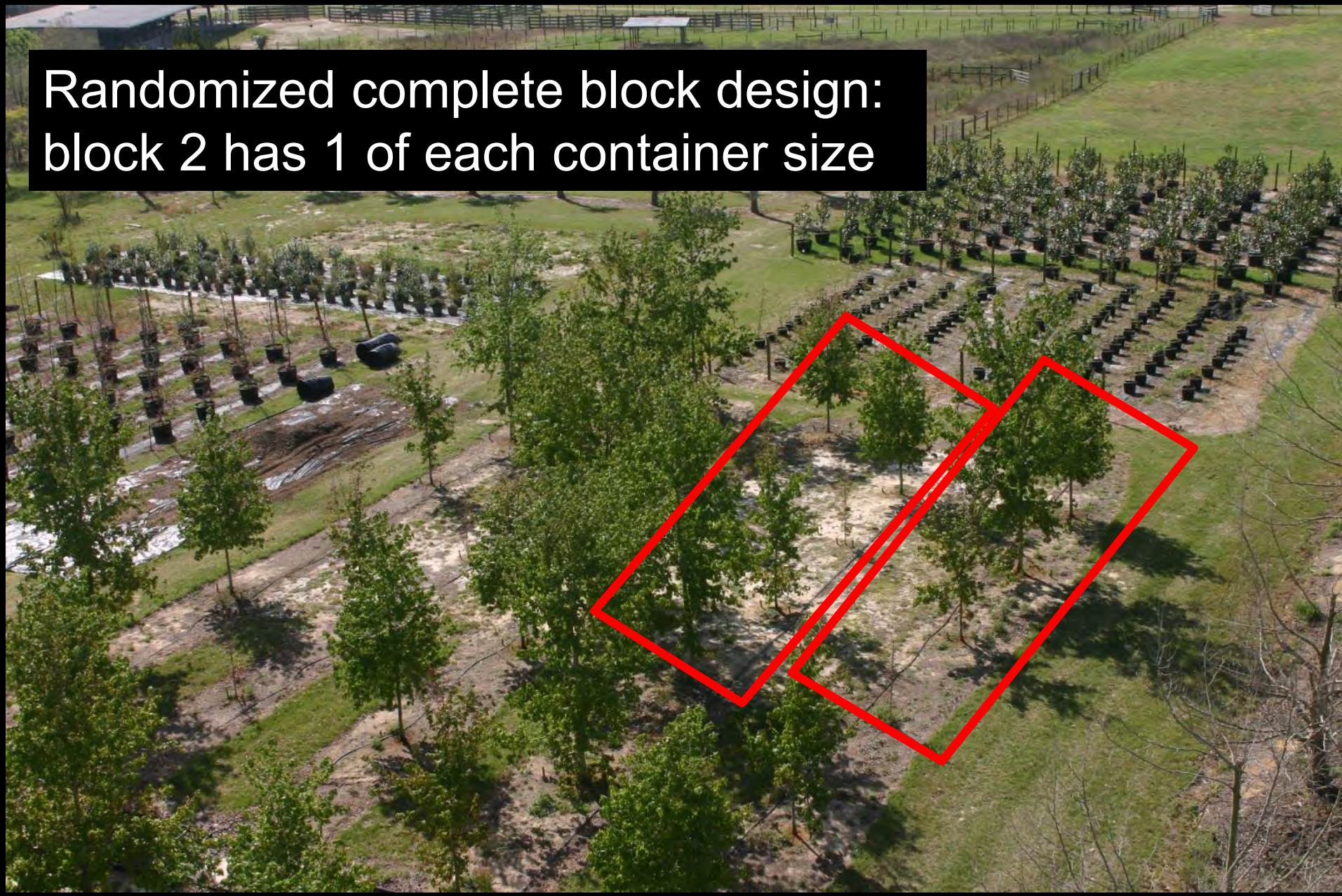
Roots over flare NOT removed at planting

Roots over flare removed at planting

Impact of initial tree size on growth, establishment, stability: *Acer* (2006-2012) Gilman et al. 2013

