University of Idaho
College of Natural Resources

PAIRED PLOT DENSITY TRIALS:
4/6 YR RESULTS

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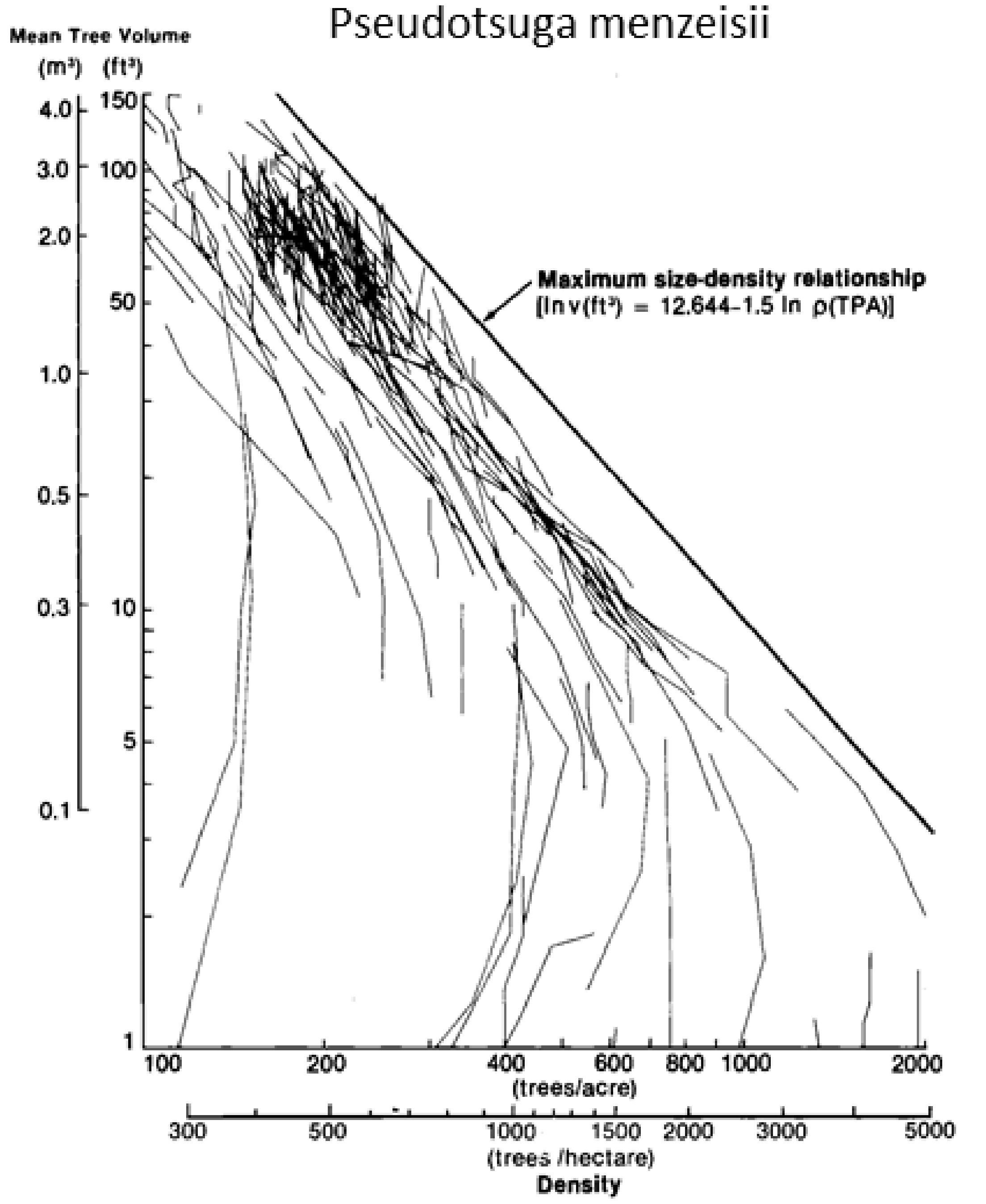
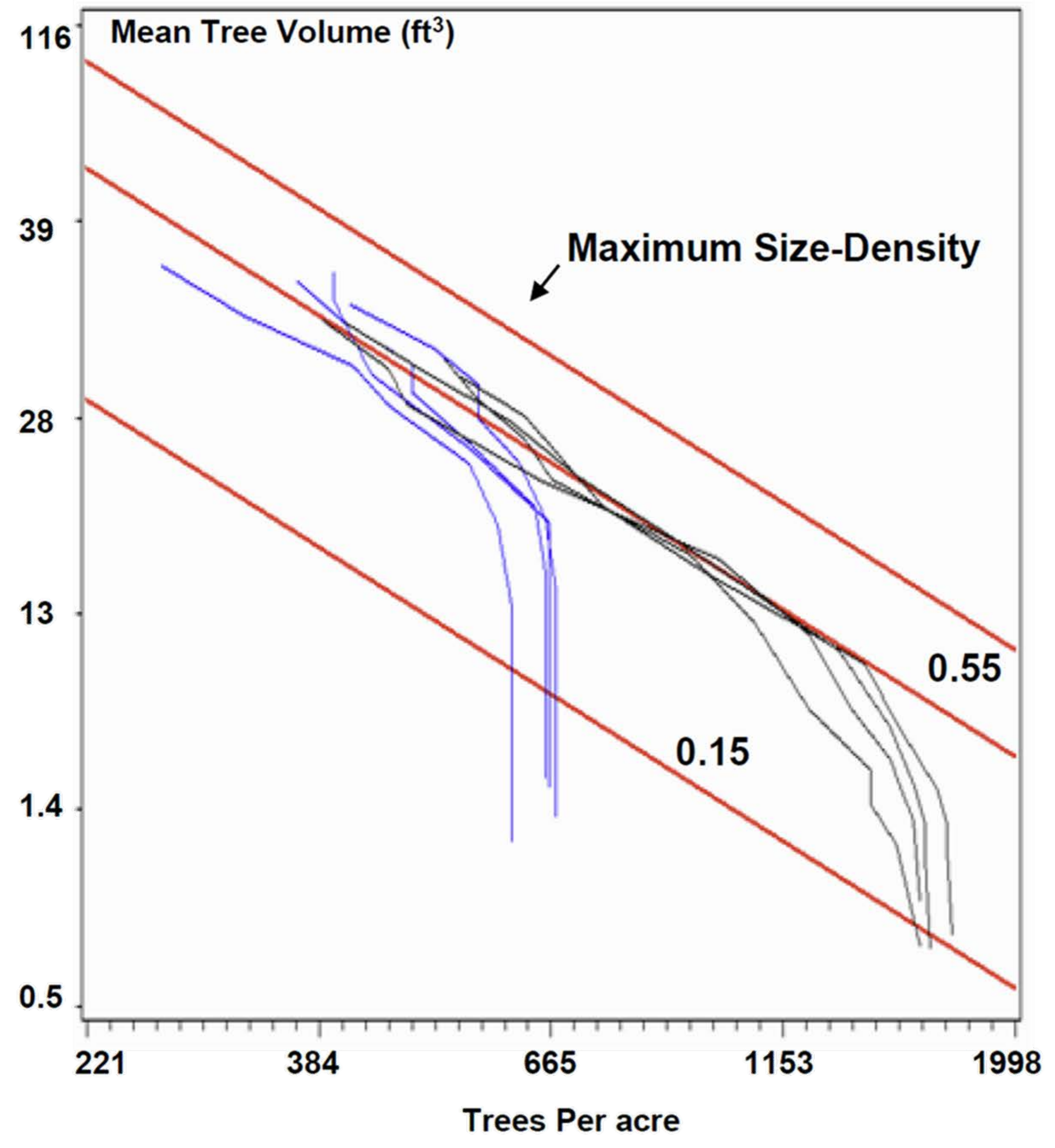
PRESENTATION OVERVIEW

- Principles of Thinning Response
- Study Design and Monitoring
- Post-Install Site Productivity Stratification Assessment
- Four-year Anova/Regression growth results:
  - Douglas-fir (+ preliminary 6 yr results)
  - Ponderosa pine
- PPDM Future

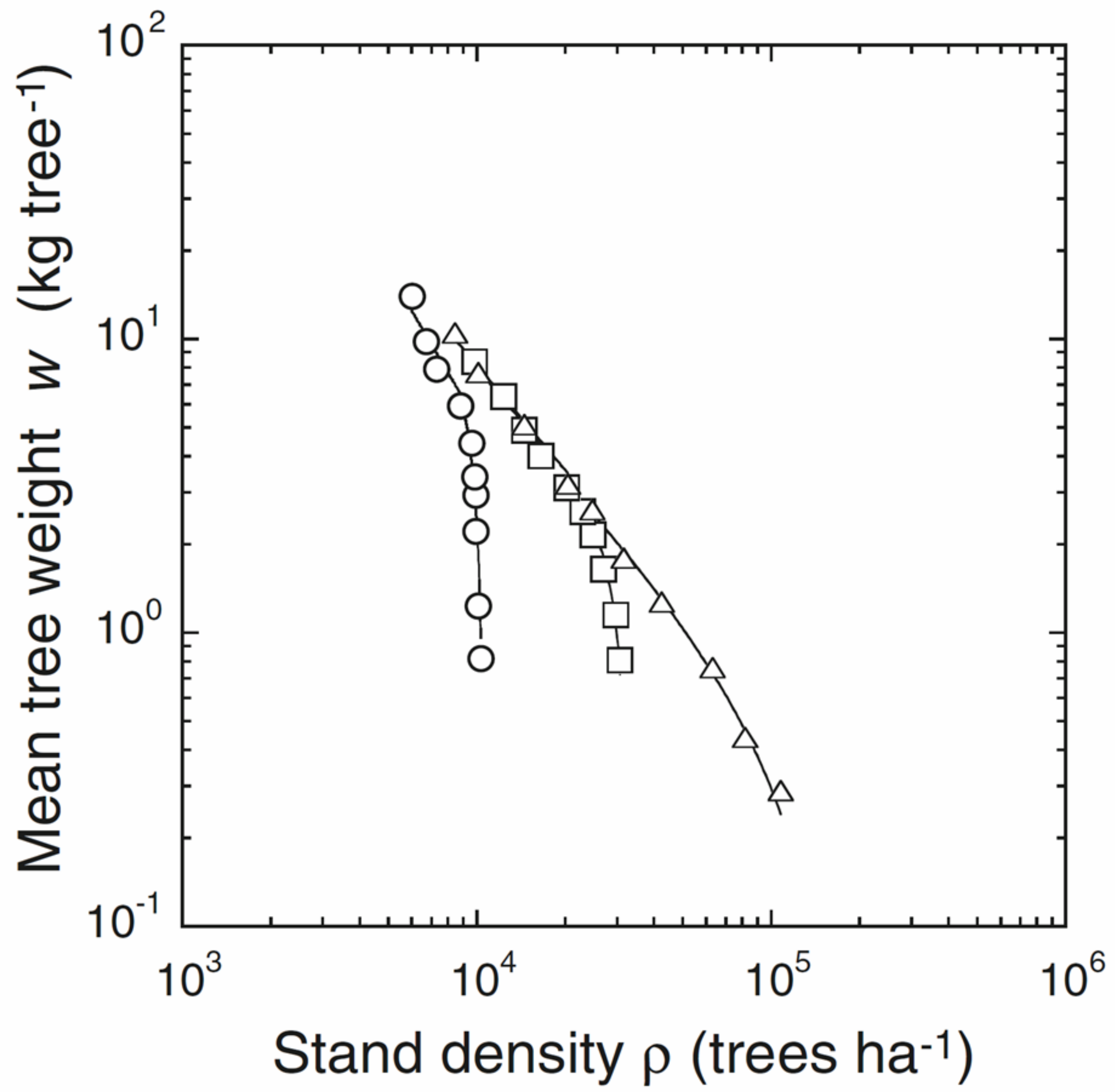
Drew & Flewelling 1977
Pseudotsuga menzeisii



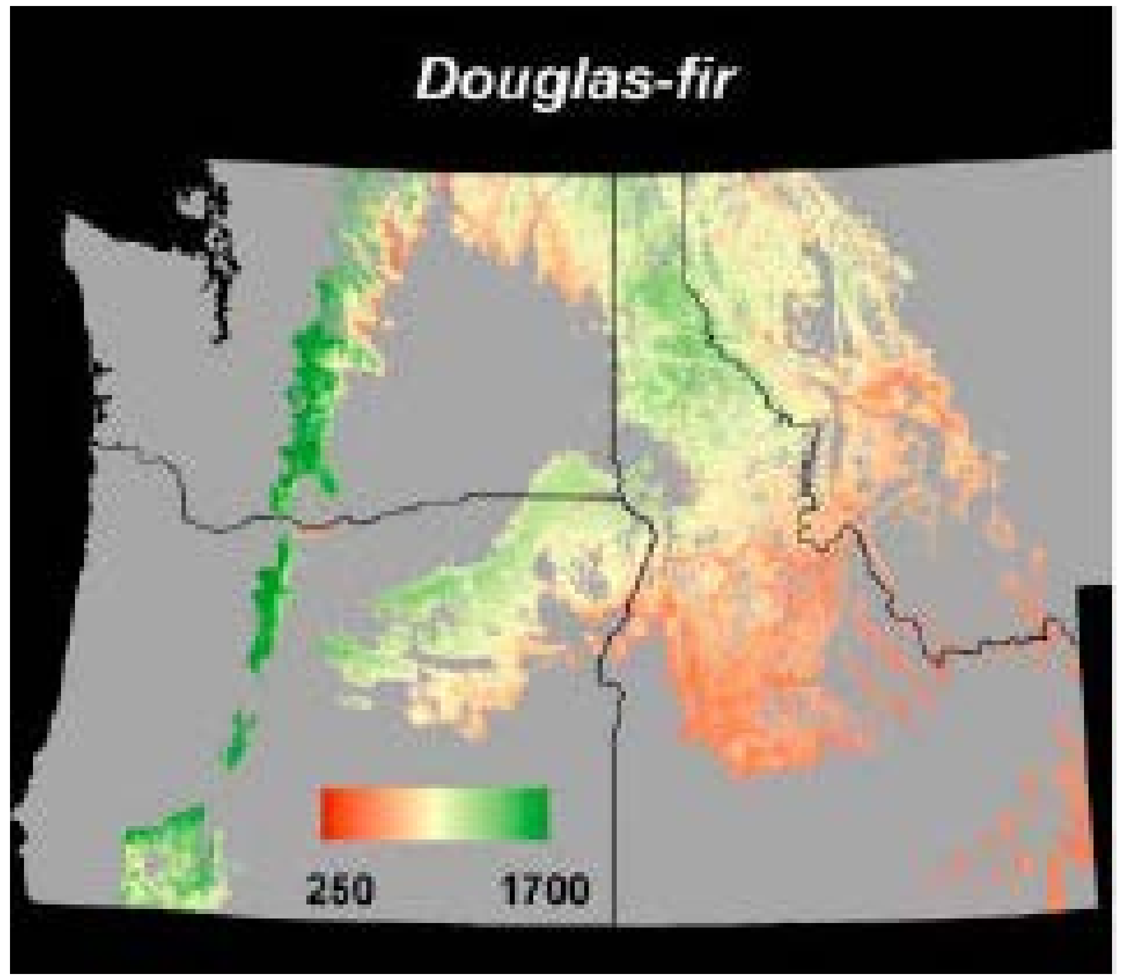
Hyink 2005
Pseudotsuga menzeisii



Xue et al 2010
Pinus densiflora



Kimsey et al., 2019



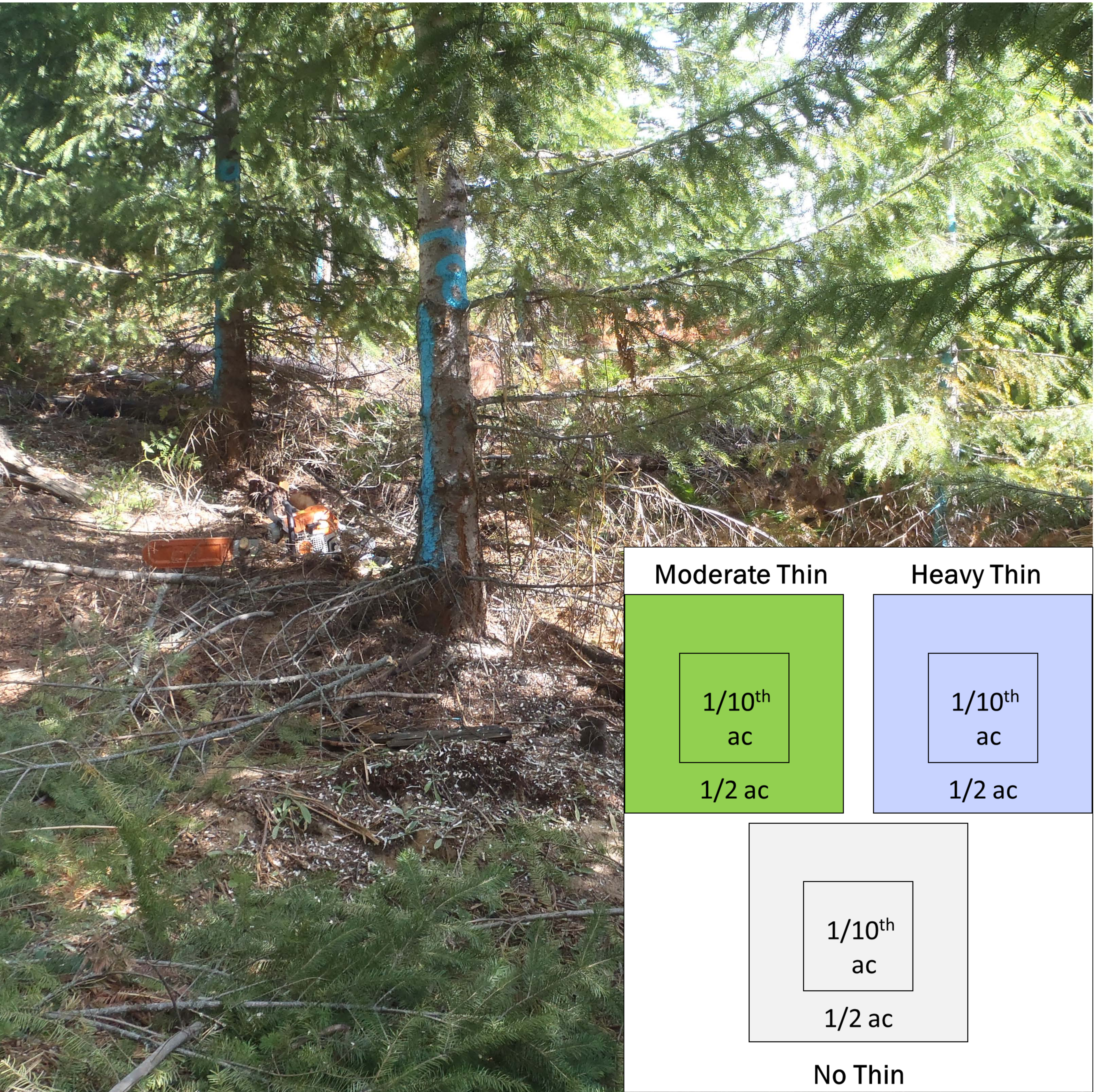
TREE AND STAND RESPONSES TO THINNING

… *ARE CONTROLLED BY COMPETITIVE INTERACTIONS*

Tree- and stand-density principles [laws]

