Pruning Automation

AUTOMATION OF DORMANT PRUNING OF SPECIALTY CROPS

Pruning by the Numbers

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The Numbers?

- Need measurable benchmark

1. To develop robotic pruning
   - What limbs to cut?
   - Threshold (when to stop?)
   - What & how much data needed?
2. To evaluate: how did we do?
3. Need for manual pruning too

Pruning Automation

AUTOMATION OF DORMANT PRUNING OF SPECIALTY CROPS

Forget the Art of Pruning—it's all Science

PURDUE UNIVERSITY

VISION ROBOTICS Corporation

PENNSTATE

USDA

USDA

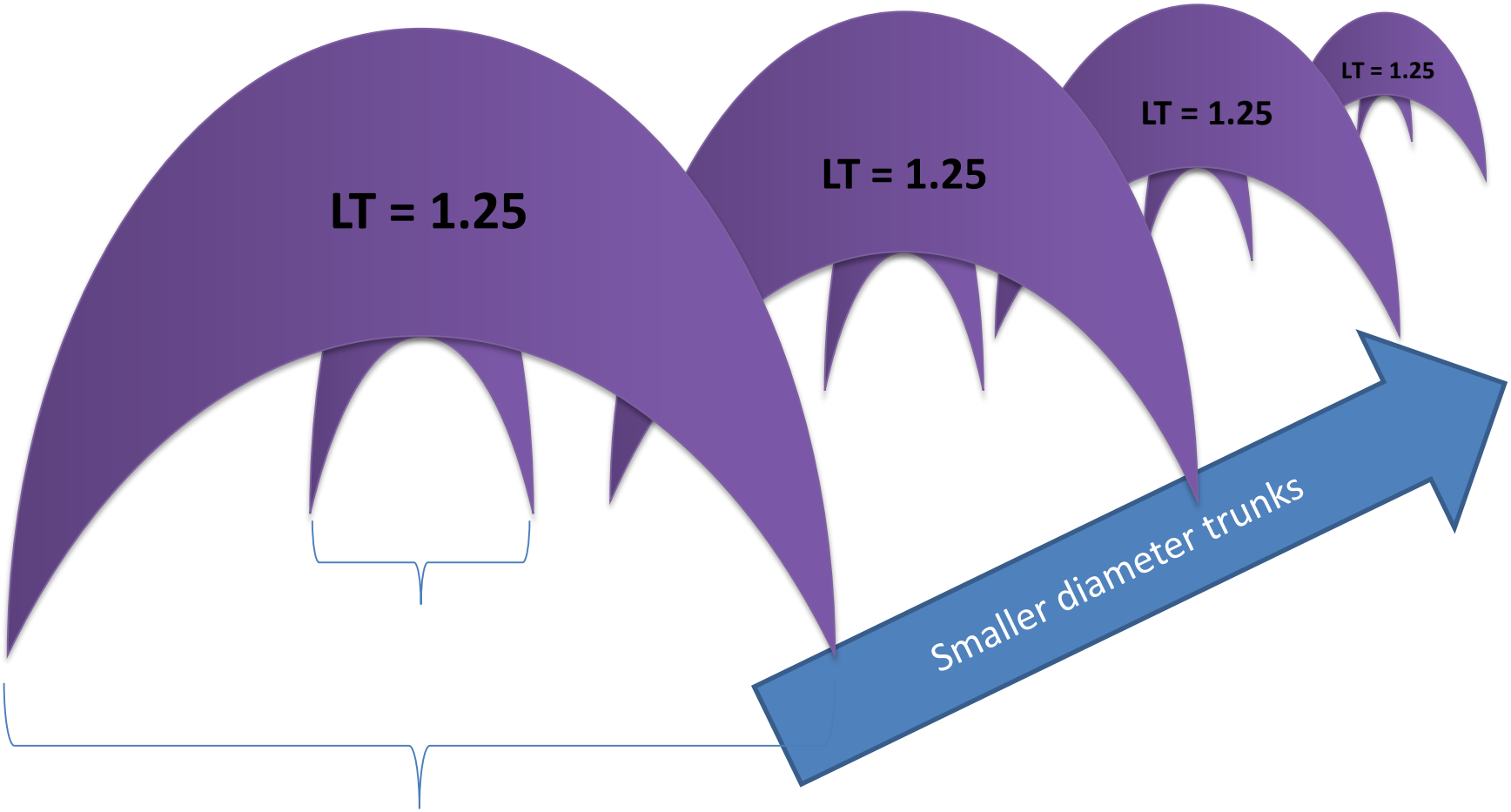
Tall Spindle

- World standard
- Productive, quality
- Common canopy features
- Minimal branching
- One simple target

Severity: Limb - Trunk Ratio

- Measure diameter of each limb on 4 trees
- Measure the trunk diameter at 12 inches
- Calculate sum [LCSA] and TCSA.
- Choose desired LT ratio.
- Prune **largest successive limbs** to desired LT ratio.