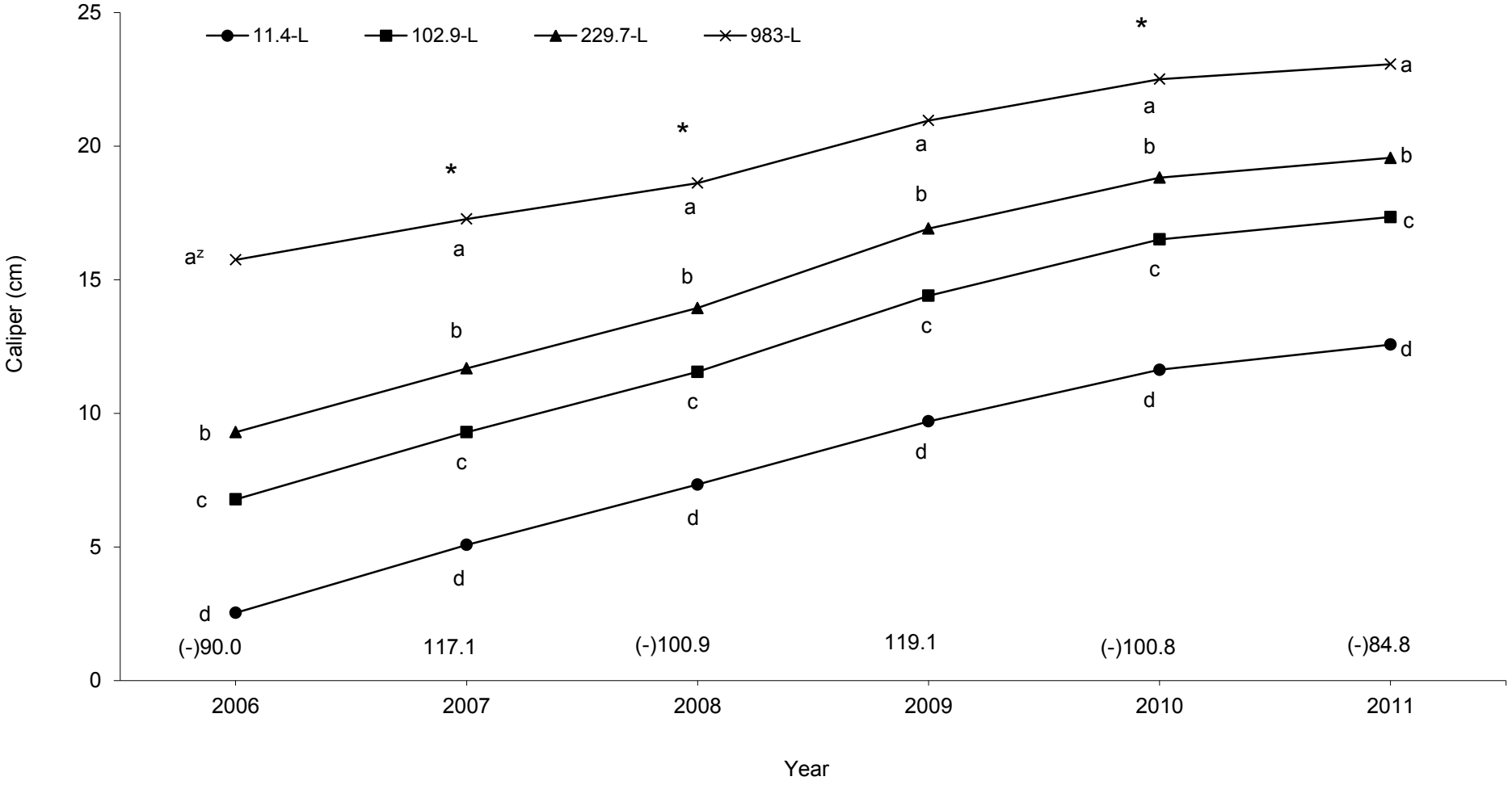
- 3 gal.
- 25 gal.
- 65 gal.
- 300 gal.