- Crowded stands will self-thin
- Competition decreases average tree size
- Two-phase growth trajectory – 1) non-competitive (limited by site), 2) competitive (track along normal or SDImax boundary)
- Consistent patterns are useful for understanding how competition limits the size of individuals
- Most studies cannot tell us about timing or site effects
  - The length in each phase is not described
  - The effects of site are uncertain

For a more in-depth look at existing literature on this topic, please review Coleman's 2017 PDF or Video



IFC PPDM NETWORK

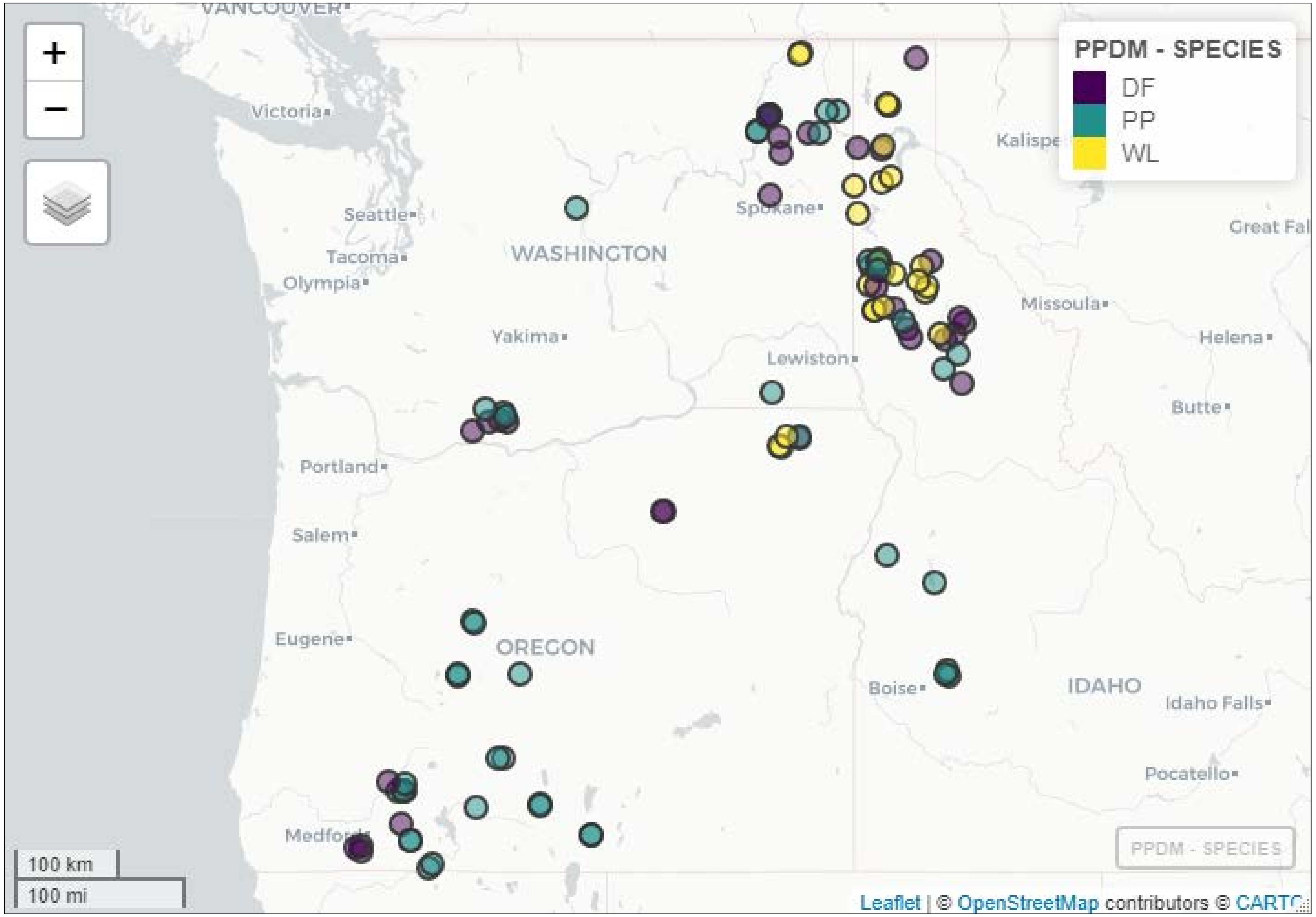
EXPERIMENTAL DESIGN REFRESHER

PPDM OBJECTIVE: IDENTIFY OPTIMAL THINNING GUIDELINES BY SPECIES AND SITE TYPE TO PROMOTE FOREST HEALTH AND PRODUCTIVITY

	Class I 10YR ≤ 18'	Class II 19' ≥ 10YR ≤ 22'	Class III 23' ≥ 10YR ≤ 26'	Class IV 10YR ≥ 27'
Index I RD ≤ 35	1 SEWA[3] (1)	4 NID (2); NEO (1); SCOR (1)	3 NID (1); SCOR (2)	3 NID (1); SCWA (2)
Index II 36 ≥ RD < 60	3 NEWA (3)	6 NEO (2); NID (1); NEWA (2); SCOR (1)	3 SCWA (1) NID (2)	1 SCWA (1)
Index III RD ≥ 60	1 NEWA (1)	3 NID (1); NEWA (1); SCOR (1)	4 NID (4)	2 NID (1); SCOR (1)

Curtis, 1982: RD = $BA/QMD^{0.5}$
Ziede 1978, 1993, 1999: 2-point method
Arney and Miller 2000, Arney 2015: 10m SI

IFC PPDM NETWORK MEASUREMENT STATUS



101 INSTALLATIONS ACROSS THE INLAND NORTHWEST

- 34 DF installations
  - 6Yr measurements (n=16)
  - 4Yr measurements (n=27)
  - 2Yr measurements (n=29)
- 44 PP installations
  - 6Yr measurements (n=0)
  - 4Yr measurements (n=28)
  - 2Yr measurements (n=42)
- 23 WL installations
  - 6Yr measurements (n=0)
  - 4Yr measurements (n=6)
  - 2Yr measurements (n=20)

IFC PPDM NETWORK

CURRENT MEASUREMENT PROTOCOL

- Every 2 yrs from 0-10, every 5 yrs thereafter
  - DBH
  - Height growth increment*
  - Defect
  - Mortality
- Measured at year 6 and 10, every 5 yrs thereafter
  - Base of live crown
  - Ingrowth

*All trees measured, no subsetting for heights

IFC PPDM NETWORK

THINNING PROTOCOL (UNTREATED + 2 THIN TREATMENTS ~ 130 – 430 TPA)

Control

10 x 10 ~ 430 TPA

14 x 14 ~ 220 TPA

POST-INSTALL

10 YR SITE INDEX STRATIFICATION ASSESSMENT:

DOUGLAS-FIR

PONDEROSA PINE

D. FIR MODEL STATISTICS

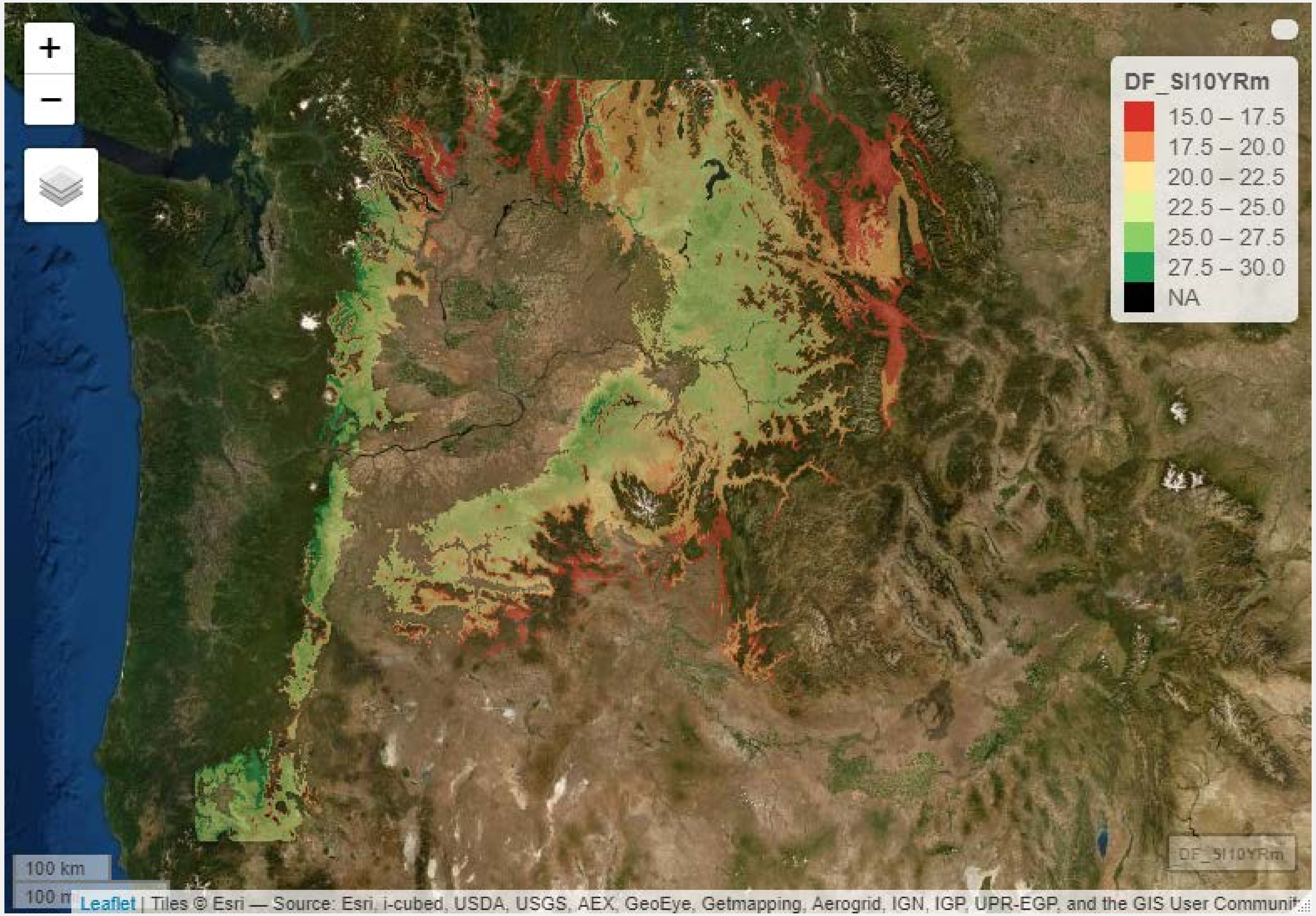
BASED ON ALL 34 INSTALLATIONS

Dependent Variable: Last 10 Yr Periodic Height Growth

Expl. Variables (Effect)	Significance
Soil (+)	p=0.0015
Elevation_Sq (-)	p=0.0519
MAP (+)	p=0.0248
MAT (-)	p=0.0018
DD<0°C (-)	P<0.0001

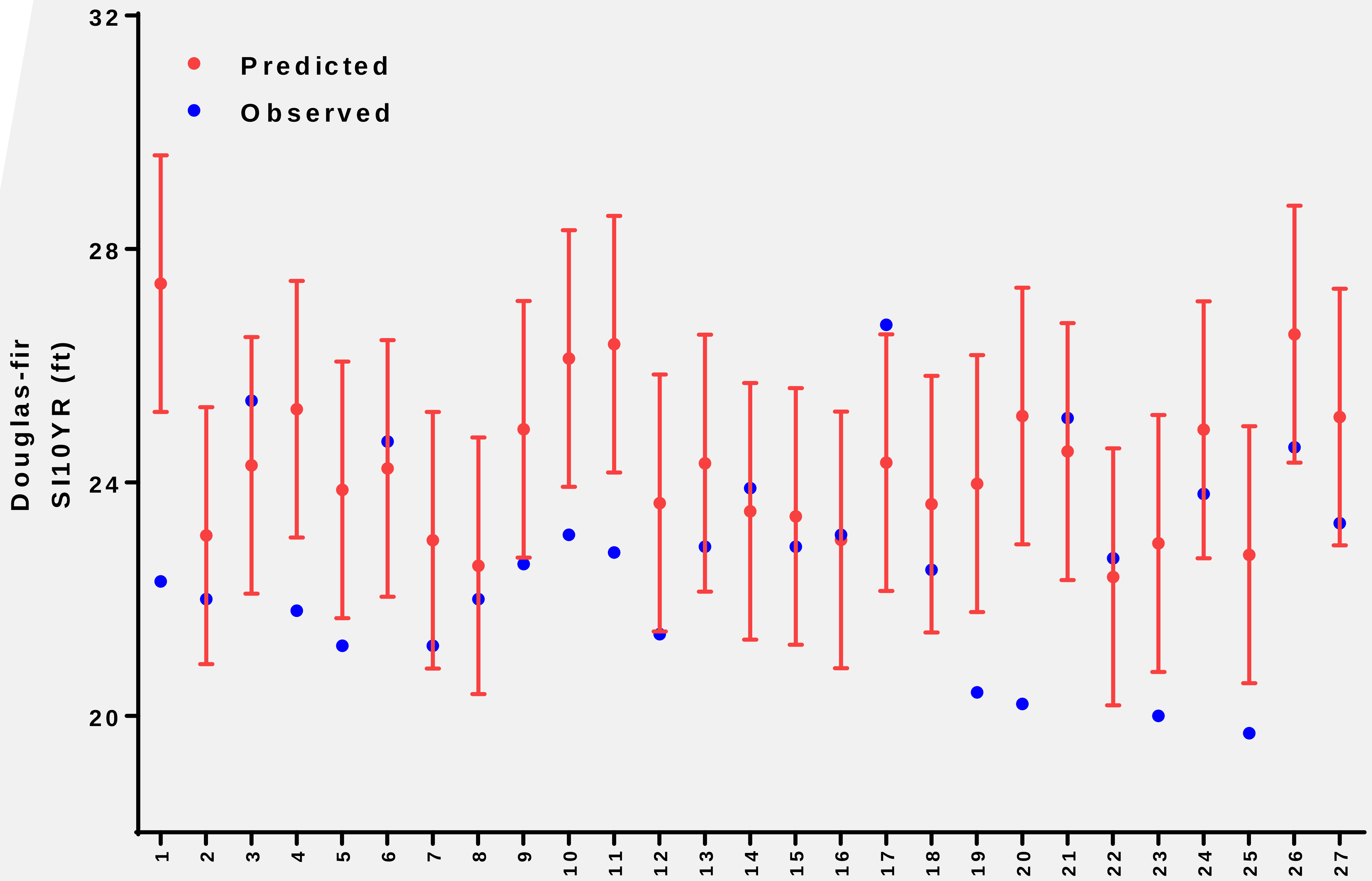
Statistics	Value
Model Pr>F	<0.0001
R^2	0.86
CV	7.5%
RMSE	1.7 ft
Mean	22.5 ft

D. FIR MODEL SPATIAL LAYER



D. FIR MODEL SI10YR VALIDATION

BASED ON AN INDEPENDENT DATASET OF 27 DF PPDM INSTALLATIONS



Whiskers: 80% PI
Min Error: 0.1 ft
Mean Error: 1.6 ft
Max Error: 5.1 ft

P. PINE MODEL STATISTICS

BASED ON ALL 44 INSTALLATIONS

Dependent Variable: Last 10 Yr Periodic Height Growth

Expl. Variables (Effect)	Significance
Tave_sp (+)	p=0.0084
PPT_at (+)	p=0.0005
RH_wt (-)	p=0.032
MSP (+)	p=0.0702

Statistics	Value
Model Pr>F	<0.0001
R^2	0.61
CV	14.3%
RMSE	2.6 ft
Mean	18.2 ft

4 YEAR RESULTS

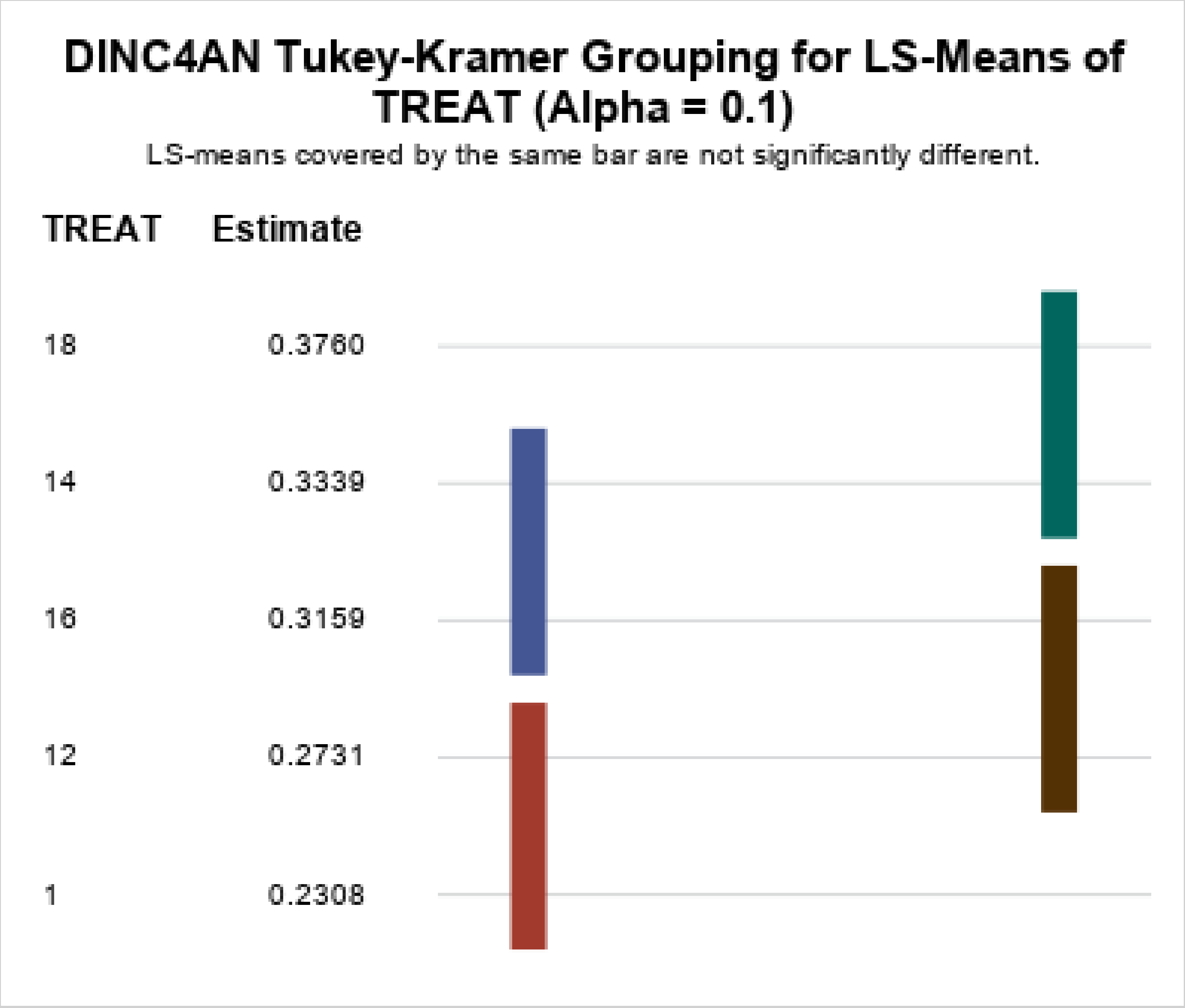
DOUGLAS-FIR + PONDEROSA PINE THINNING RESPONSE BY:

INDIVIDUAL/CROP TREE – DBH/HT

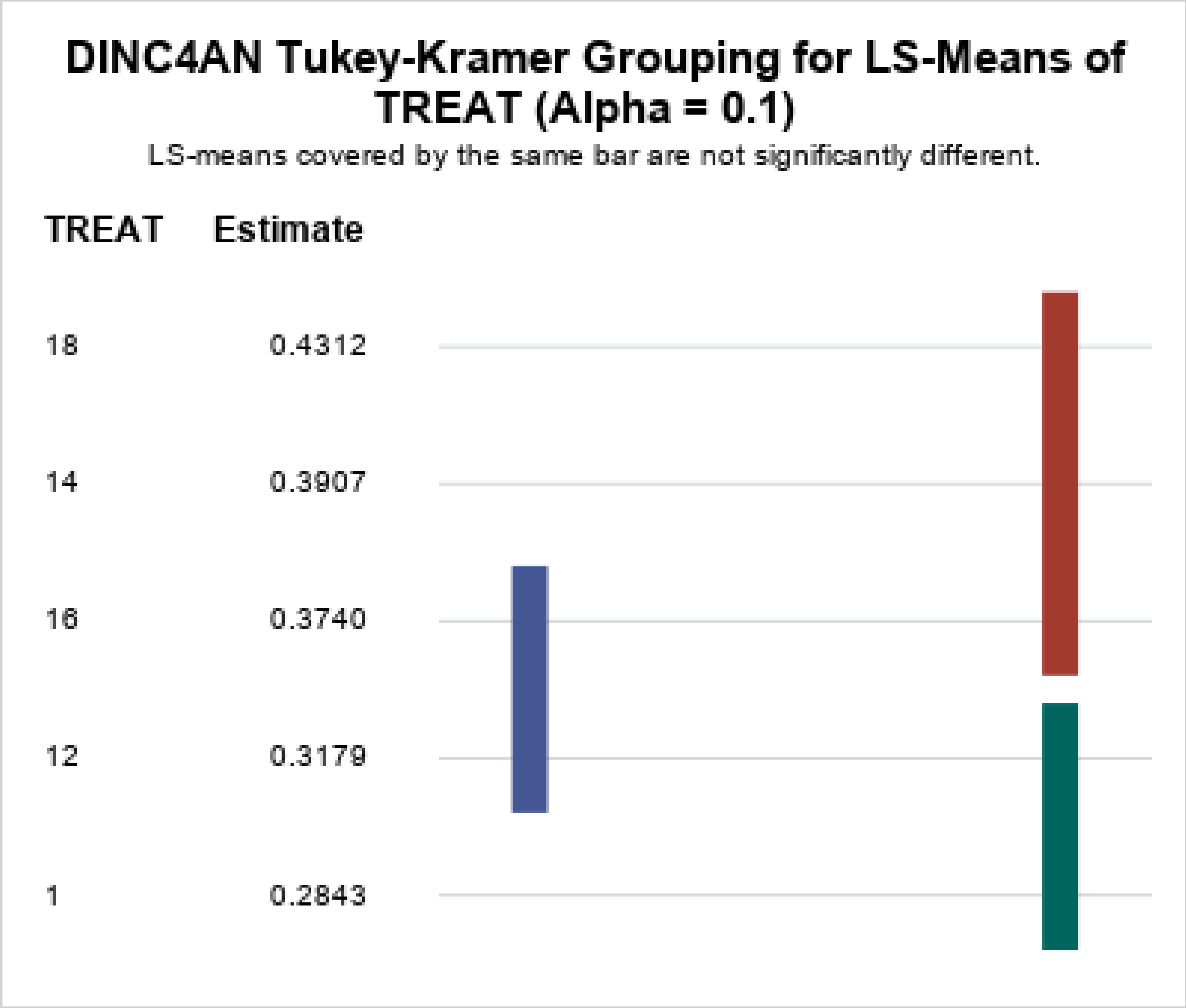
CROP TREE/STAND – VOLUME

D. FIR – 4YR DBH ANOVA

AVERAGE TREE RESPONSE



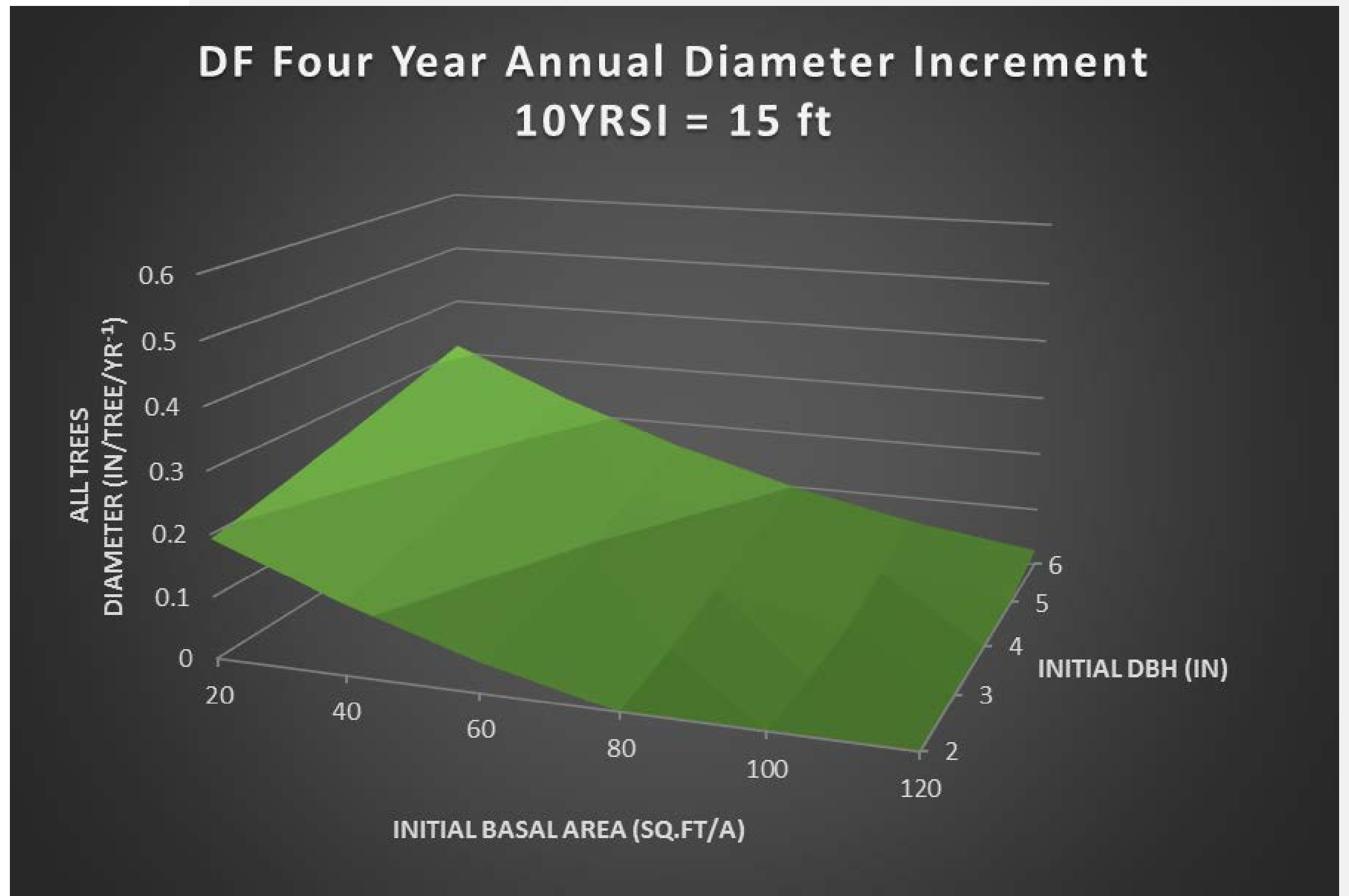
CROP TREE RESPONSE

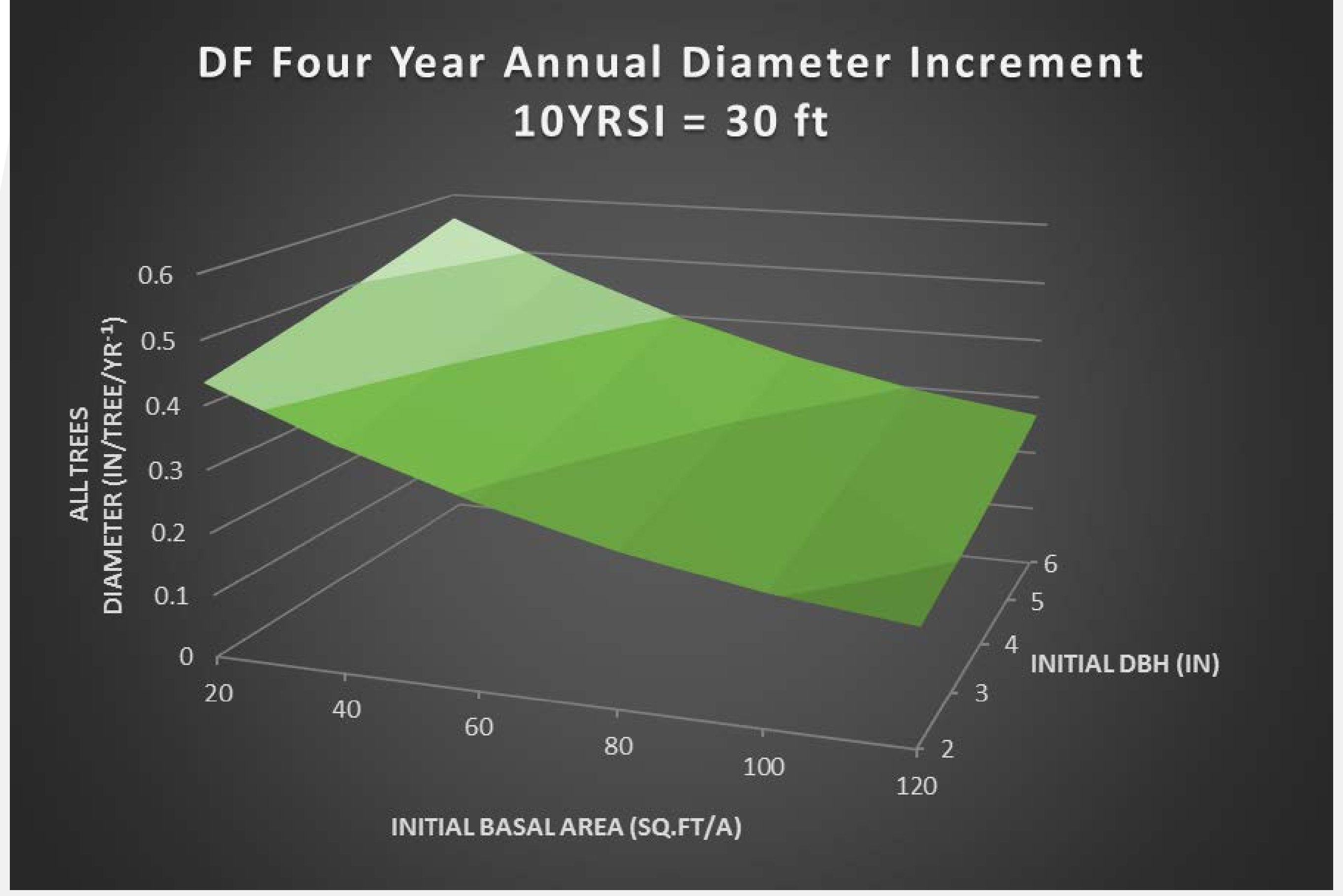


Means adjusted for SI10YR, initial density and initial diameter

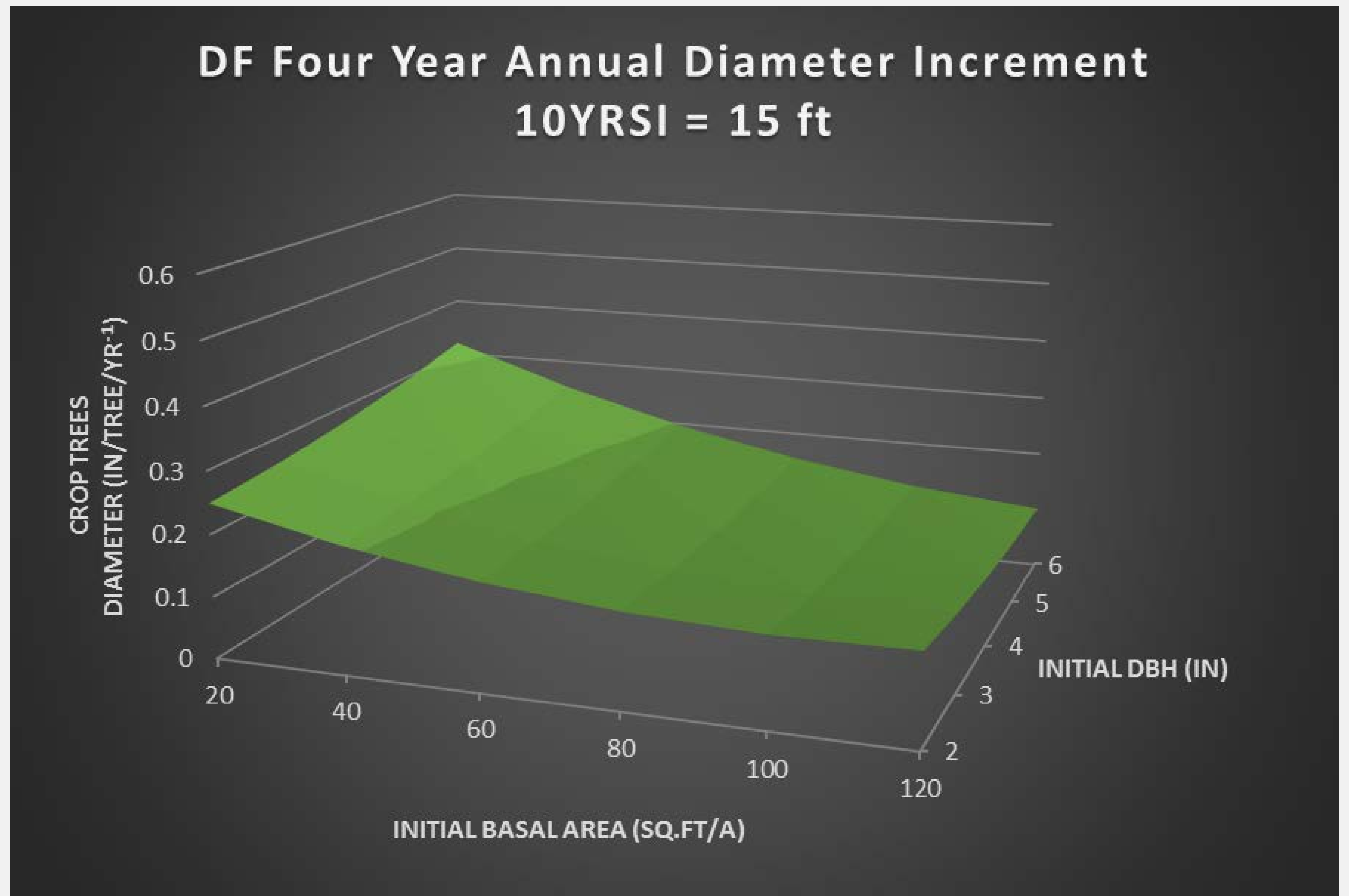
D. FIR – 4YR DBH REGRESSION