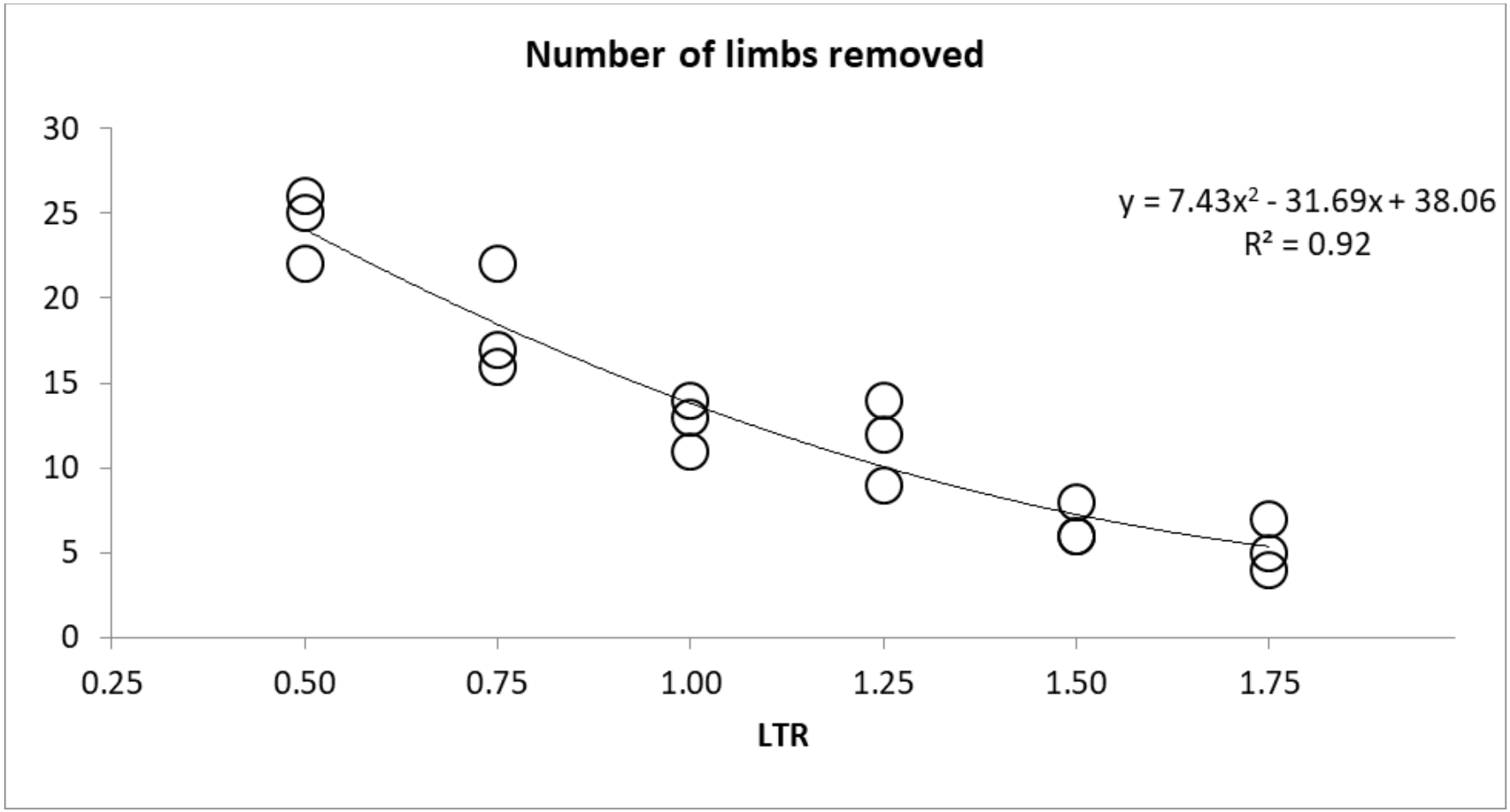
MD: Maximum Allowable Branch Diameter



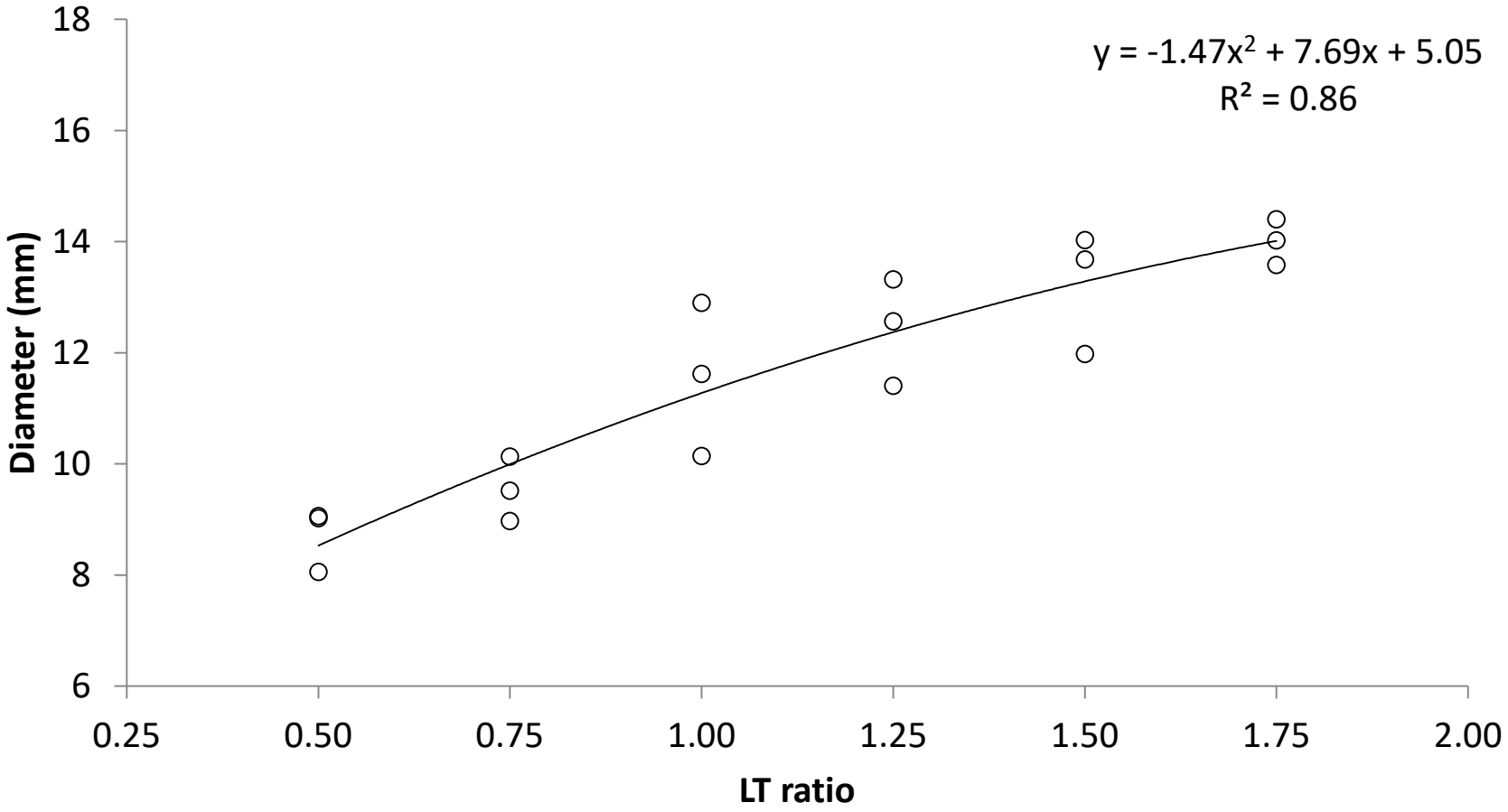
Pruning Severity Treatments

Unpruned LTR = 1.25 LTR= 1.00 LTR = 0.50

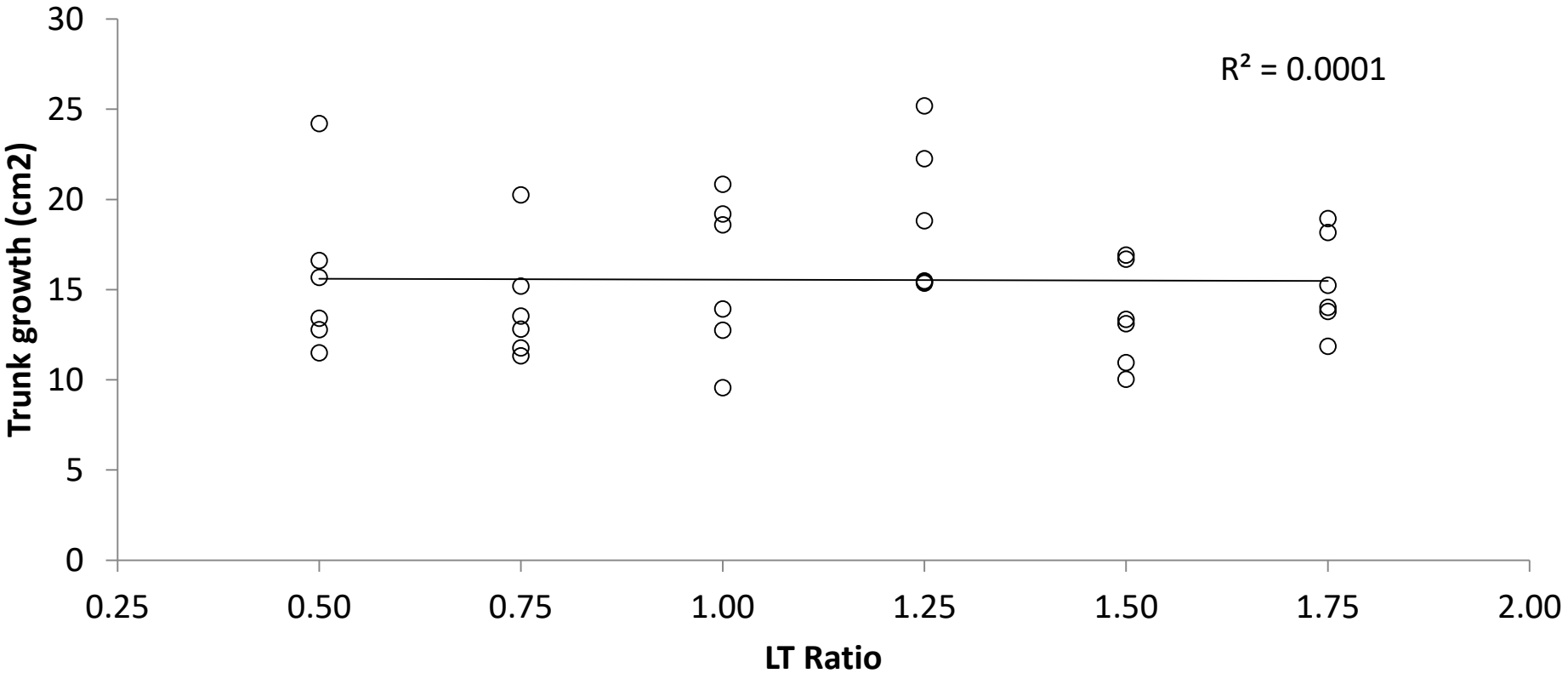
Remove a sequence of limbs, always removing the largest remaining limb until the level of severity meets the target value


Number of limbs removed
30
25
20
15
10
5
0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
LTR
y = 7.43x² - 31.69x + 38.06
R² = 0.92