16 blocks of 4 treatments



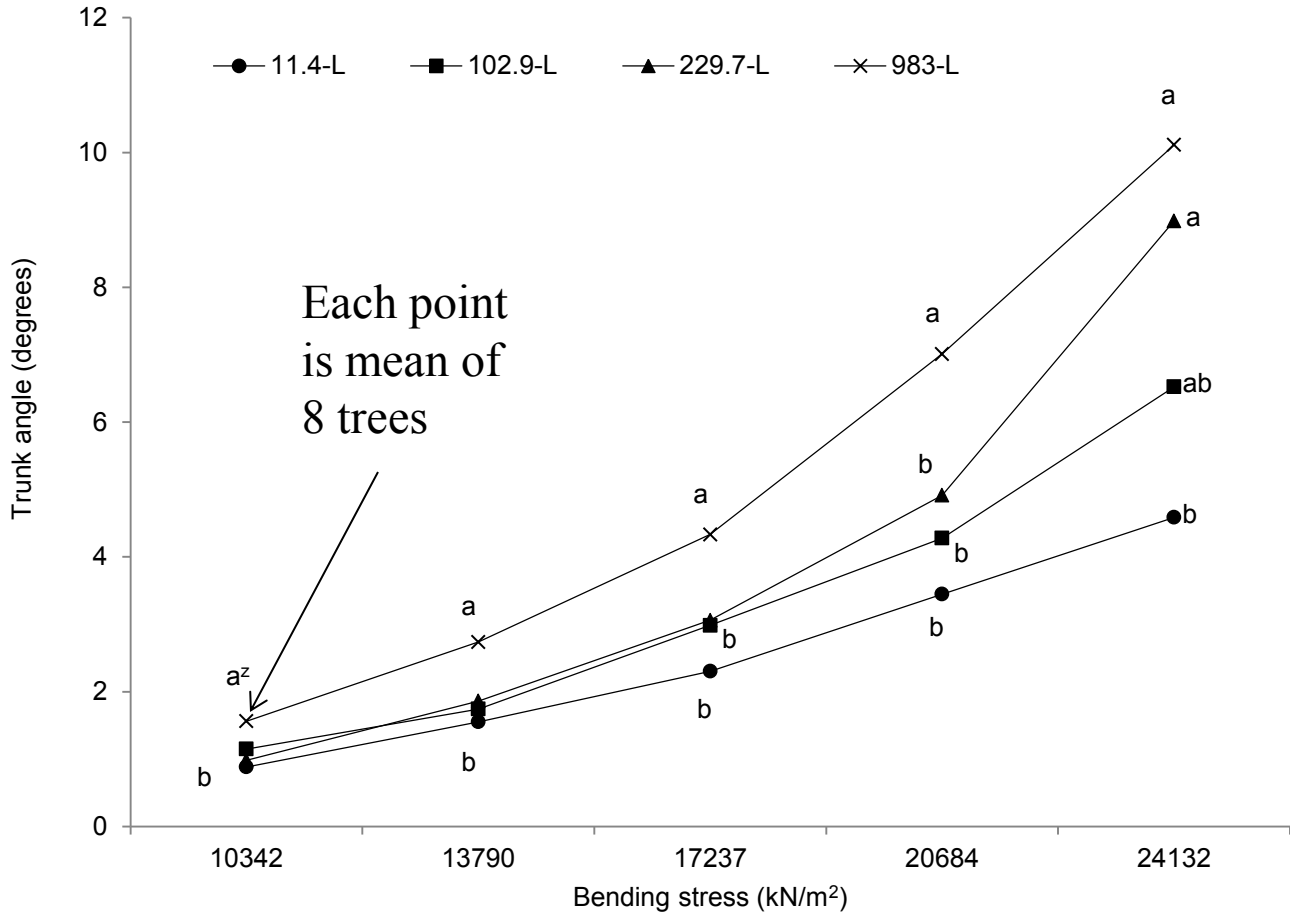
Did anchorage depended on tree size at planting?