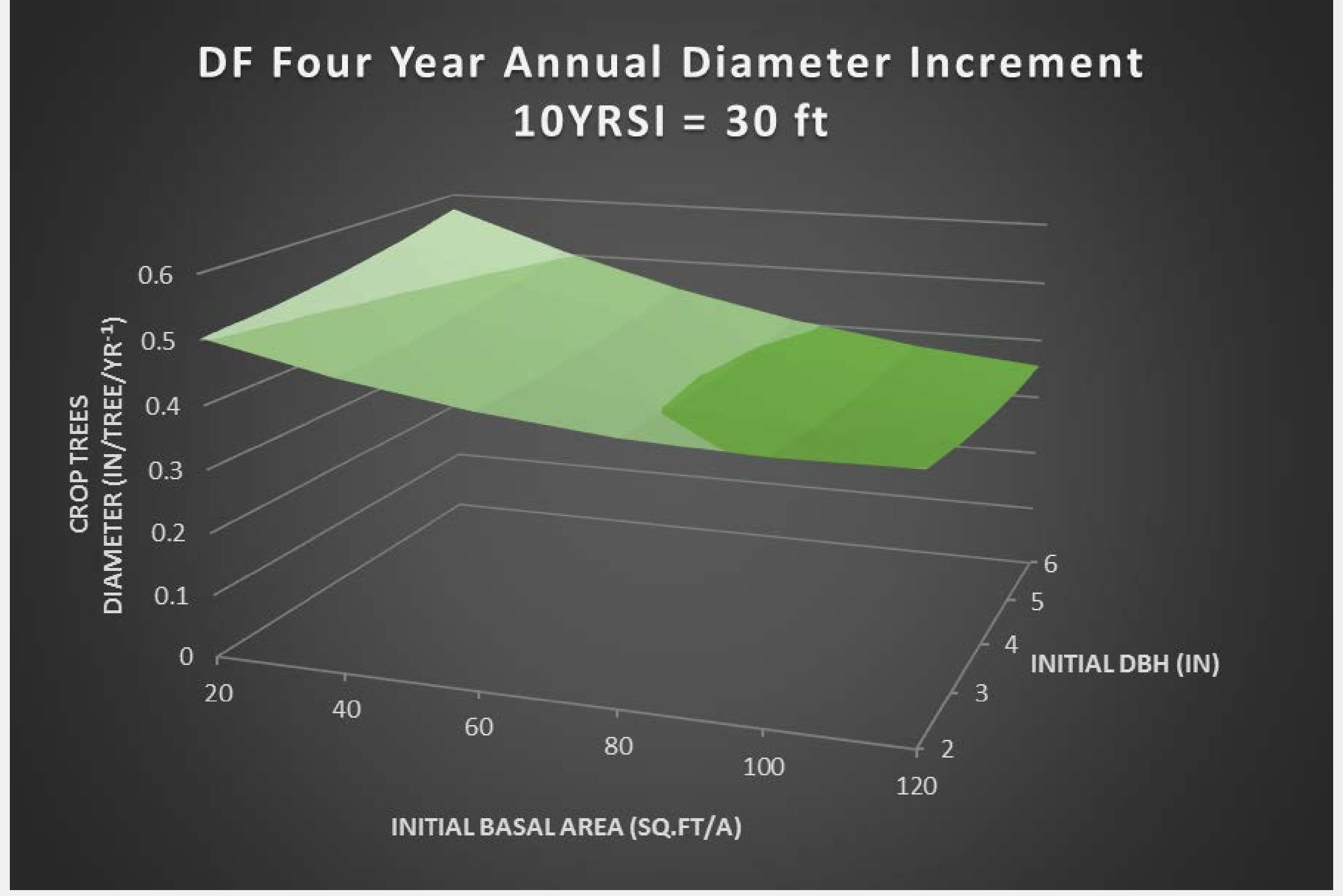
AVERAGE TREE RESPONSE





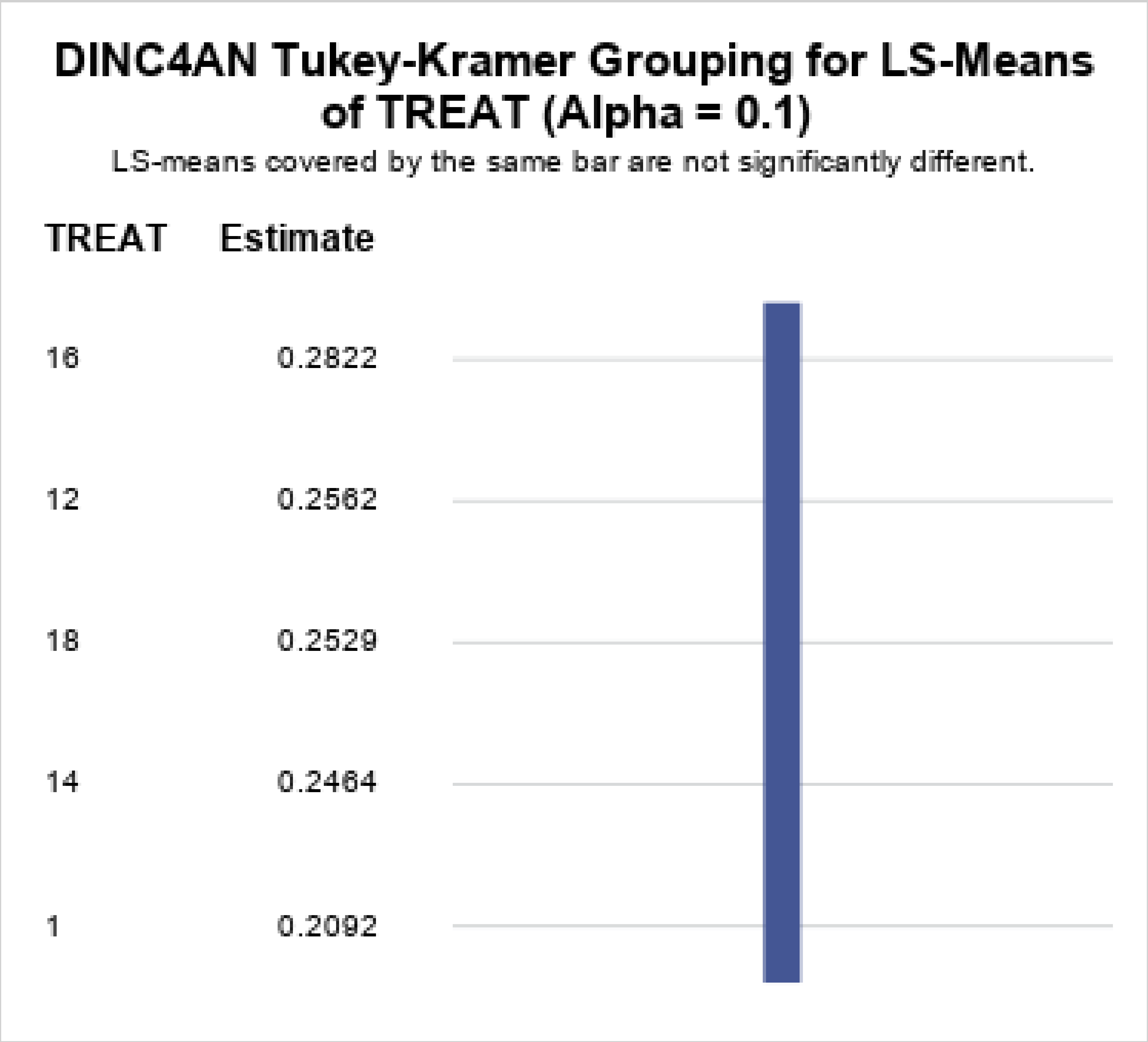
CROP TREE RESPONSE



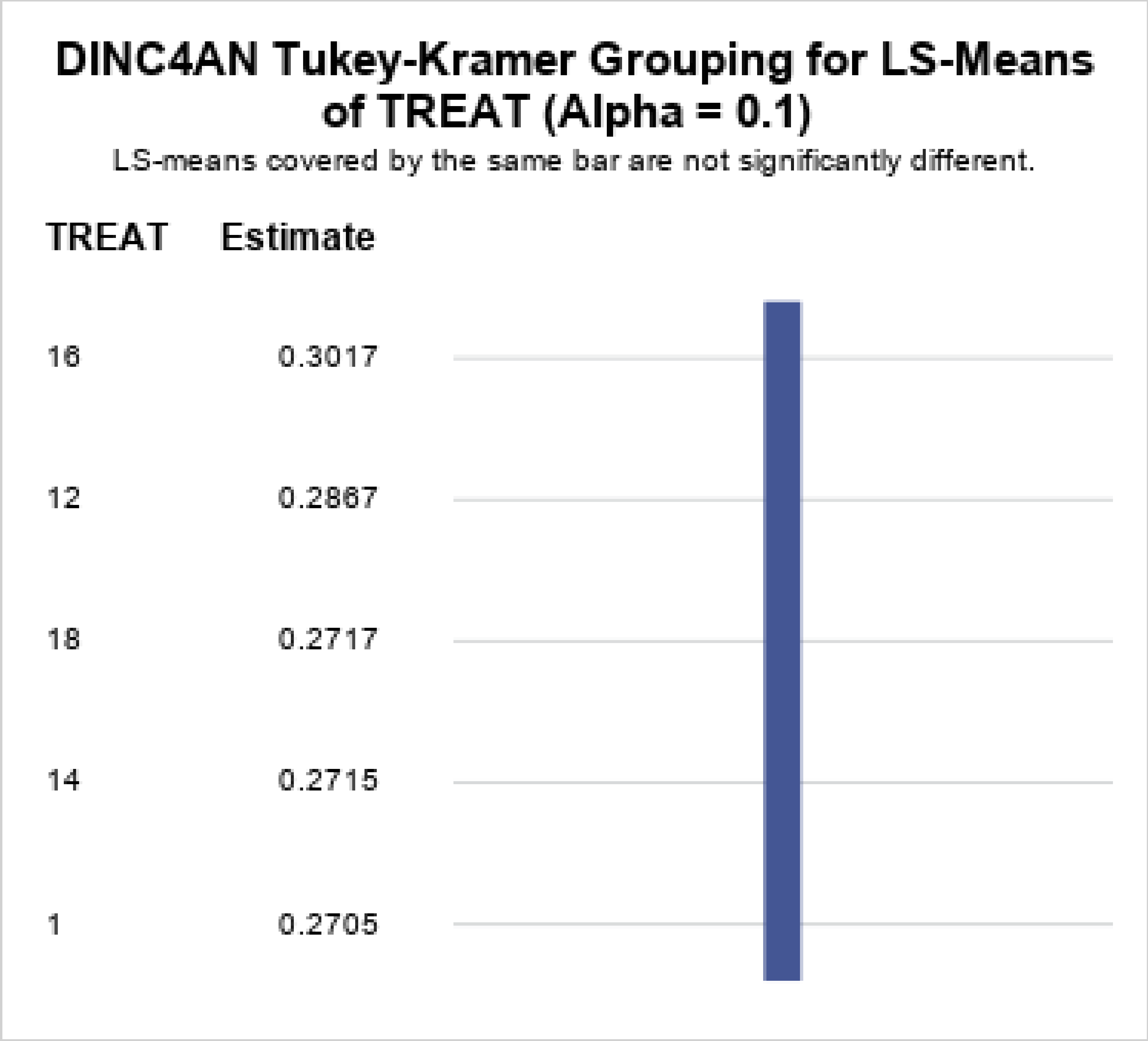


P. PINE – 4YR DBH ANOVA

AVERAGE TREE RESPONSE



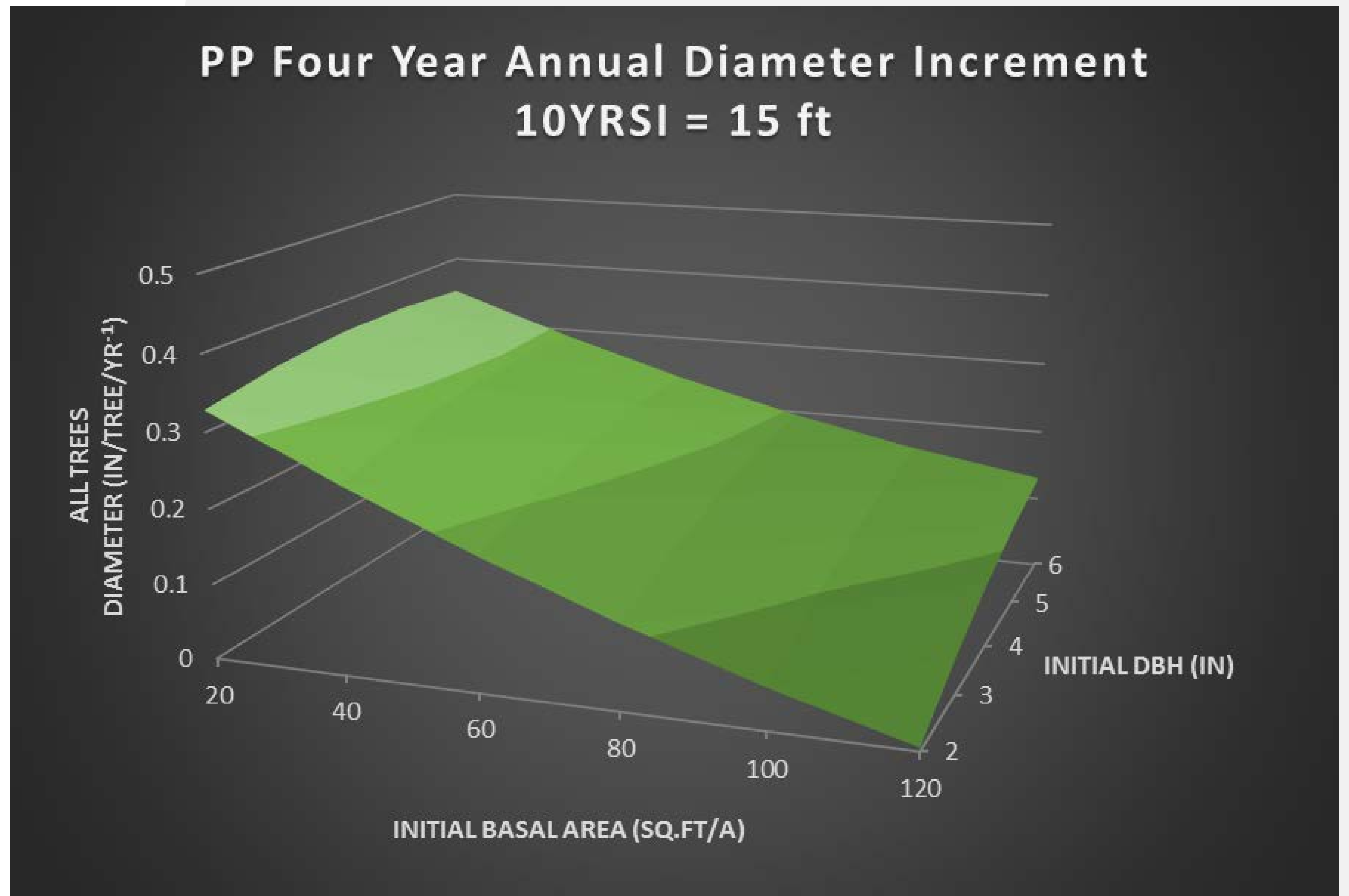
CROP TREE RESPONSE

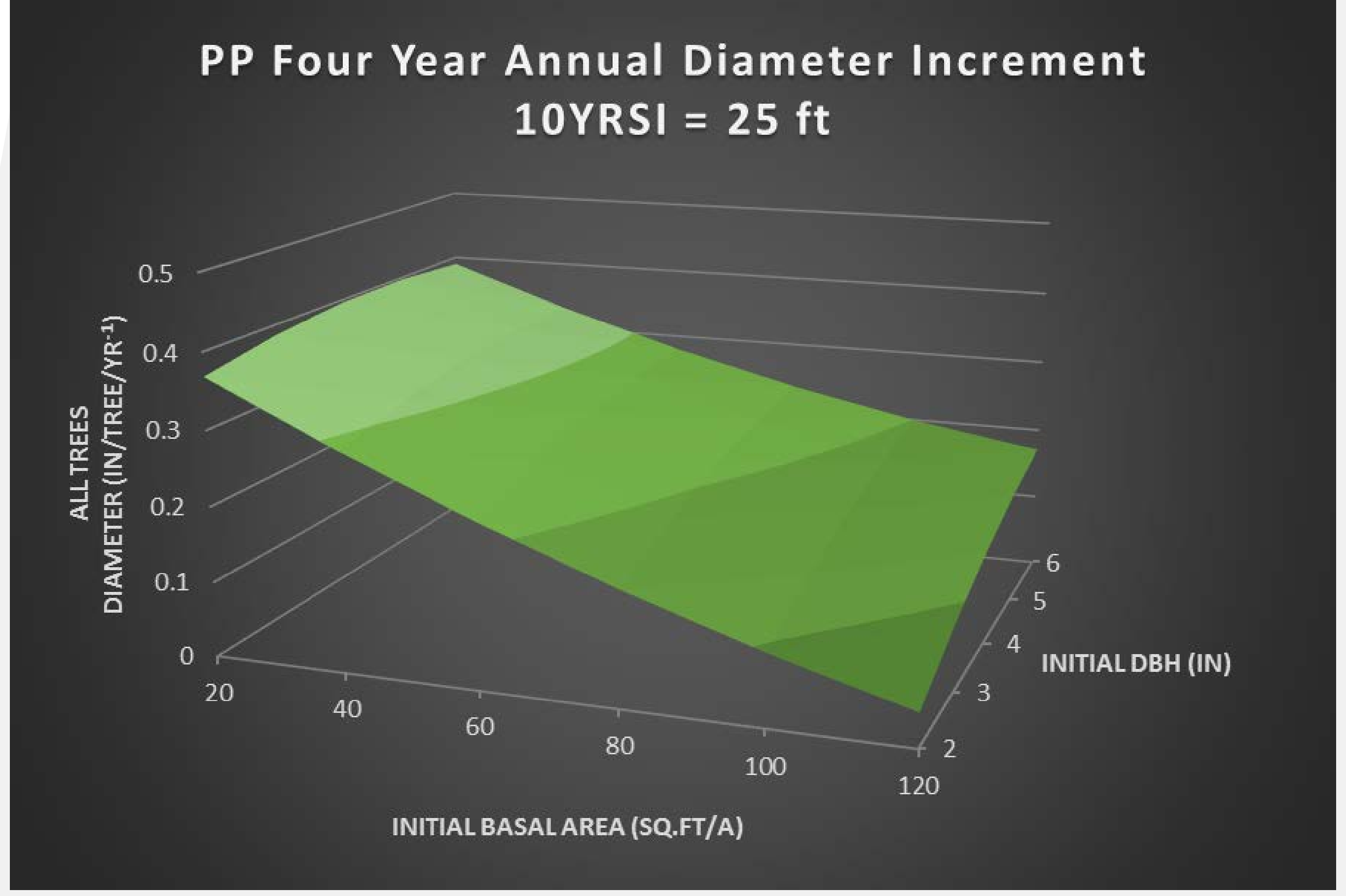


Means adjusted for SI10YR, initial density and initial diameter

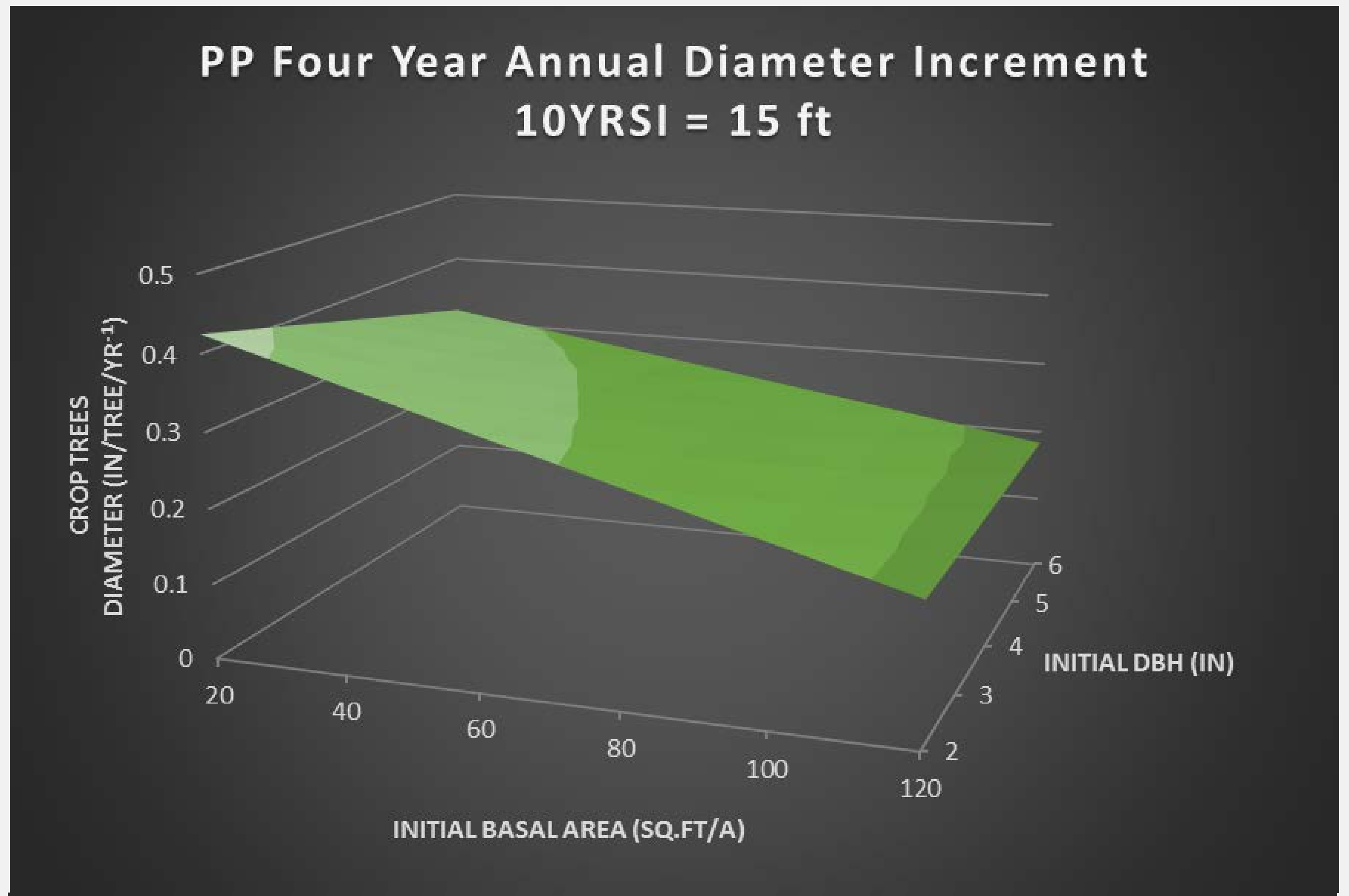