Max remaining limb diameter after pruning

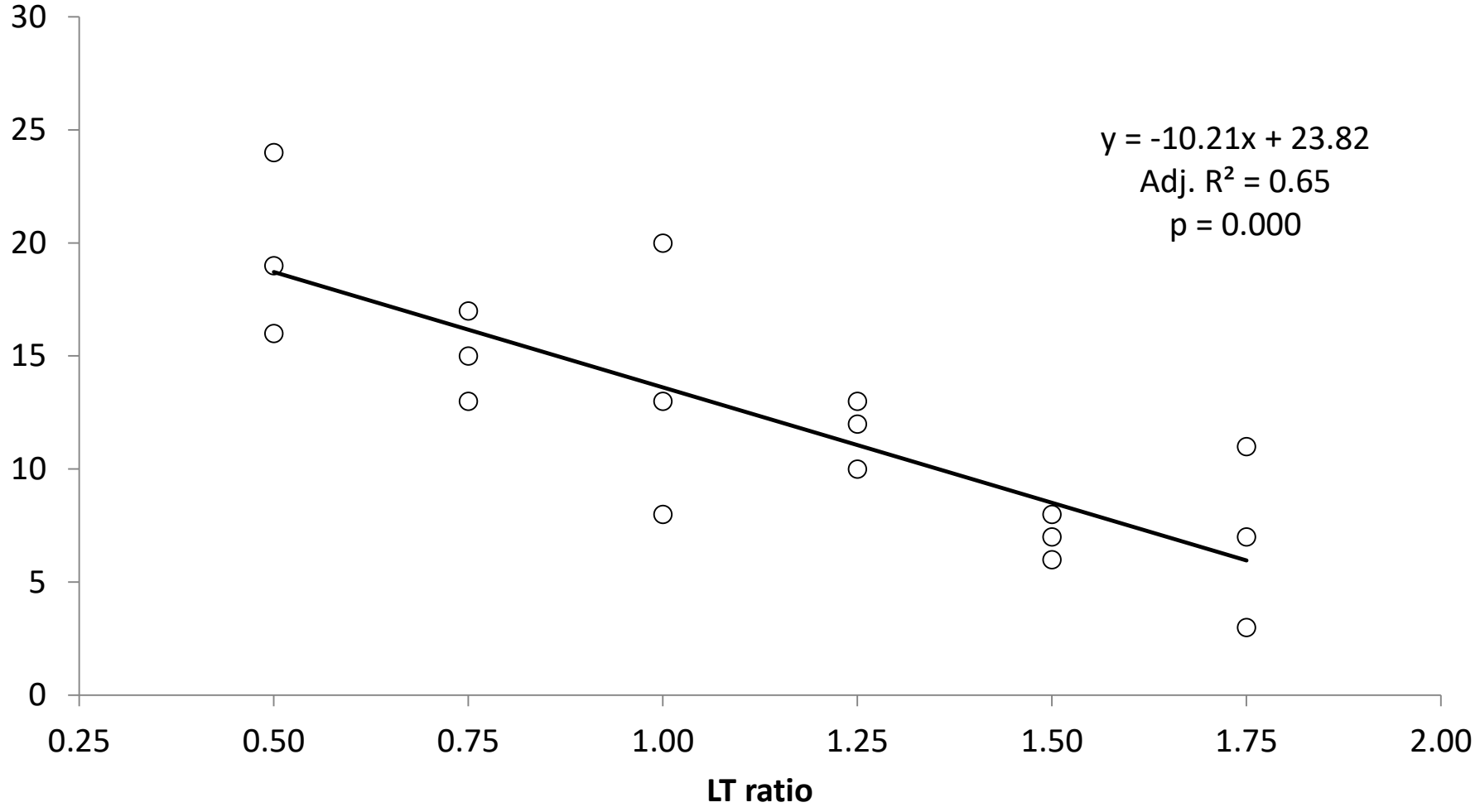


Trunk Growth

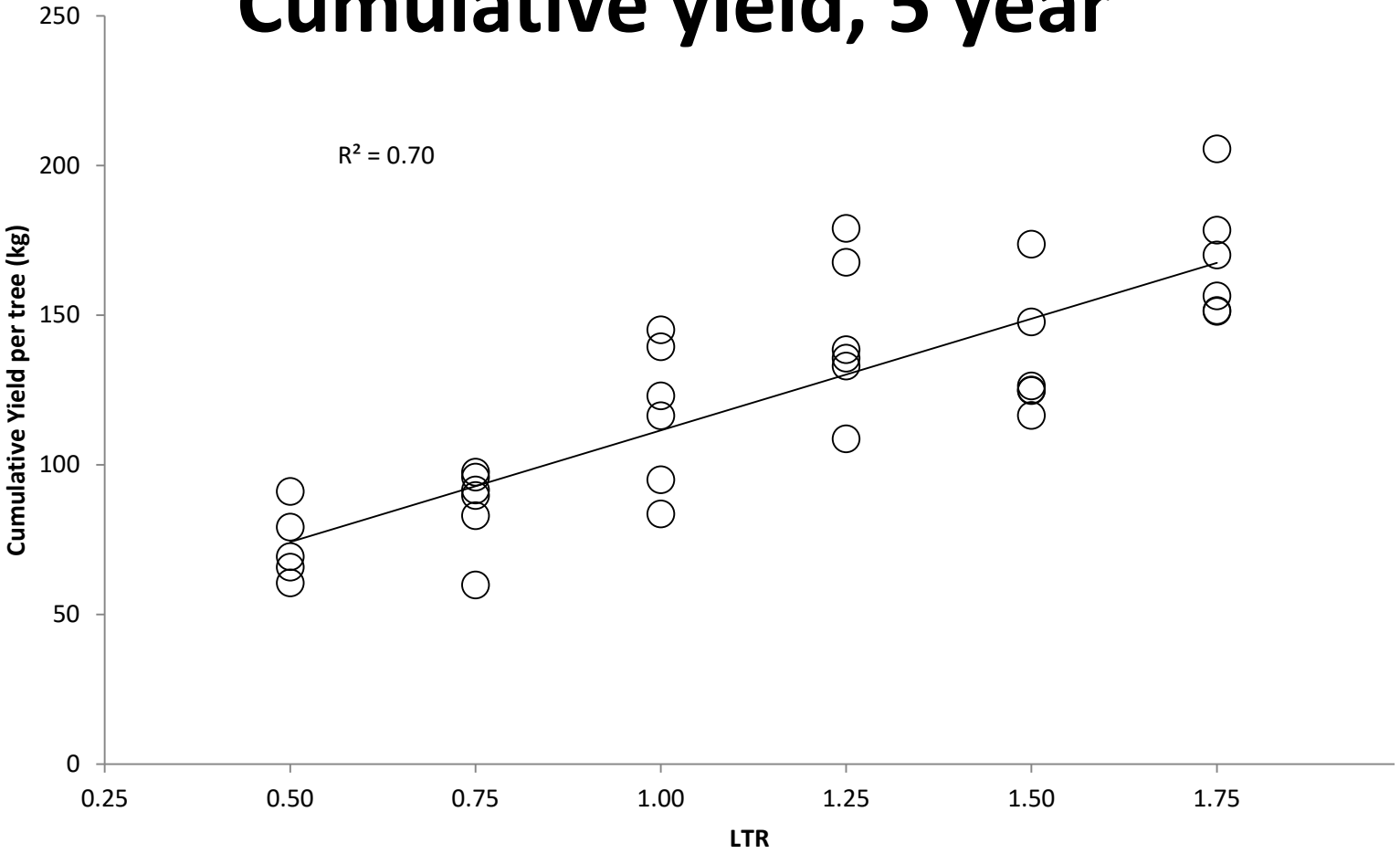


Renewal Cut / Shoot

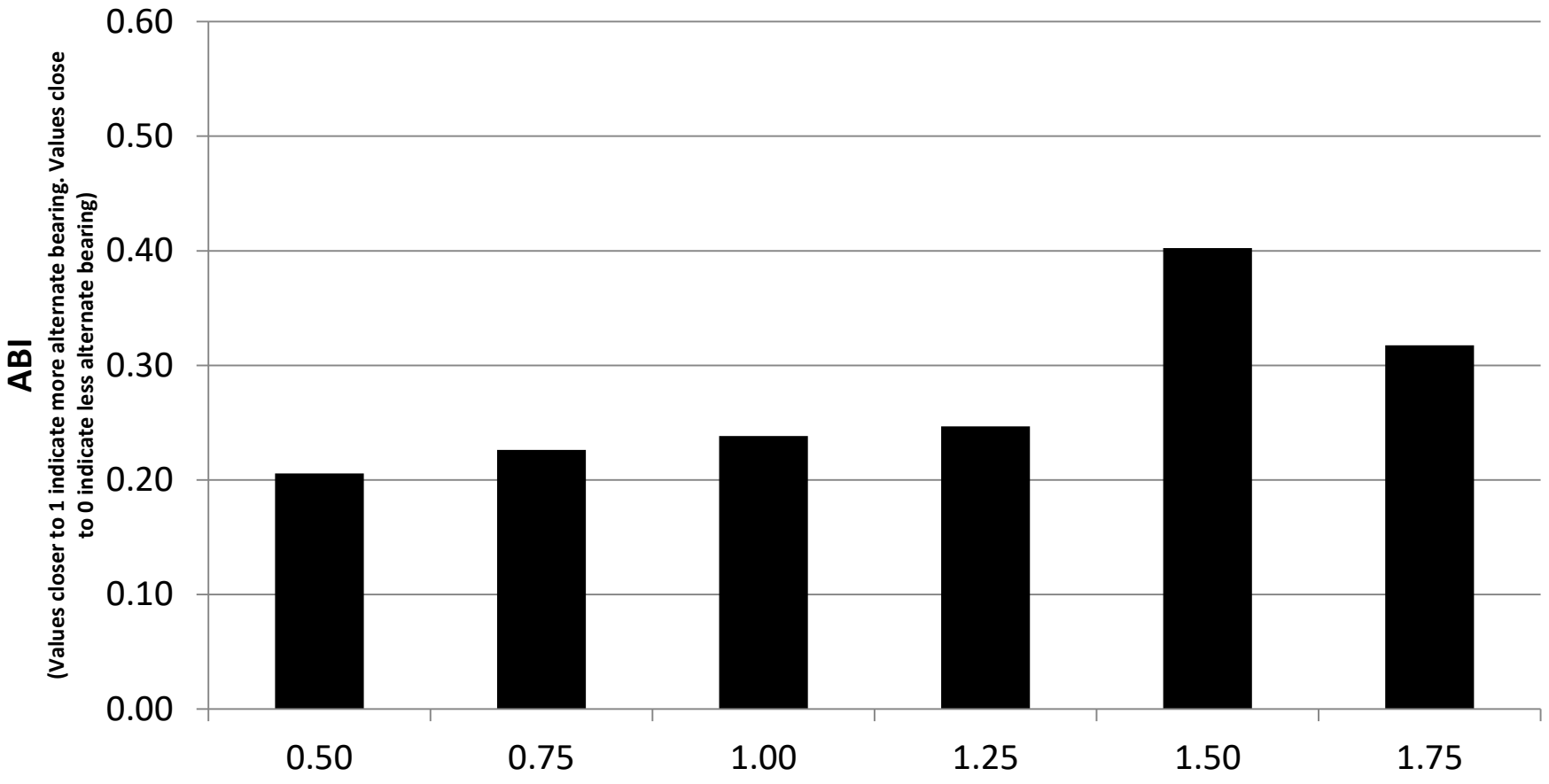
Renewal Shoots / Tree, 2013



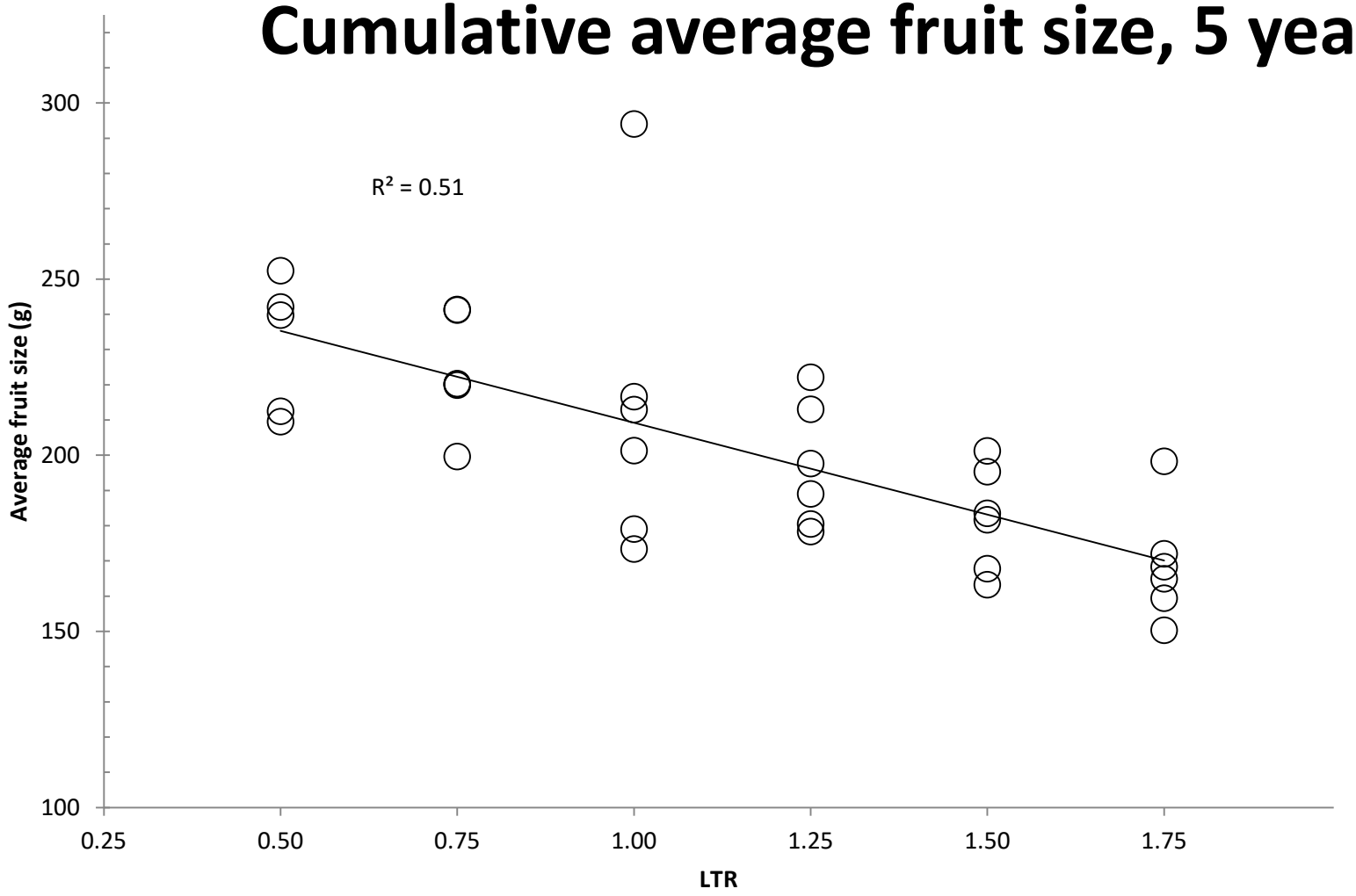
Cumulative yield, 5 year



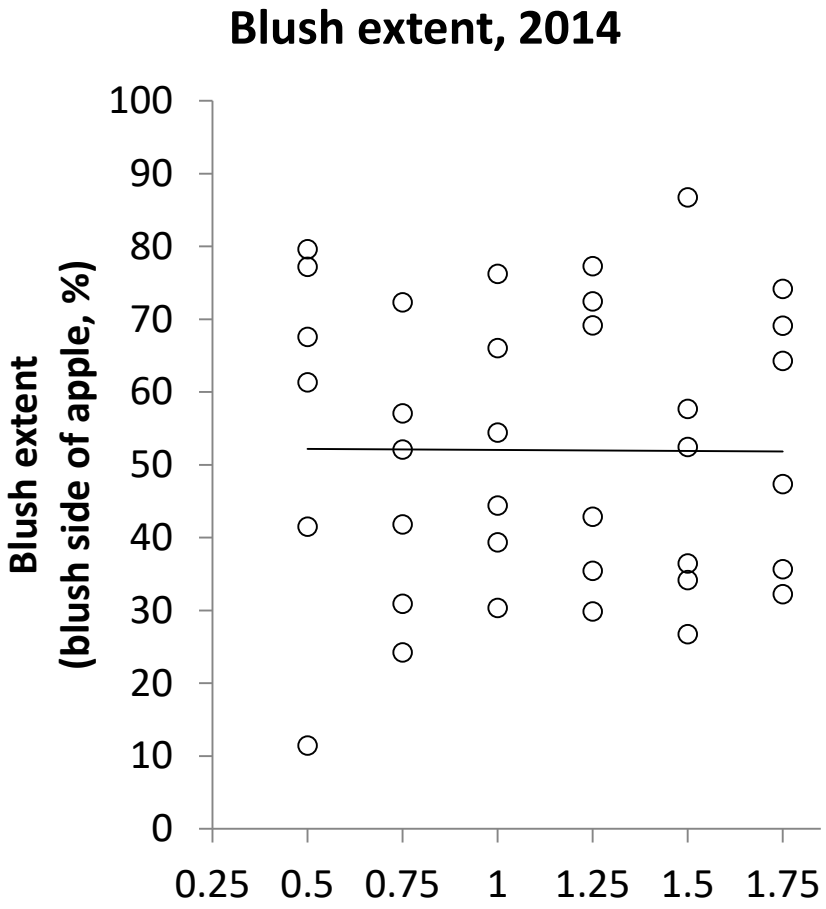
Alternate bearing index

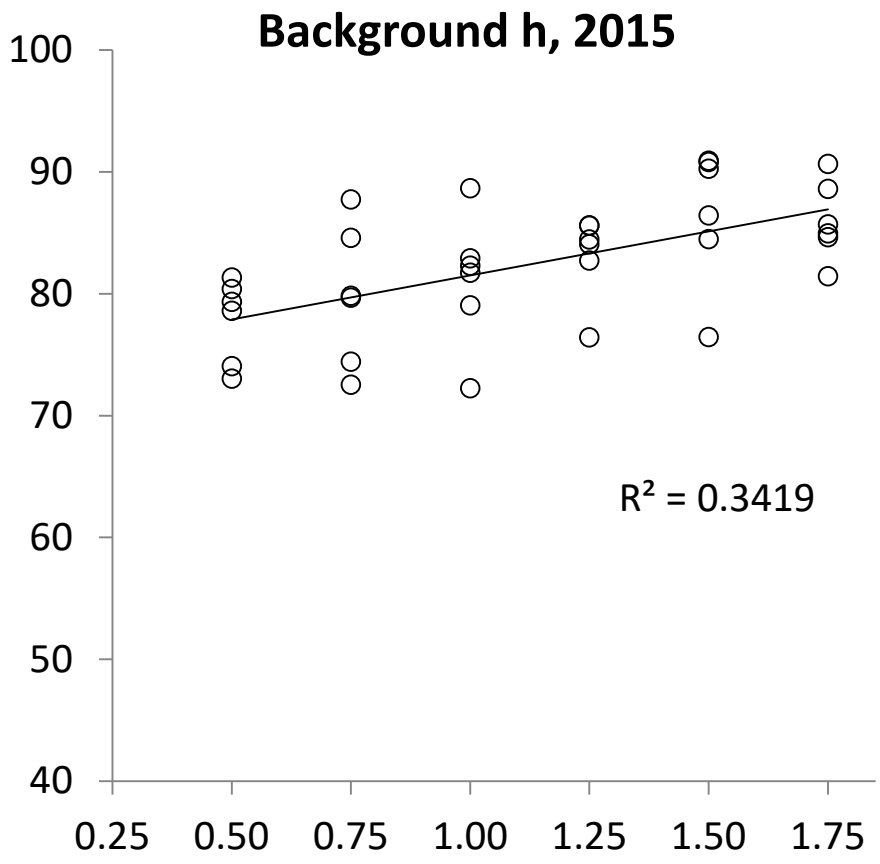


Cumulative average fruit size, 5 year