Trunk diameter growth first 6 years after planting



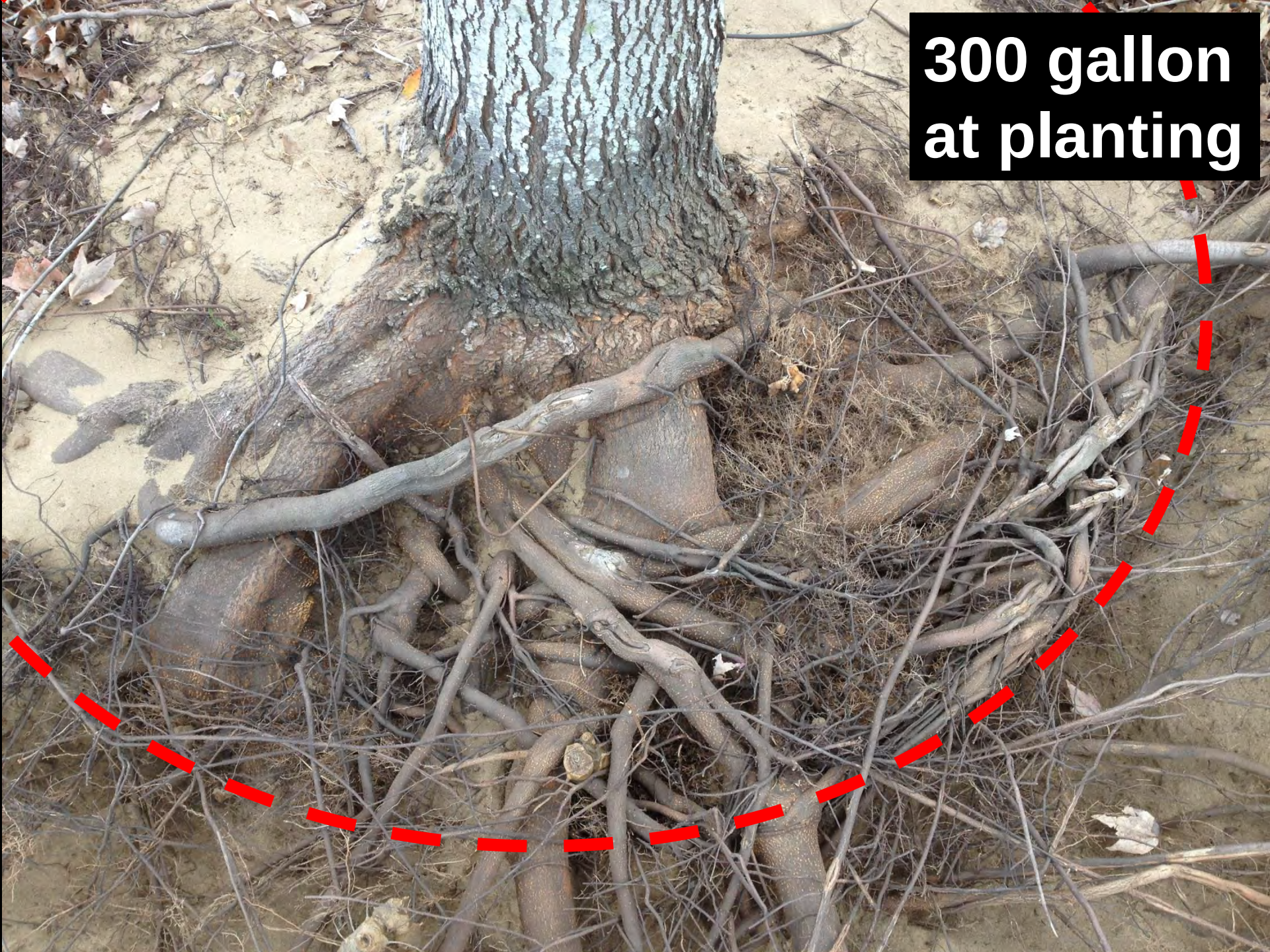

JOHN DEERE