P. PINE – 4YR DBH REGRESSION

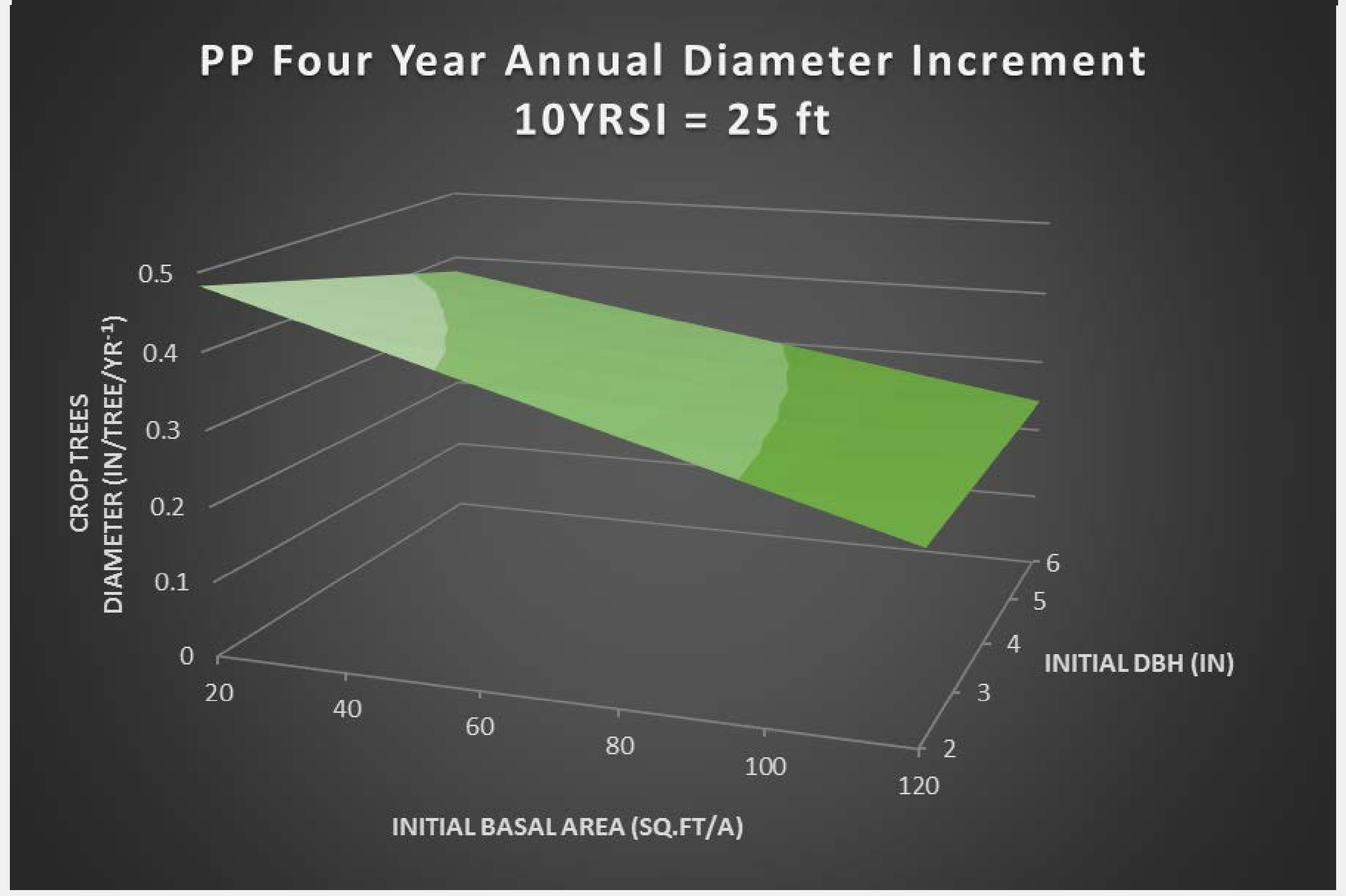
AVERAGE TREE RESPONSE





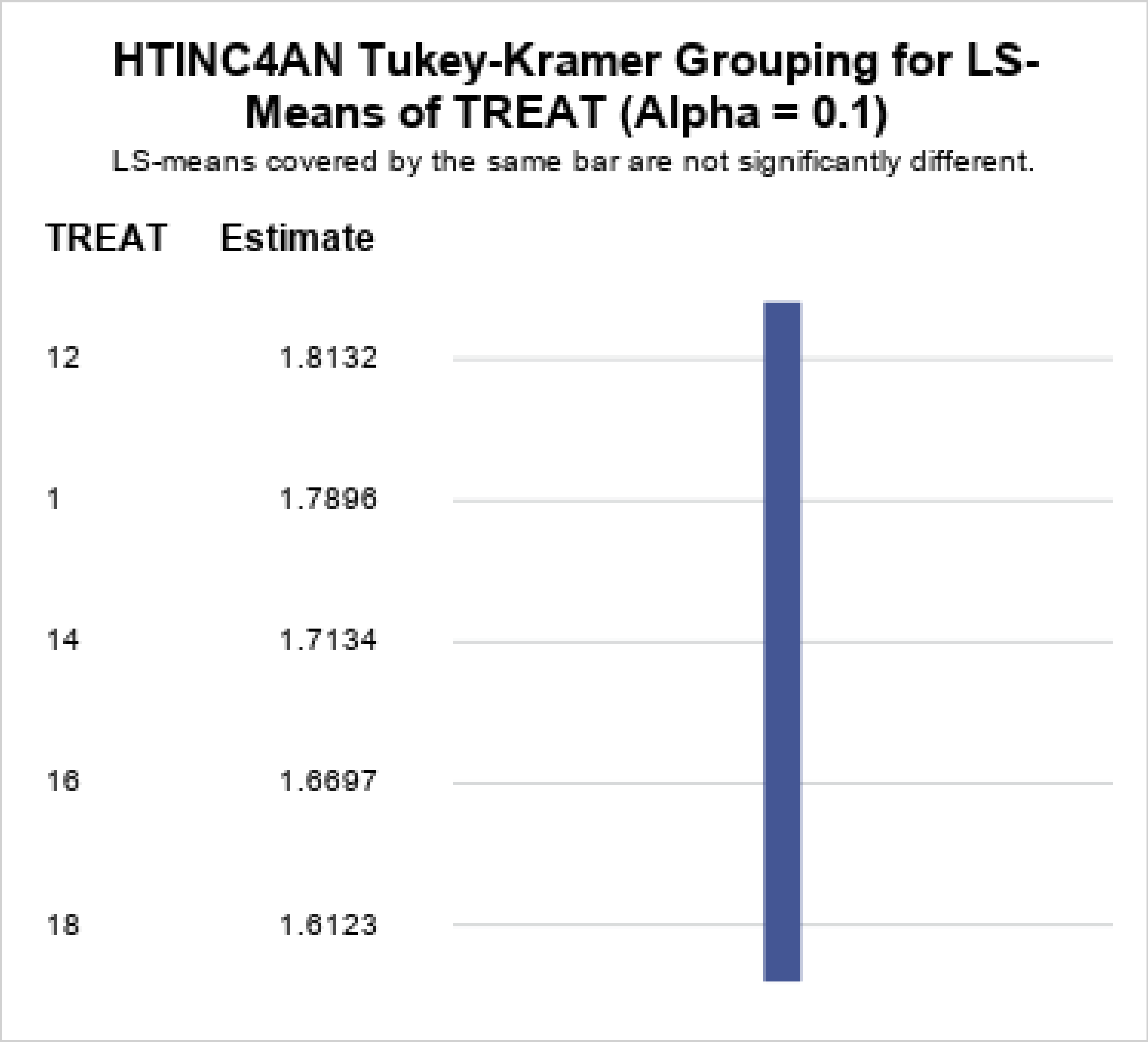
CROP TREE RESPONSE



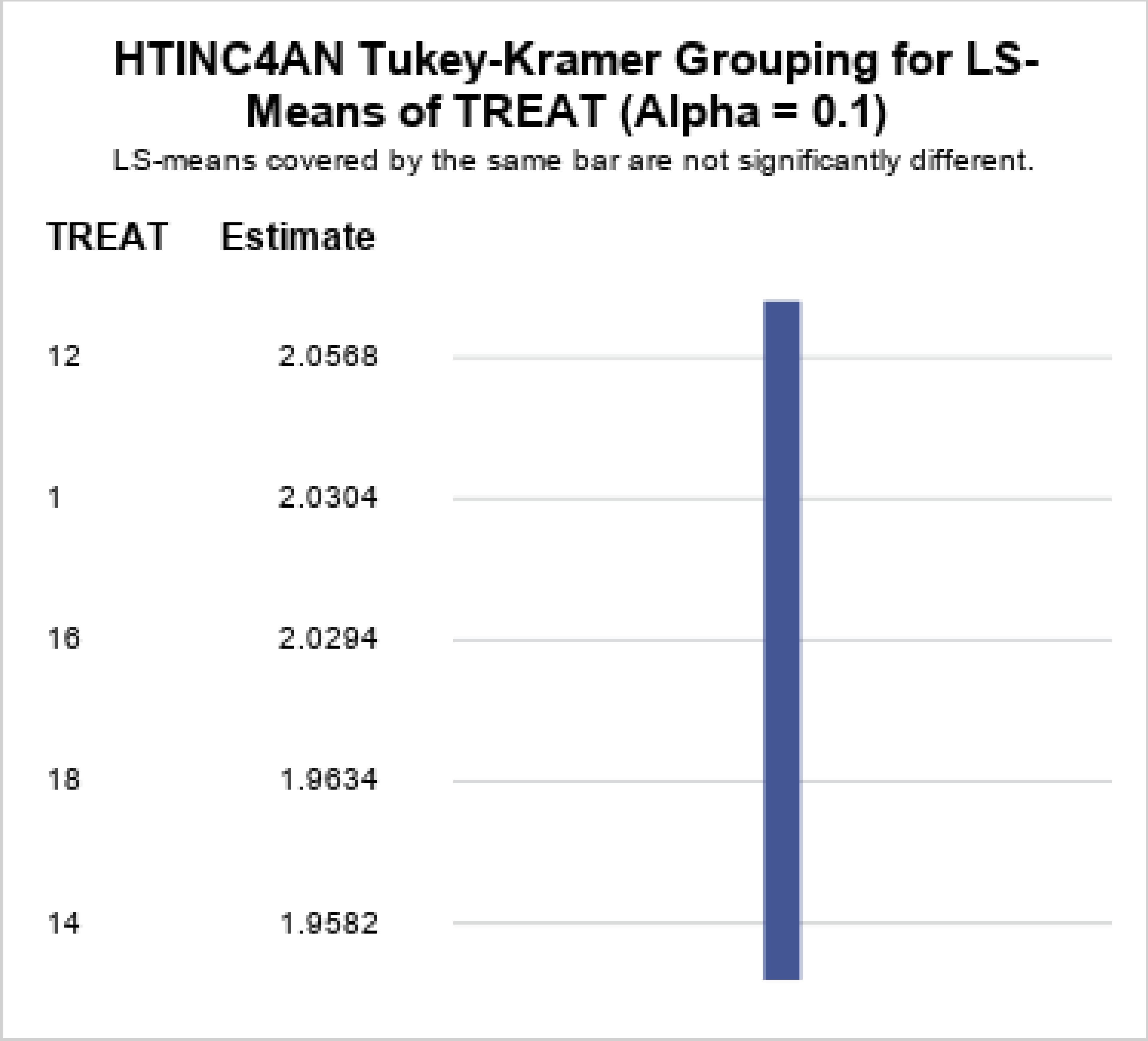


D. FIR – 4YR HEIGHT ANOVA

AVERAGE TREE RESPONSE



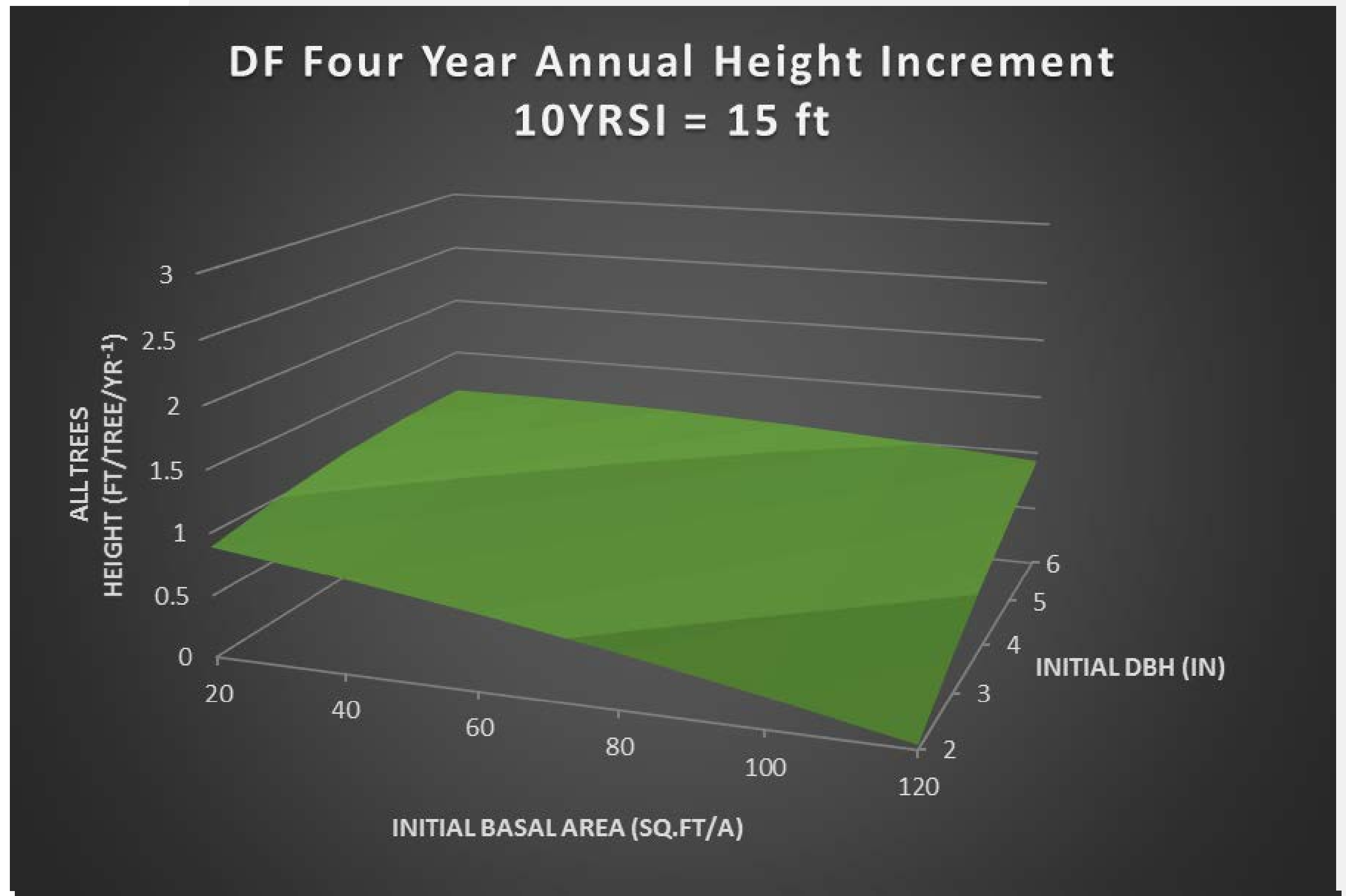
CROP TREE RESPONSE

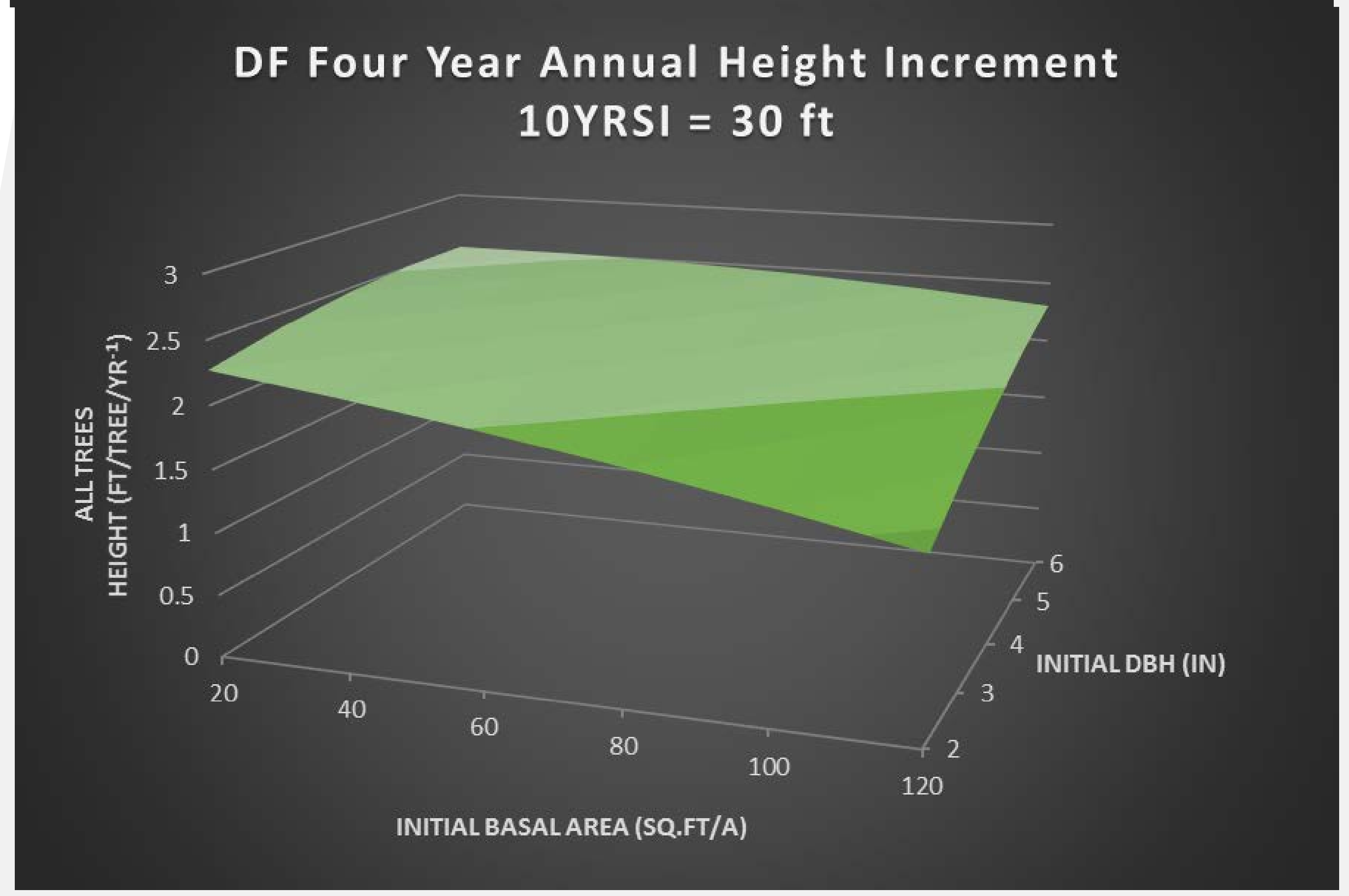