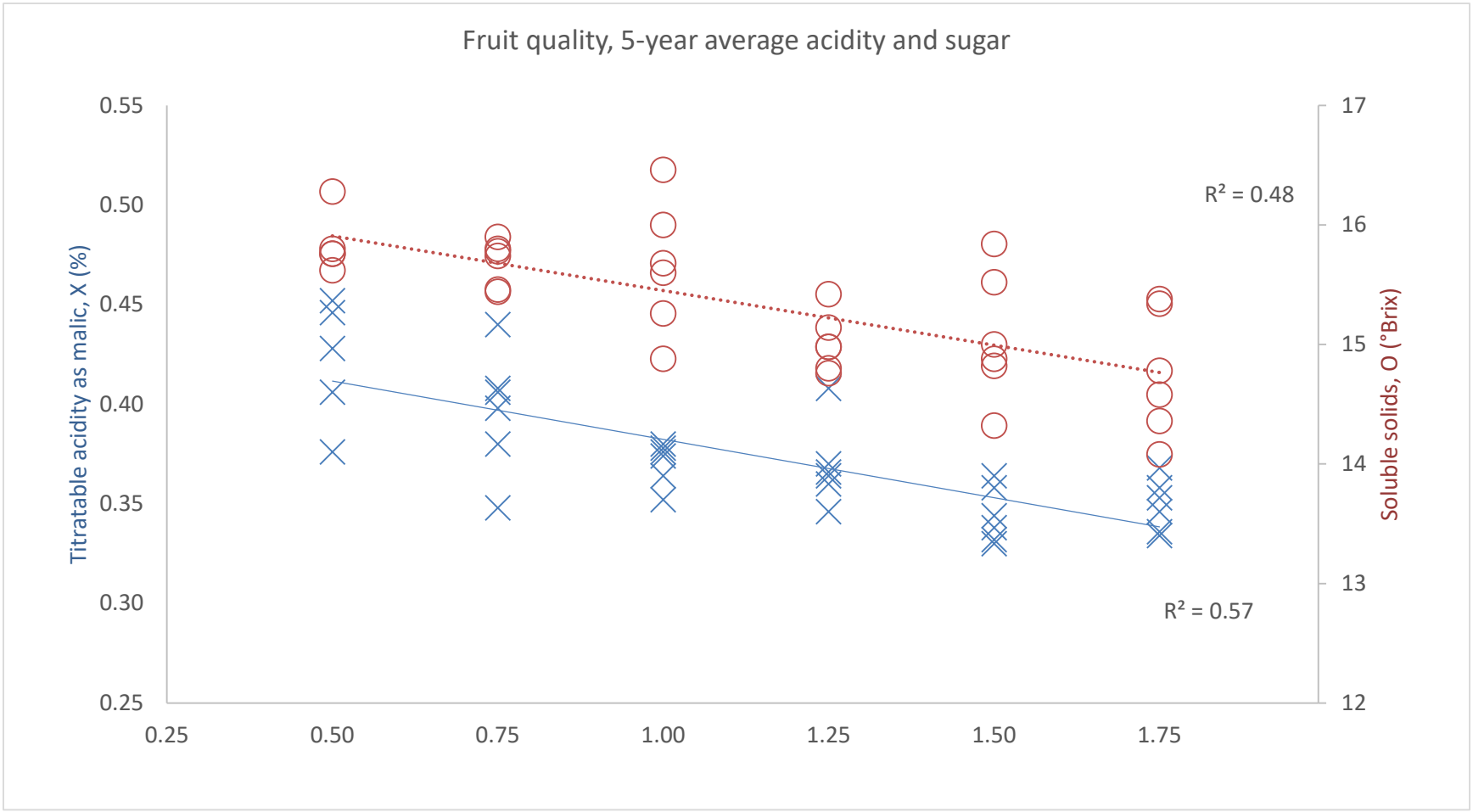


Blush Analysis

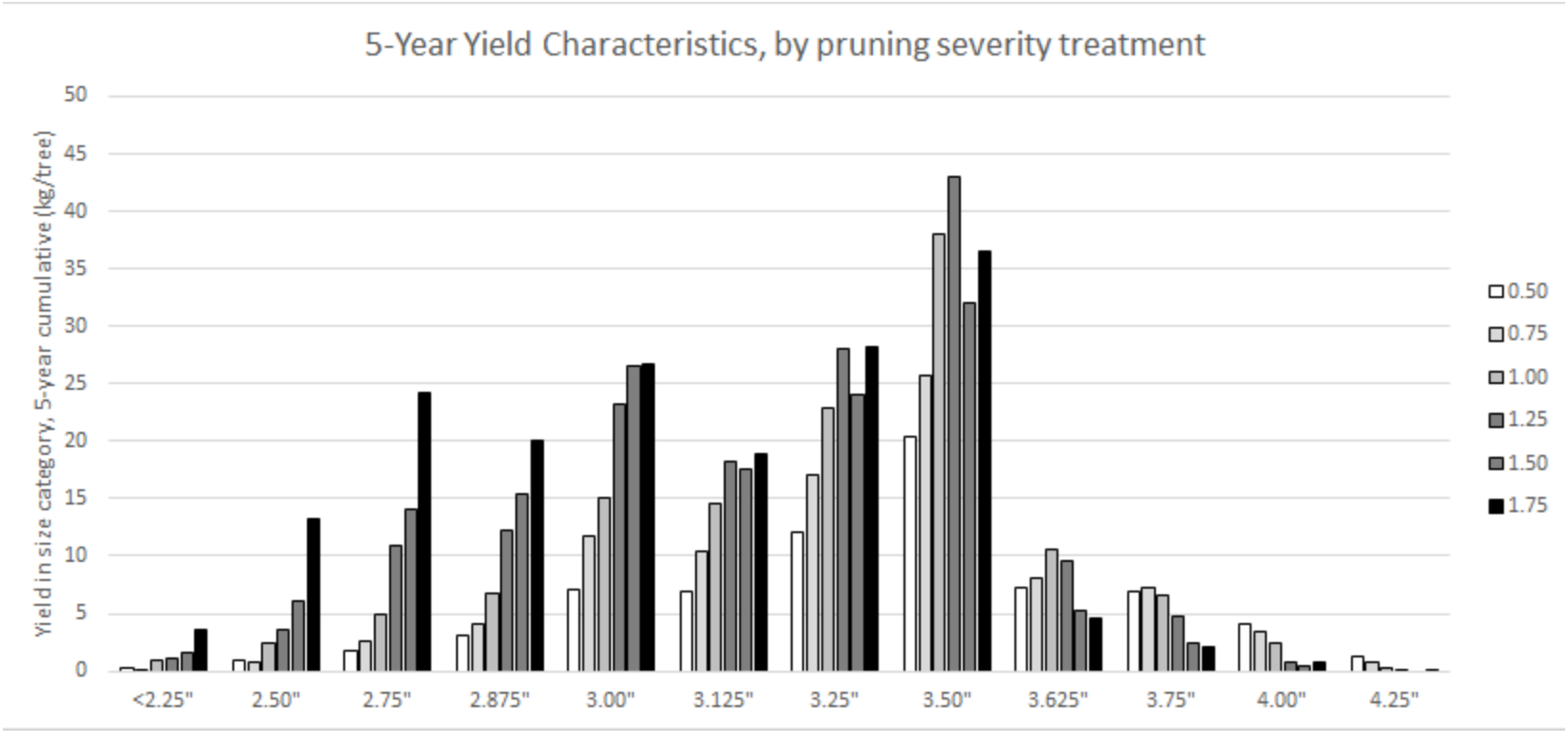




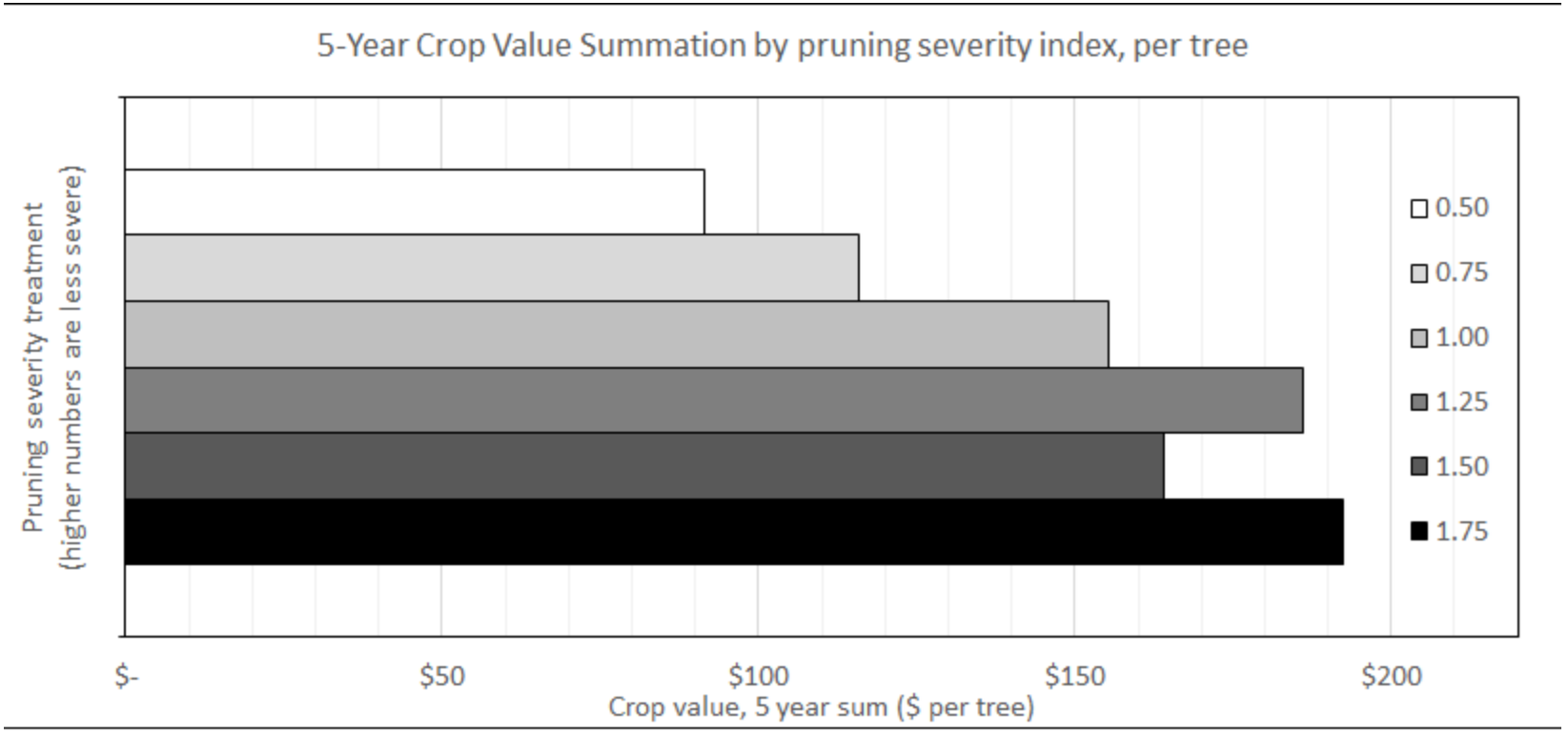
Sugar and Acidity



Fuji Fruit Size, 5 Year Average



Fuji Crop Value

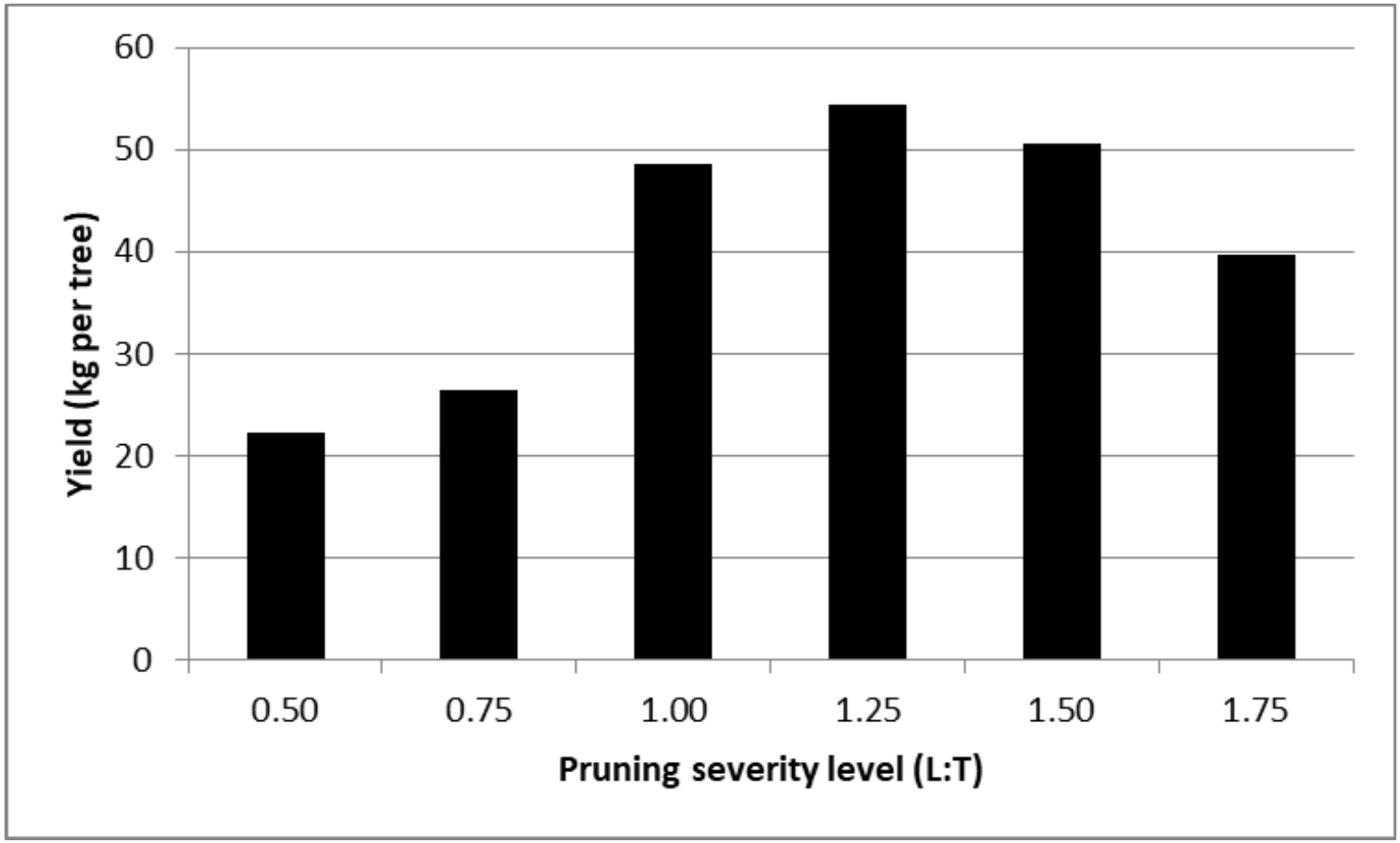


Fuji Pruning Severity Trial

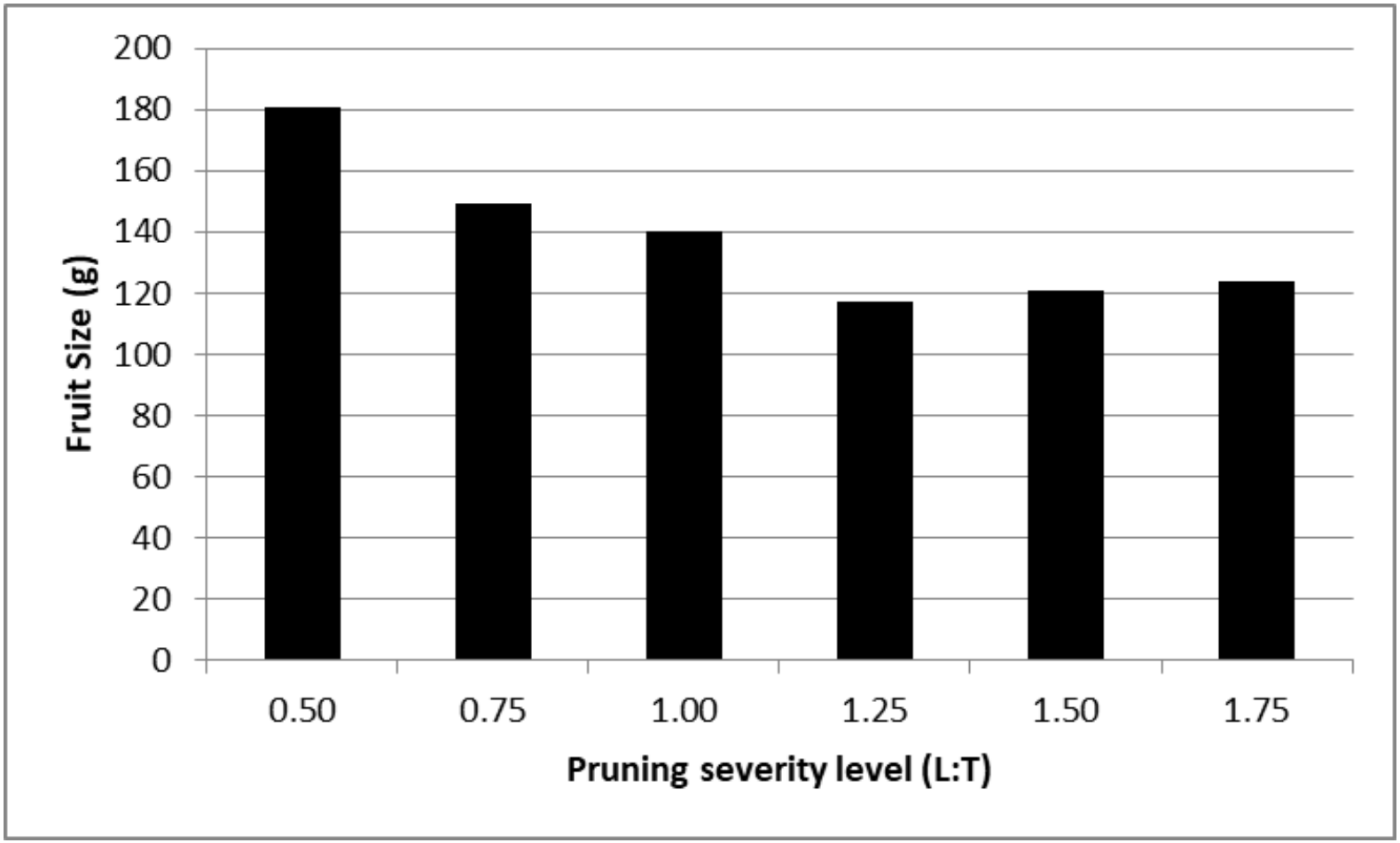
UNPRUNED

PRUNED TO 1.25 LT RATIO

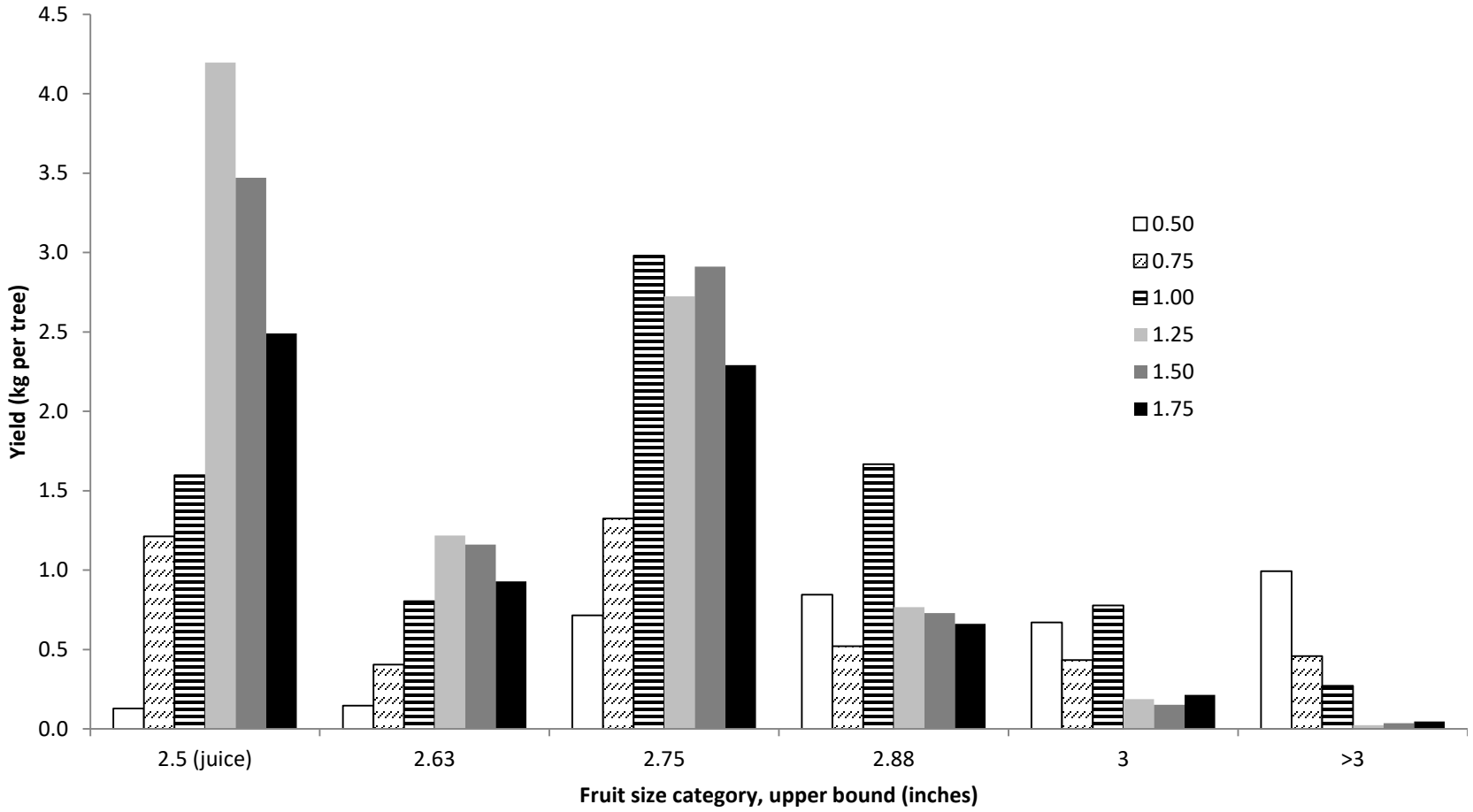
Gala Yield per Tree