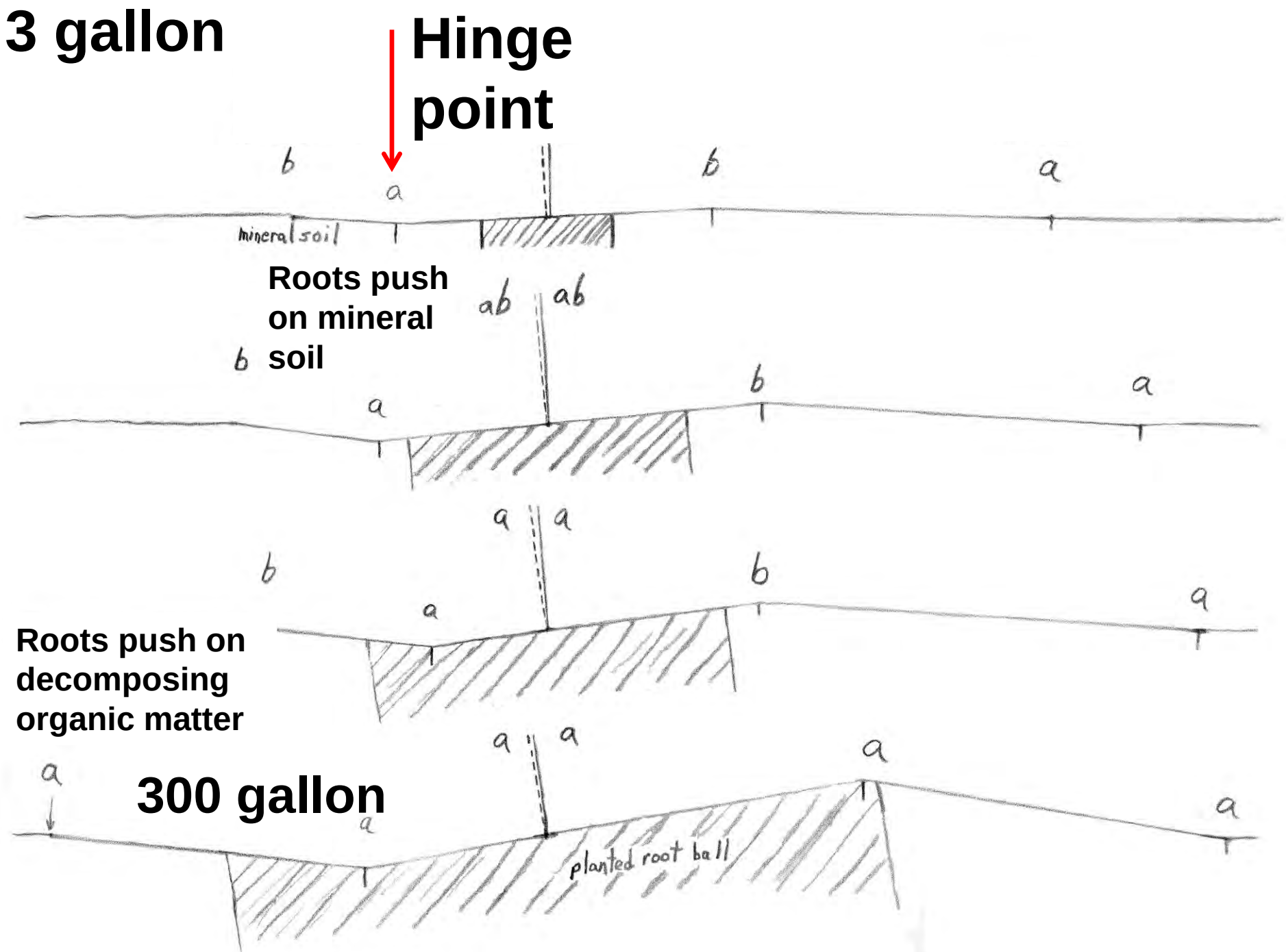
Trunk angle for 4 container sizes pulled at 5 stresses