Means adjusted for SI10YR, initial density and initial diameter

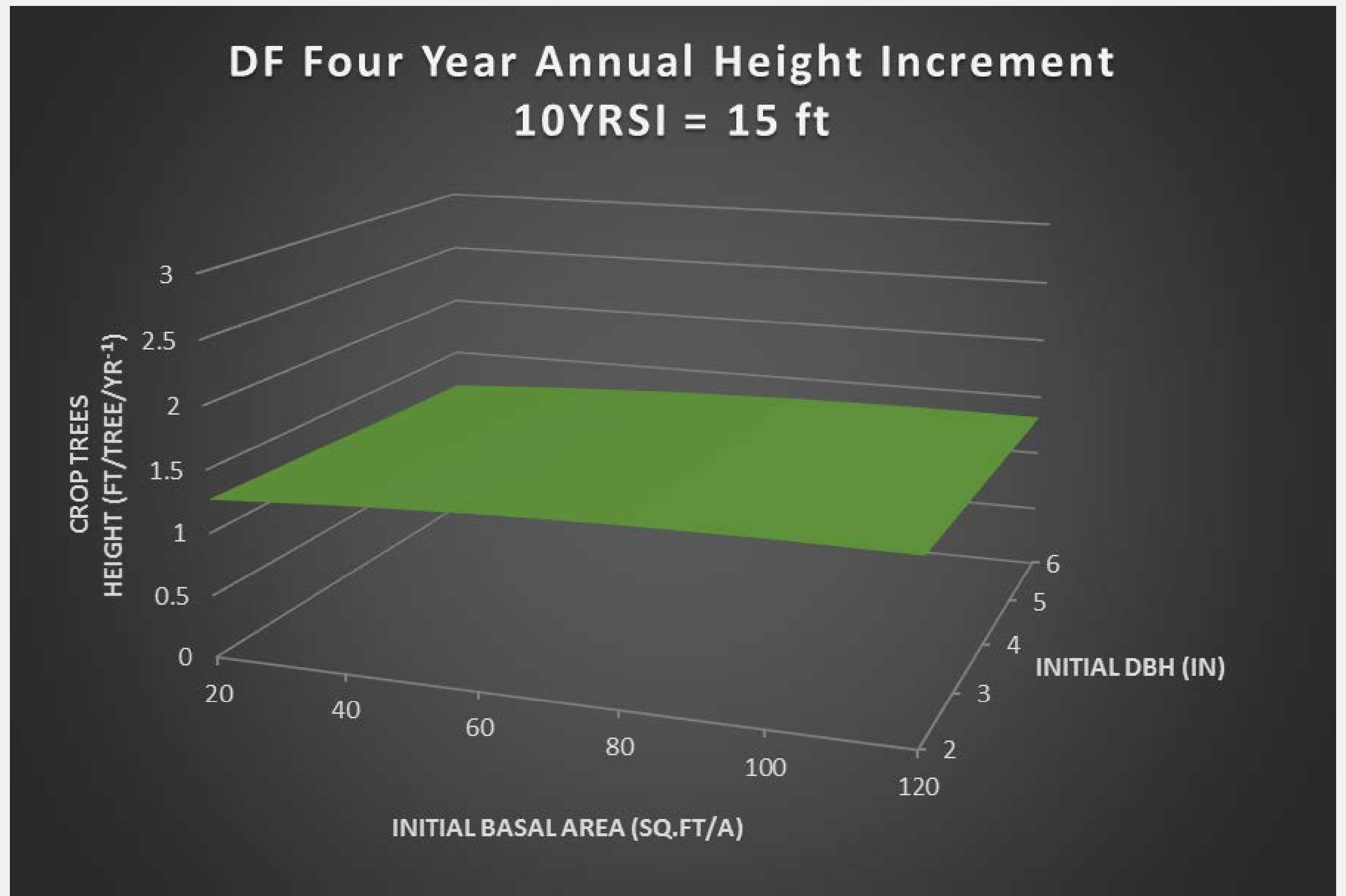
D. FIR – 4YR HEIGHT REGRESSION

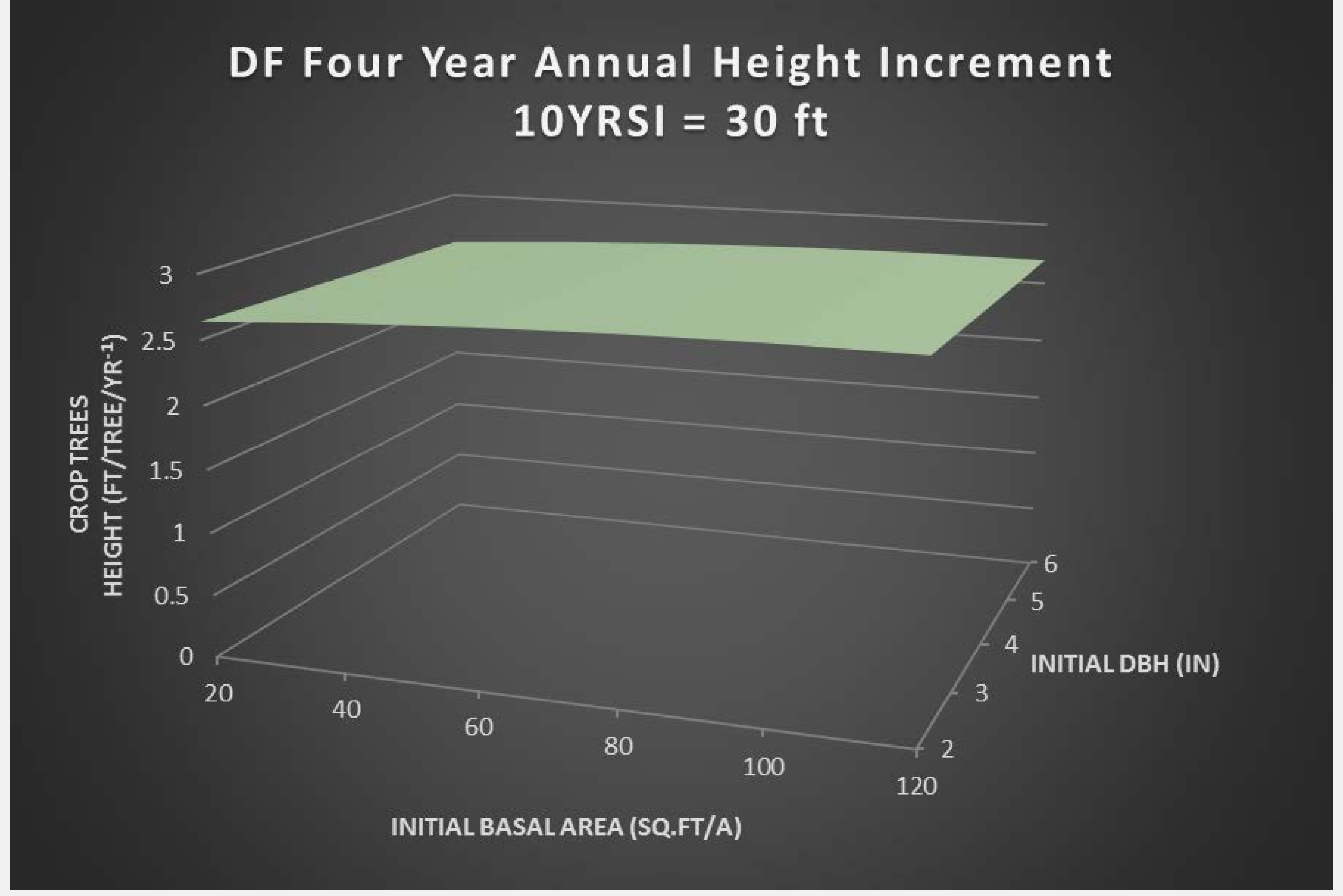
AVERAGE TREE RESPONSE





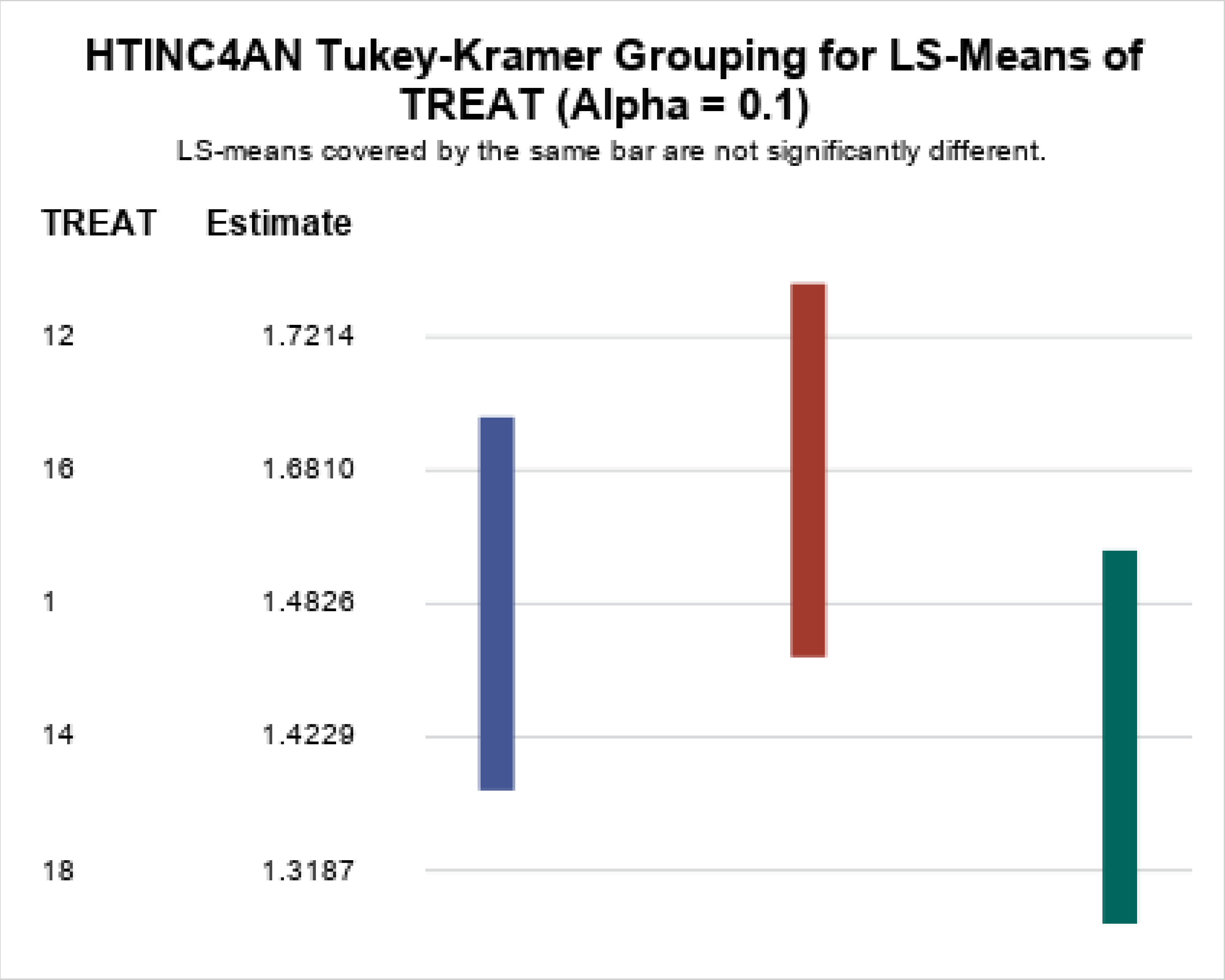
CROP TREE RESPONSE



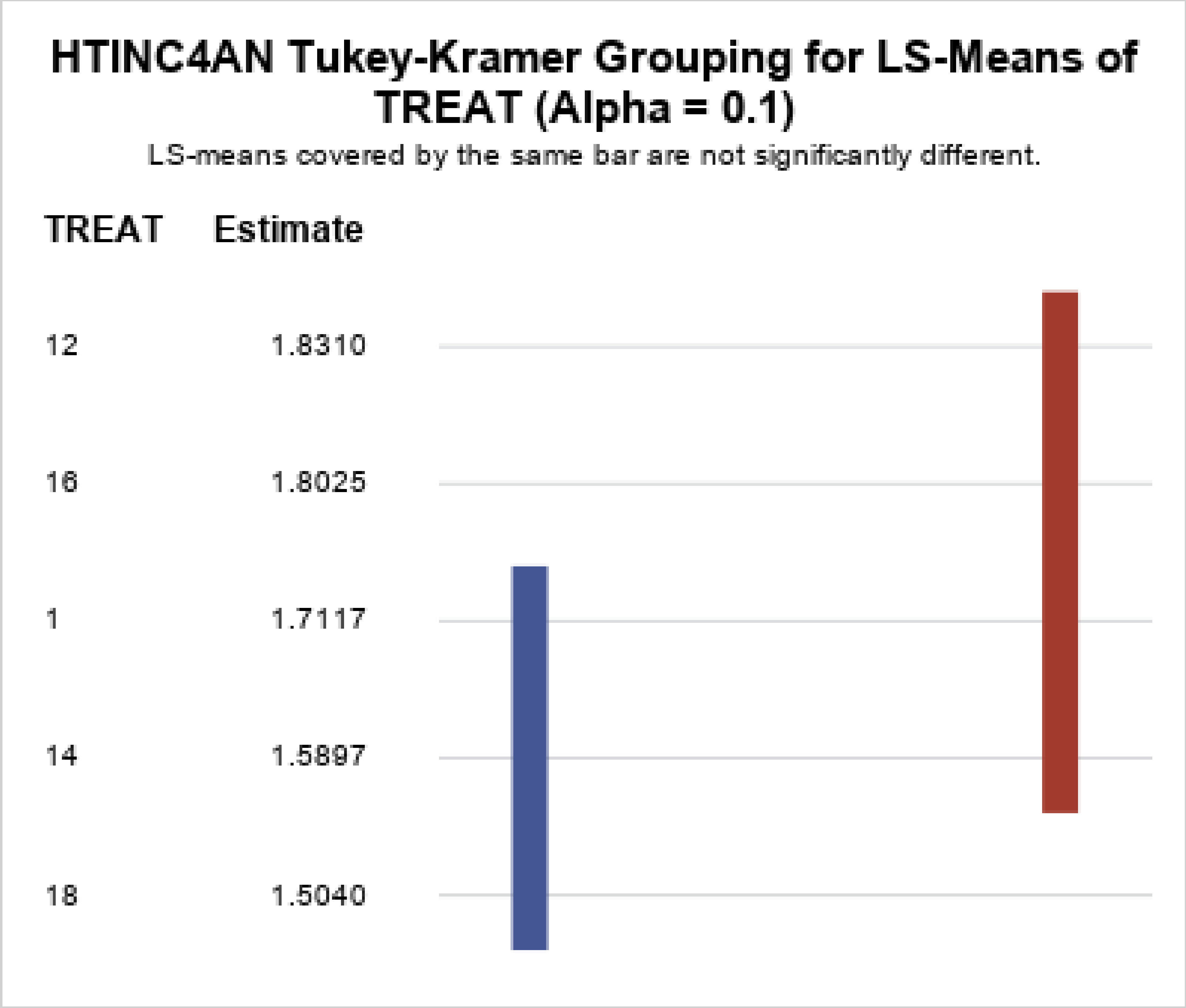


P. PINE – 4YR HEIGHT ANOVA

AVERAGE TREE RESPONSE



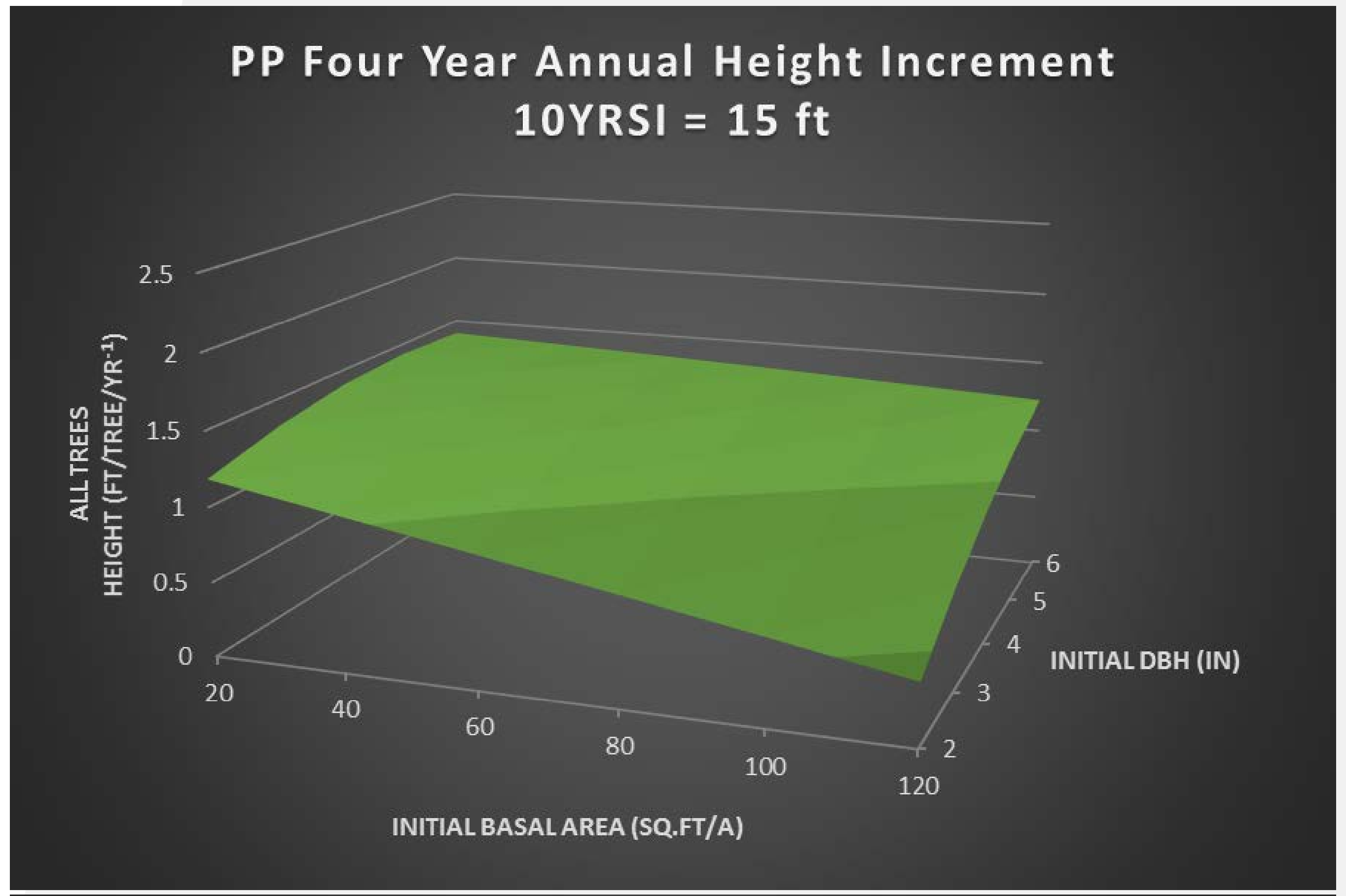
CROP TREE RESPONSE