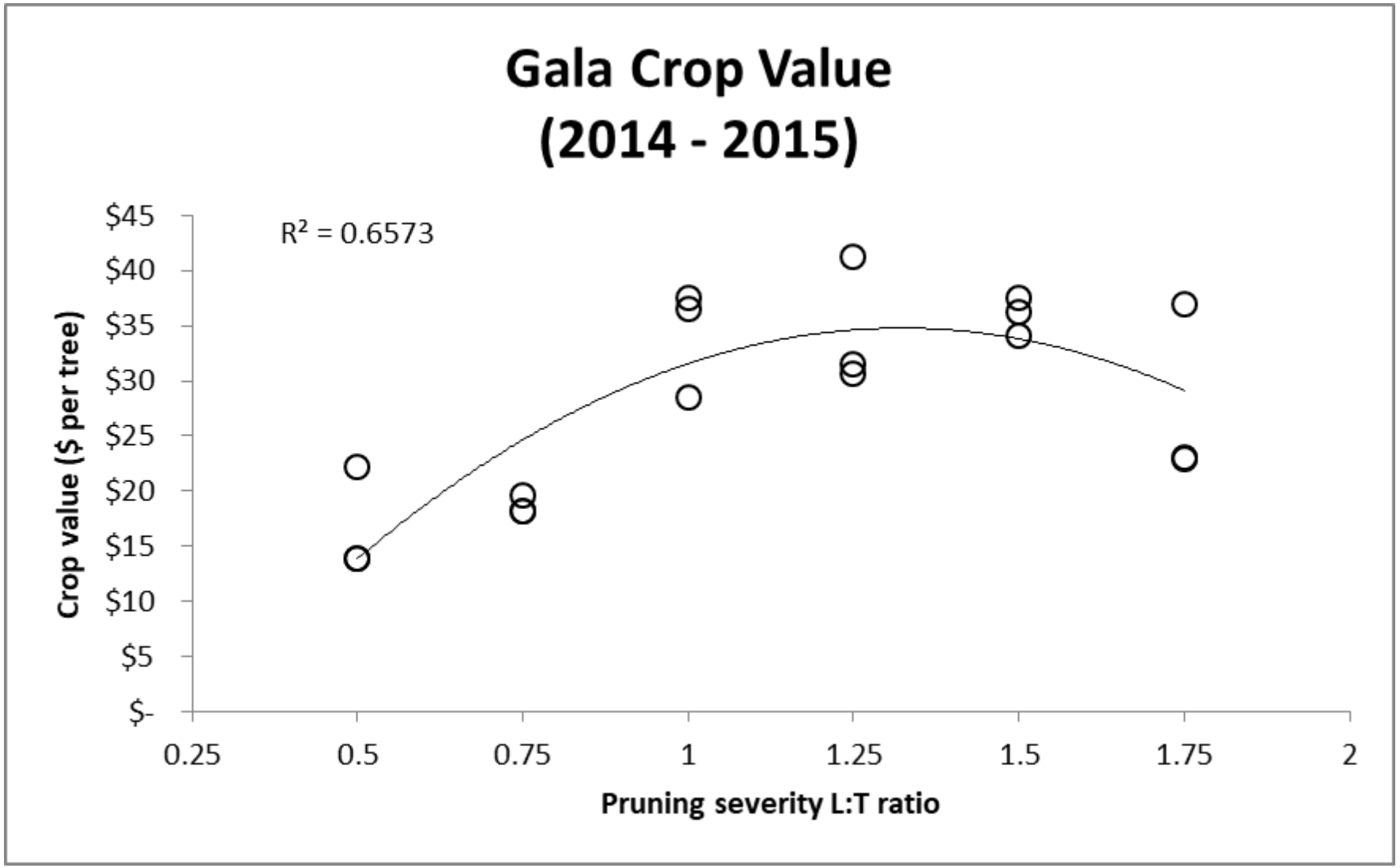


Gala Fruit Size



Gala Fruit Size Distribution




Gala Crop Value
(2014 - 2015)
R² = 0.6573
Crop value ($ per tree)
$45
$40
$35
$30
$25
$20
$15
$10
$5
$-
0.25
0.5
0.75
1
1.25
1.5
1.75
2
Pruning severity L:T ratio

Summary

- **LT ratio worked well for setting severity**
- **Removing largest branches to threshold is ~3/4 of the required pruning**
- **Severity can be accurately set to desired outcome**