3 gallon at planting

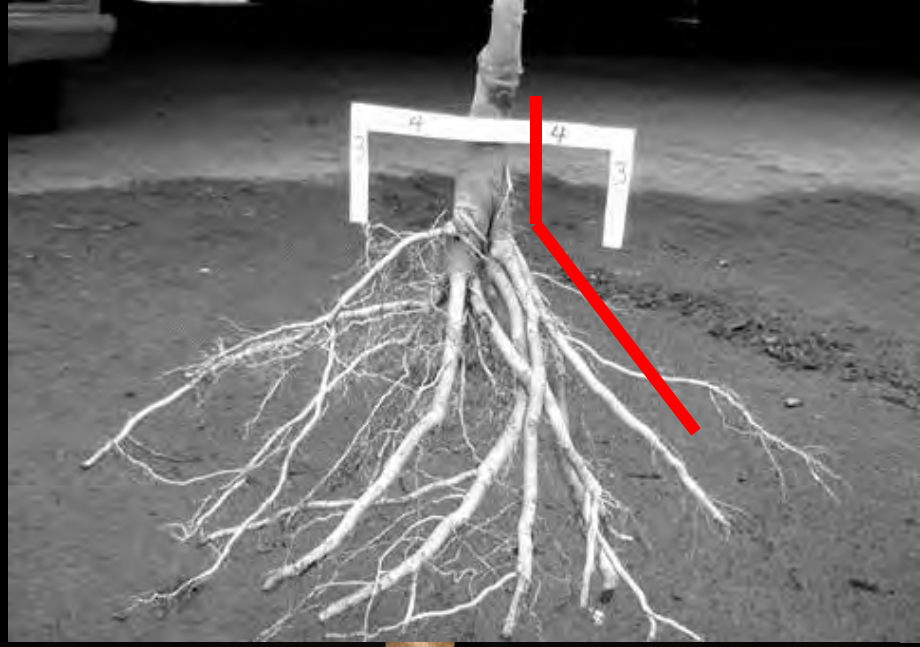

300 gallon
at planting

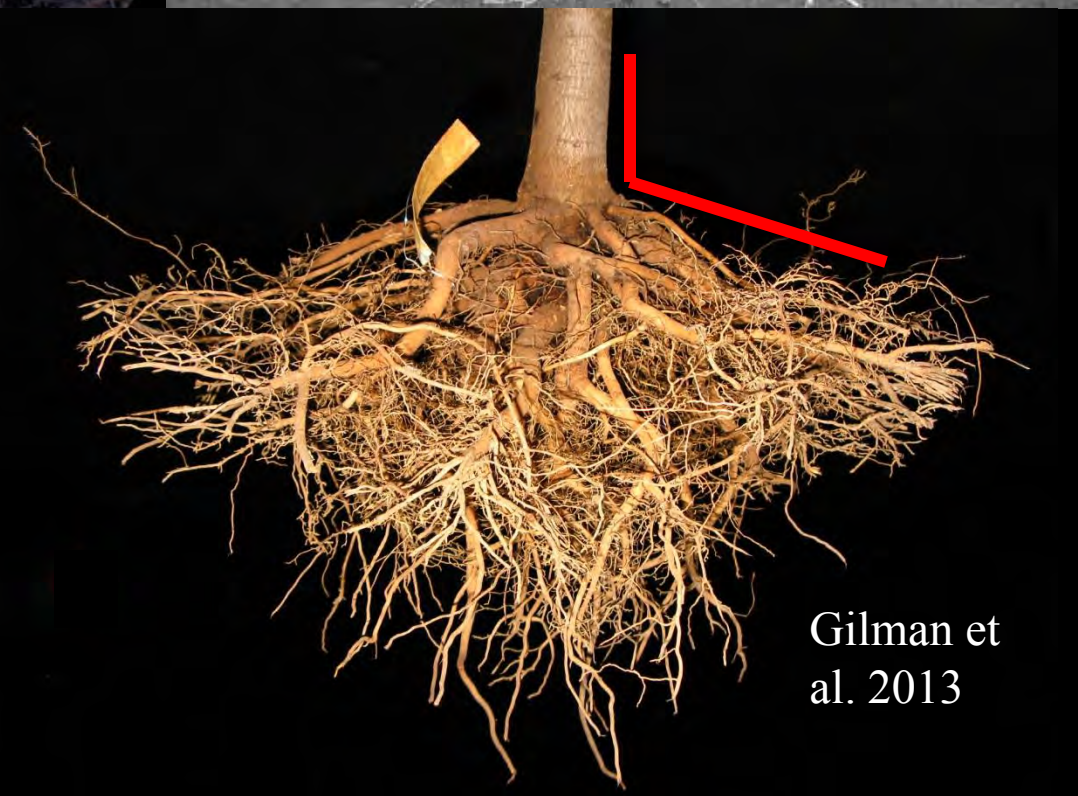

300 gallon
at planting


3 gallon
Hinge point
b
a
b
a
mineral soil
Roots push on mineral soil
ab
ab
b
a
b
a
a
a
b
a
b
a
Roots push on decomposing organic matter
a
a
a
a
a
300 gallon
a
planted root ball

In conclusion

- Large straight roots with some at the surface are important
- Write modern nursery stock specifications
- Write modern planting specifications





Gilman et al. 2013

Thank you very much

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