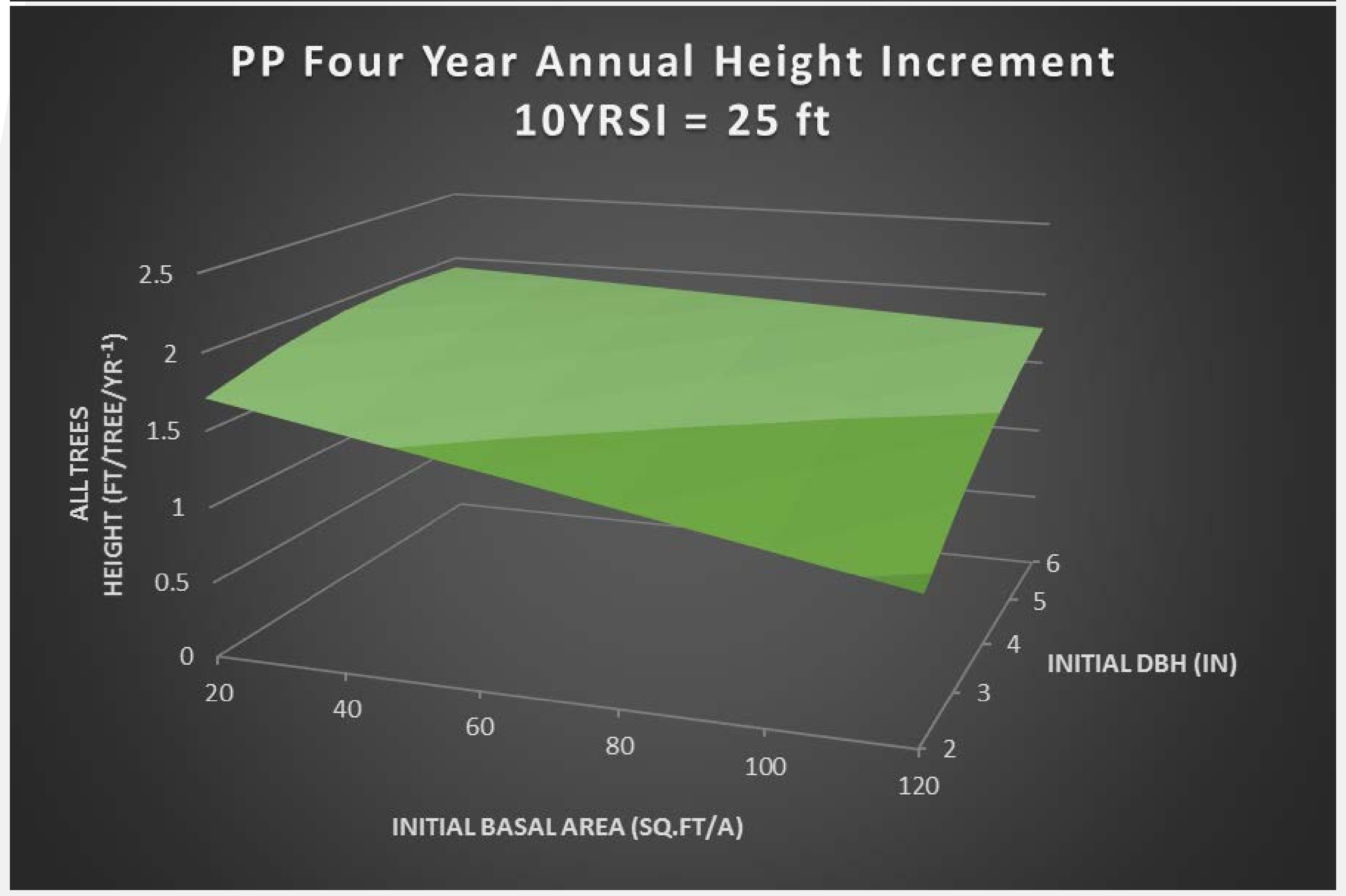


Means adjusted for SI10YR, initial density and initial diameter

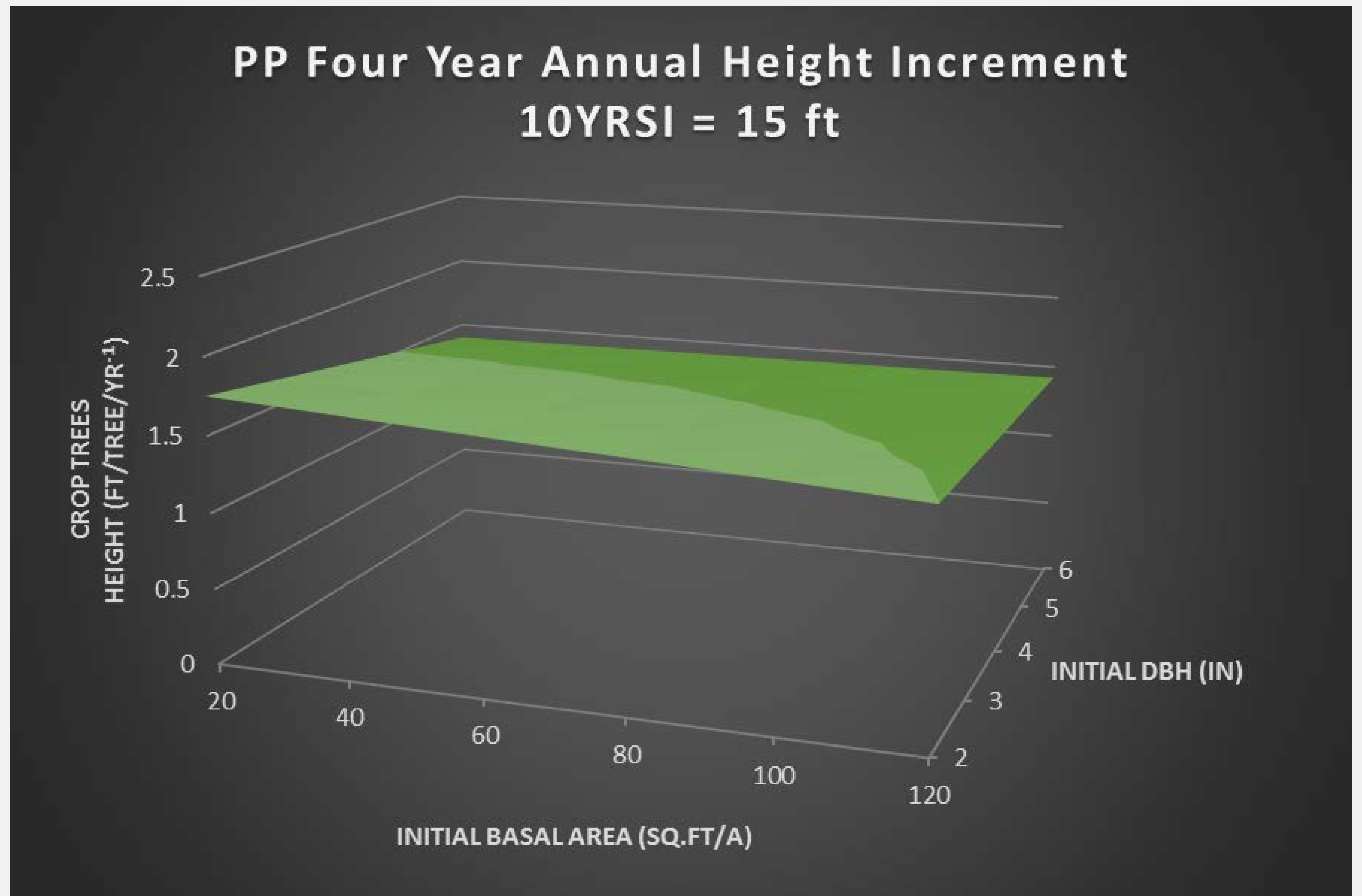
P. PINE – 4YR HEIGHT REGRESSION

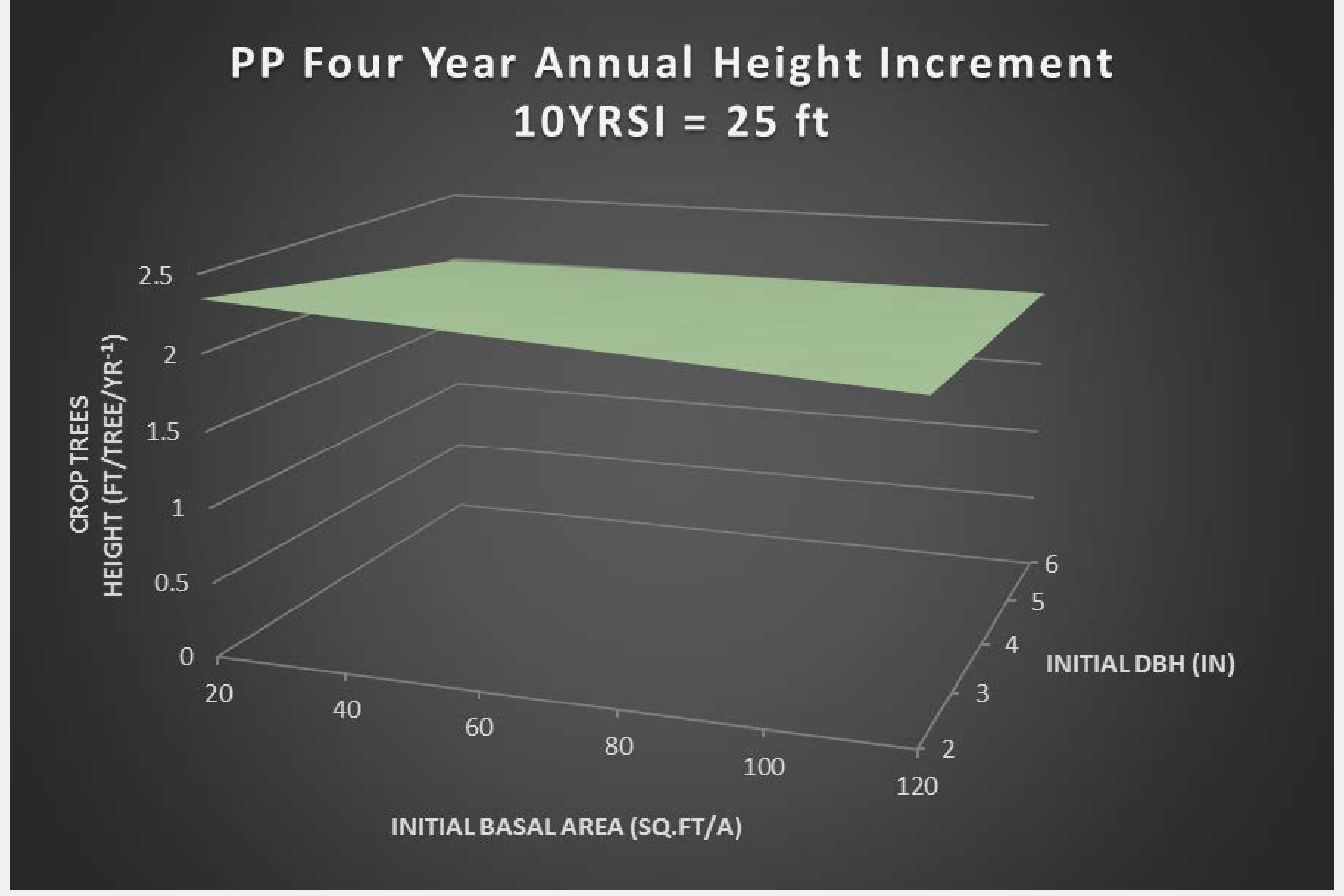
AVERAGE TREE RESPONSE





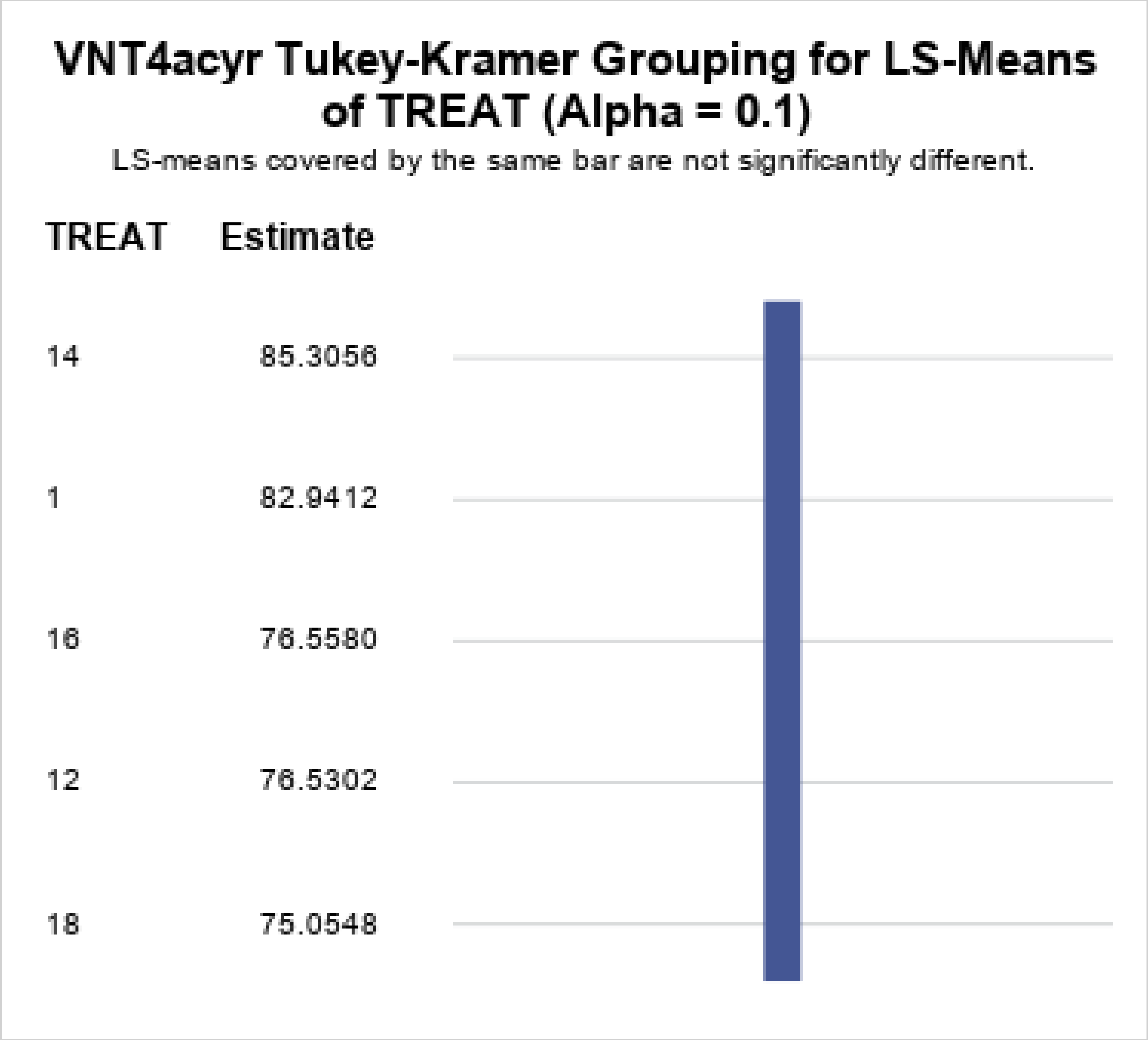
CROP TREE RESPONSE



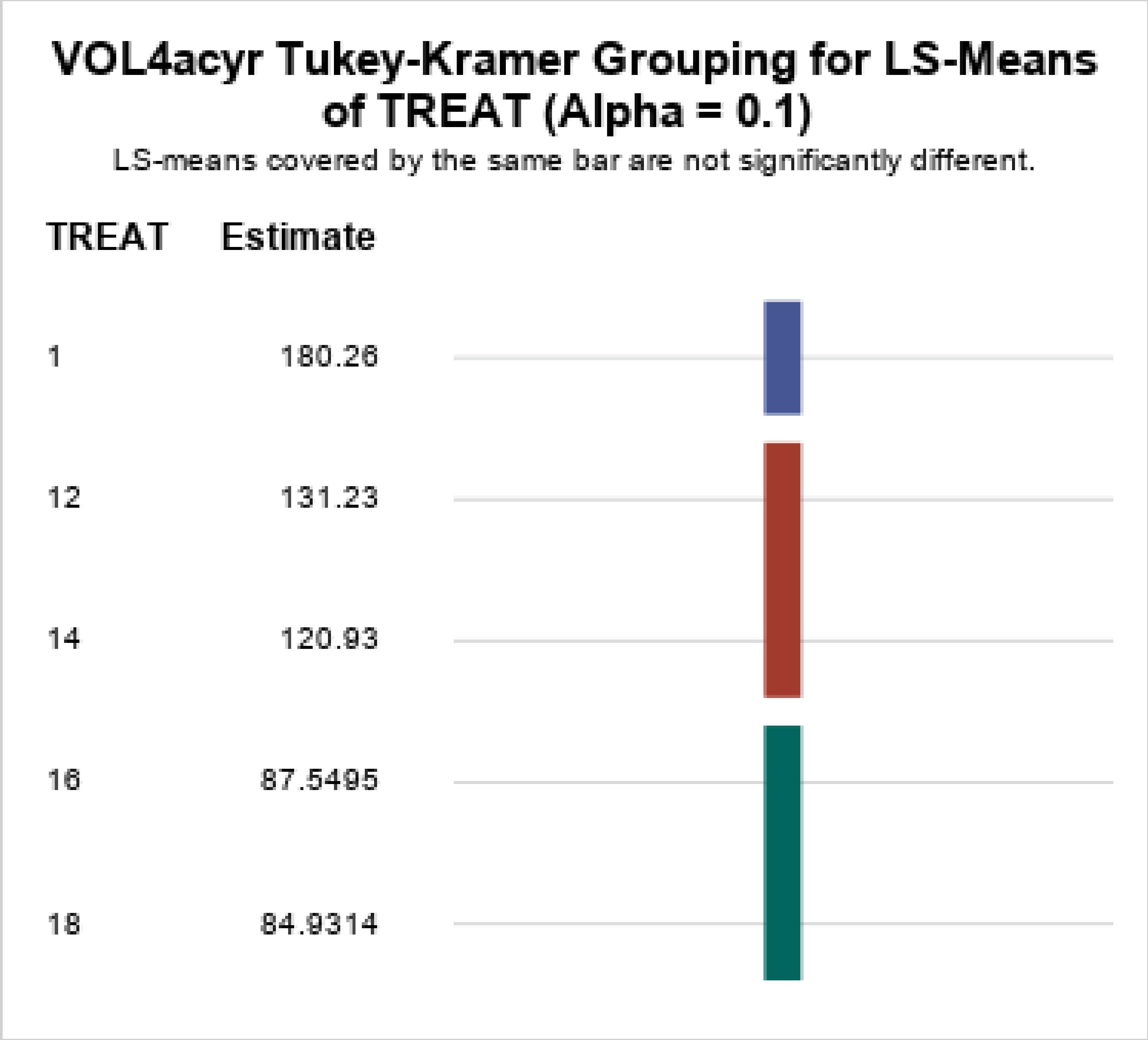


D. FIR – 4YR STAND VOLUME ANOVA