    - 1.0 to 1.25 produced best outcome for Gala
    - 1.5 to 1.75 was best for Fuji
- **Simple Severity Rule for Engineers**

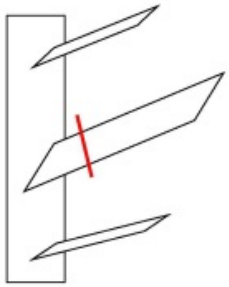
Pruning Rule Orders

1. Remove all >MD limbs with renewal cut
2. Remove all pendant / upright limbs
3. Thin out horizontal limbs to 8 per m
4. ~~Prune each remaining limb to a single horizontal axis~~

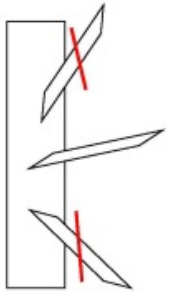
Pocket Guide

Sequential Pruning Procedures

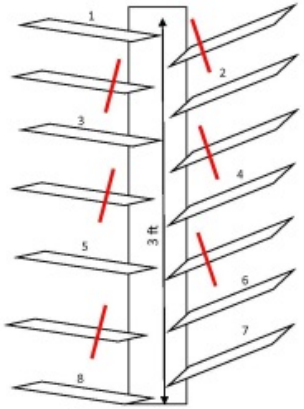
1 Remove all limbs > 1/2 inch diameter with renewal cut



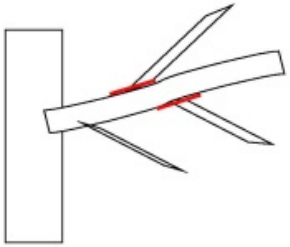
2 Remove all pendant ("hangers") and upright limbs ("risers")



3 Thin out remaining limbs to 8 per 3 ft of leader length

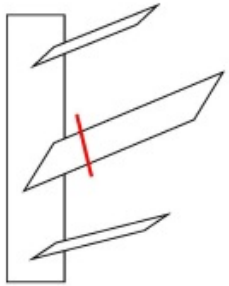


4 Thin out secondary branches on each remaining limb to create a single axis

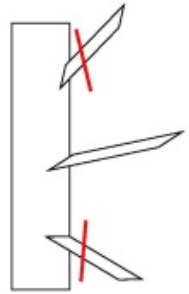


Orden de los Pasos para la Poda

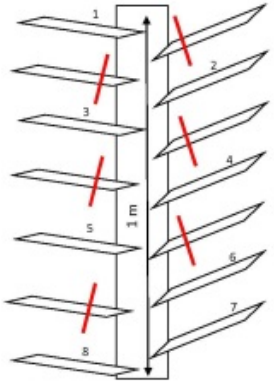
1 Remover todos las ramas de más de 1.25 cm de diámetro con un corte de renovación



2 Remover todas las ramas colgantes (que crecen hacia abajo) o verticales



3 Entresacar la cantidad de ramas que quedan hasta 8 por cada 1 m de la altura del tronco



4 Entresacar las ramitas secundarias en cada rama que queda para formar un solo eje