CROP TREE RESPONSE



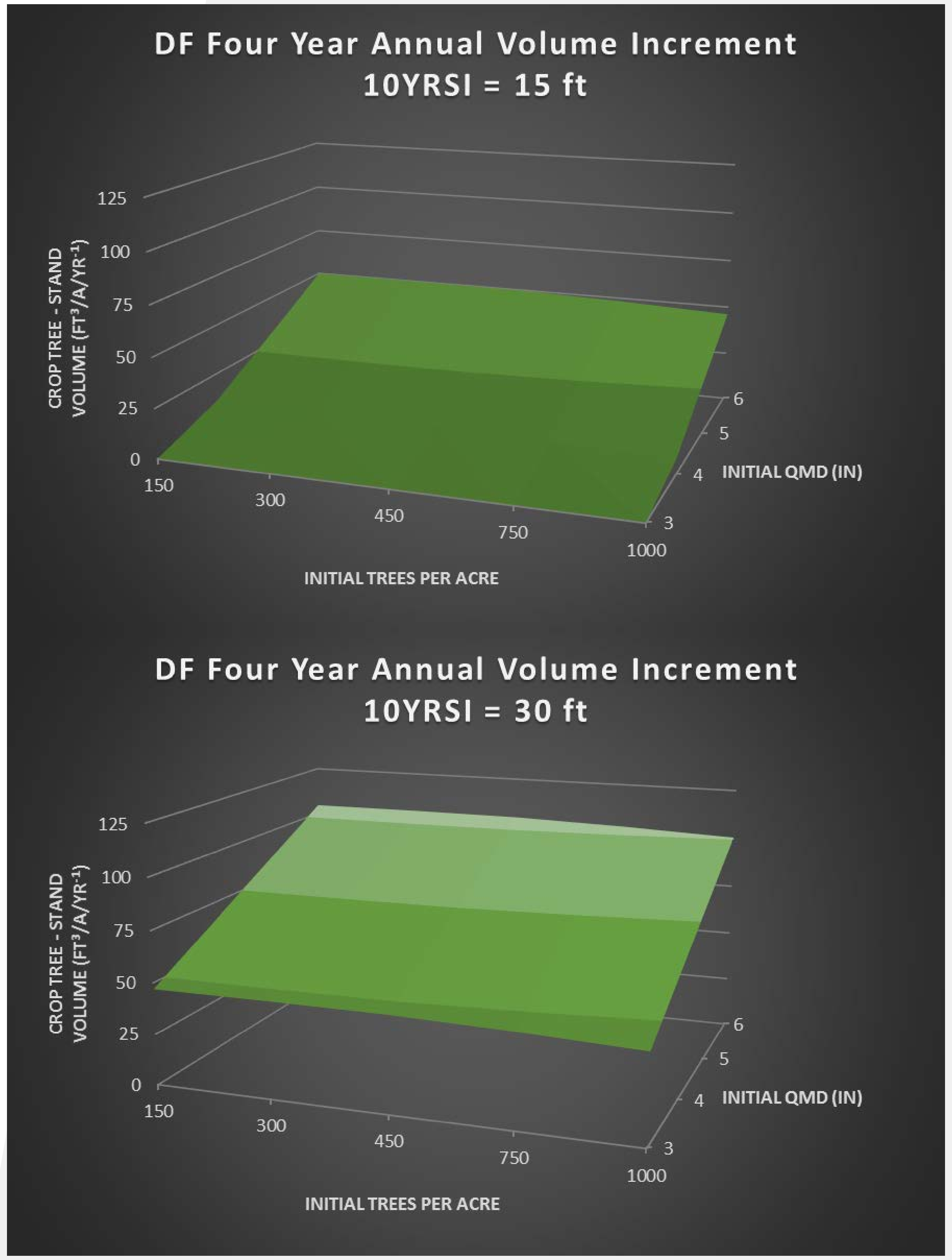
STAND RESPONSE



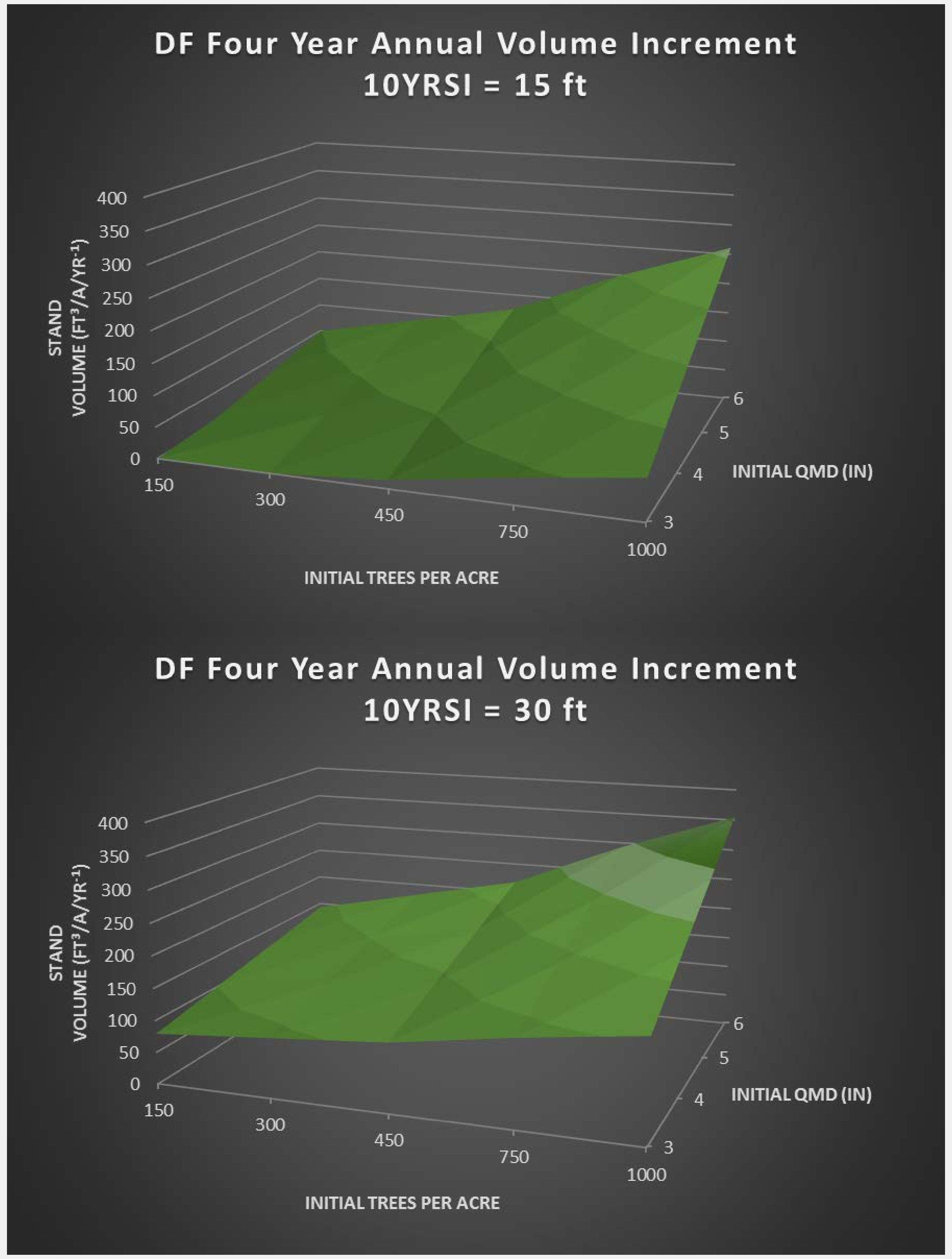
Means adjusted for SI10YR, initial TPA and initial QMD

D. FIR – 4YR STAND VOLUME REGRESSION

CROP TREE RESPONSE

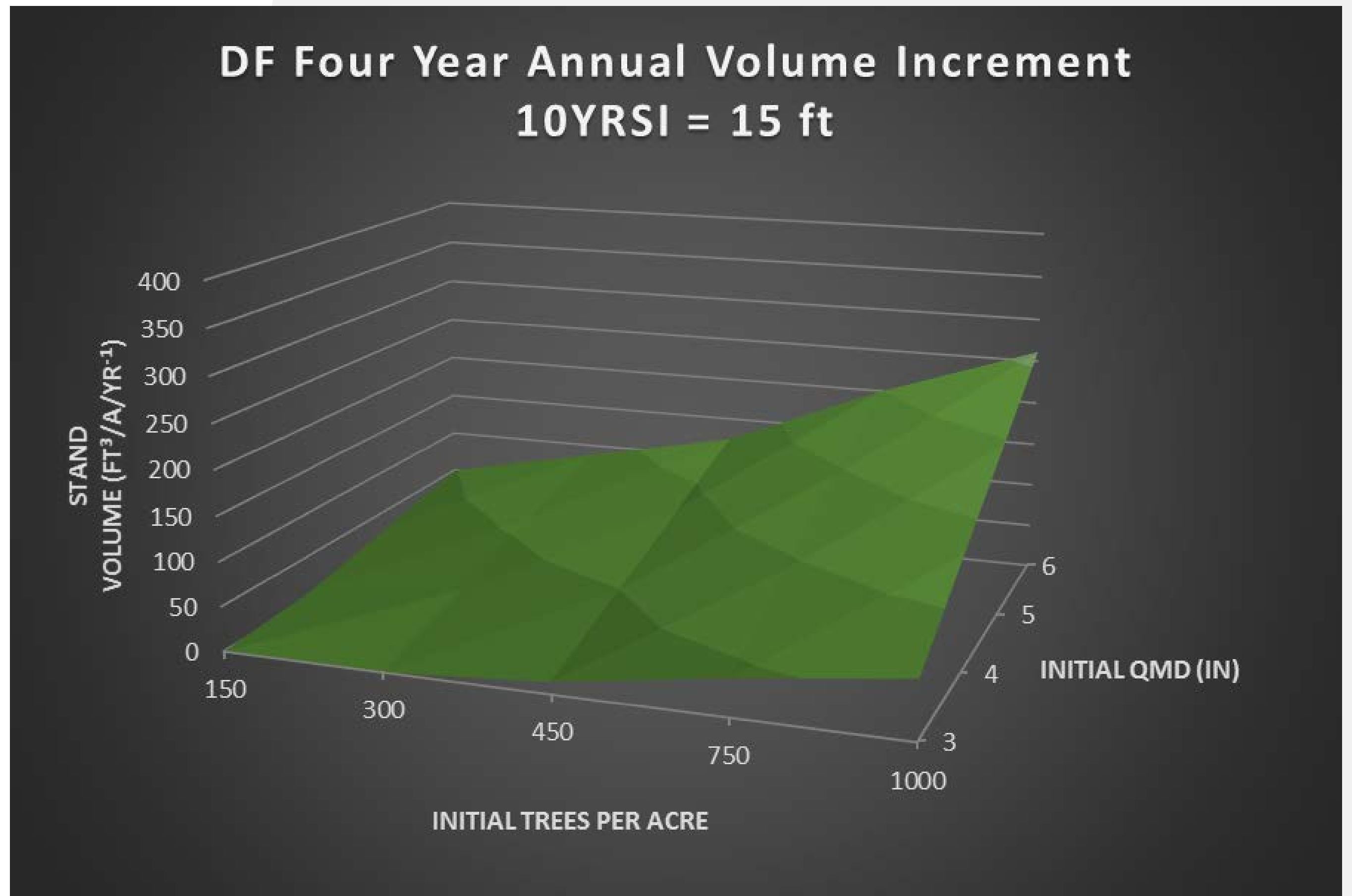


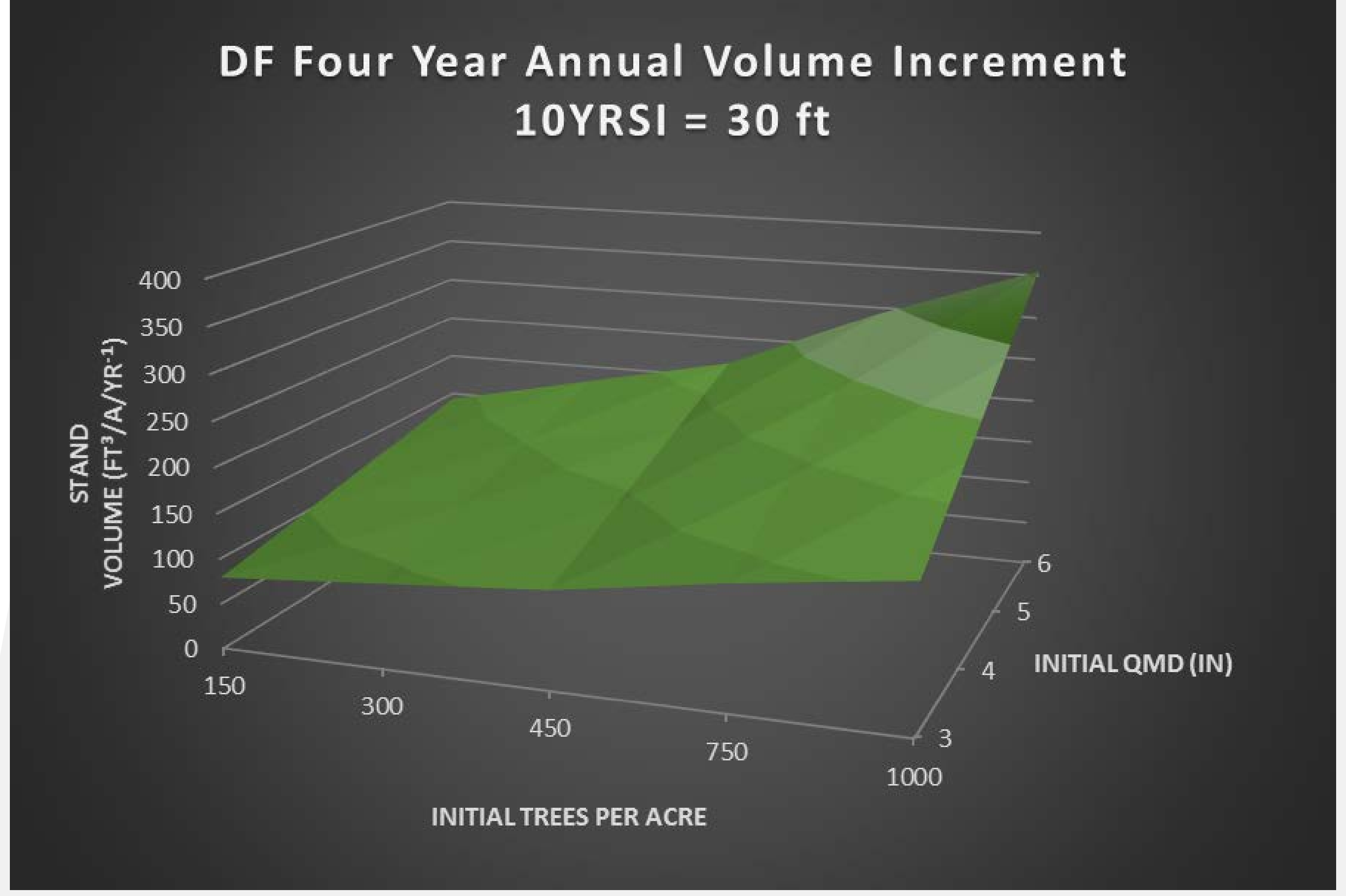
STAND RESPONSE



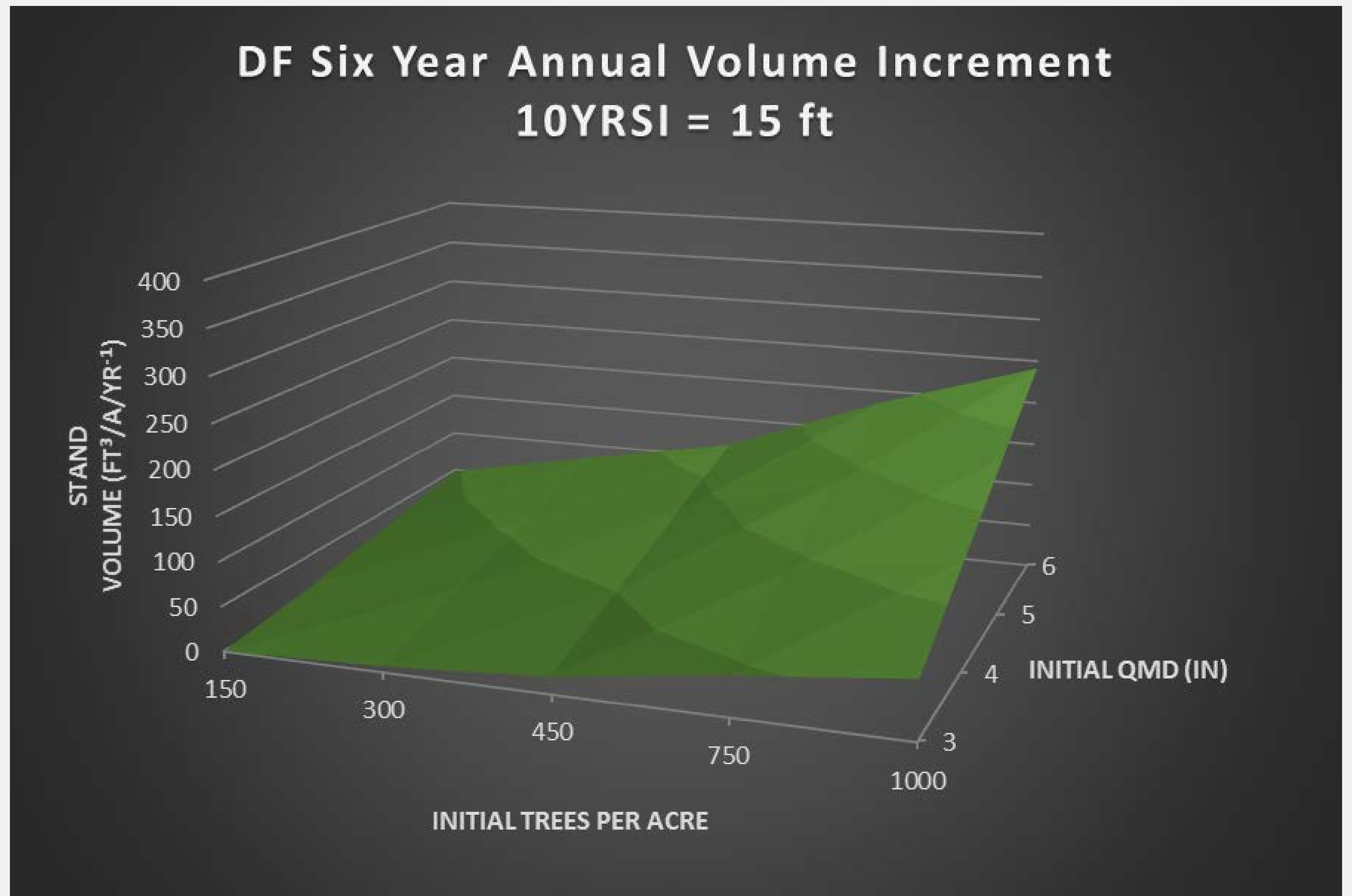
D. FIR – 4 VS 6YR STAND VOLUME

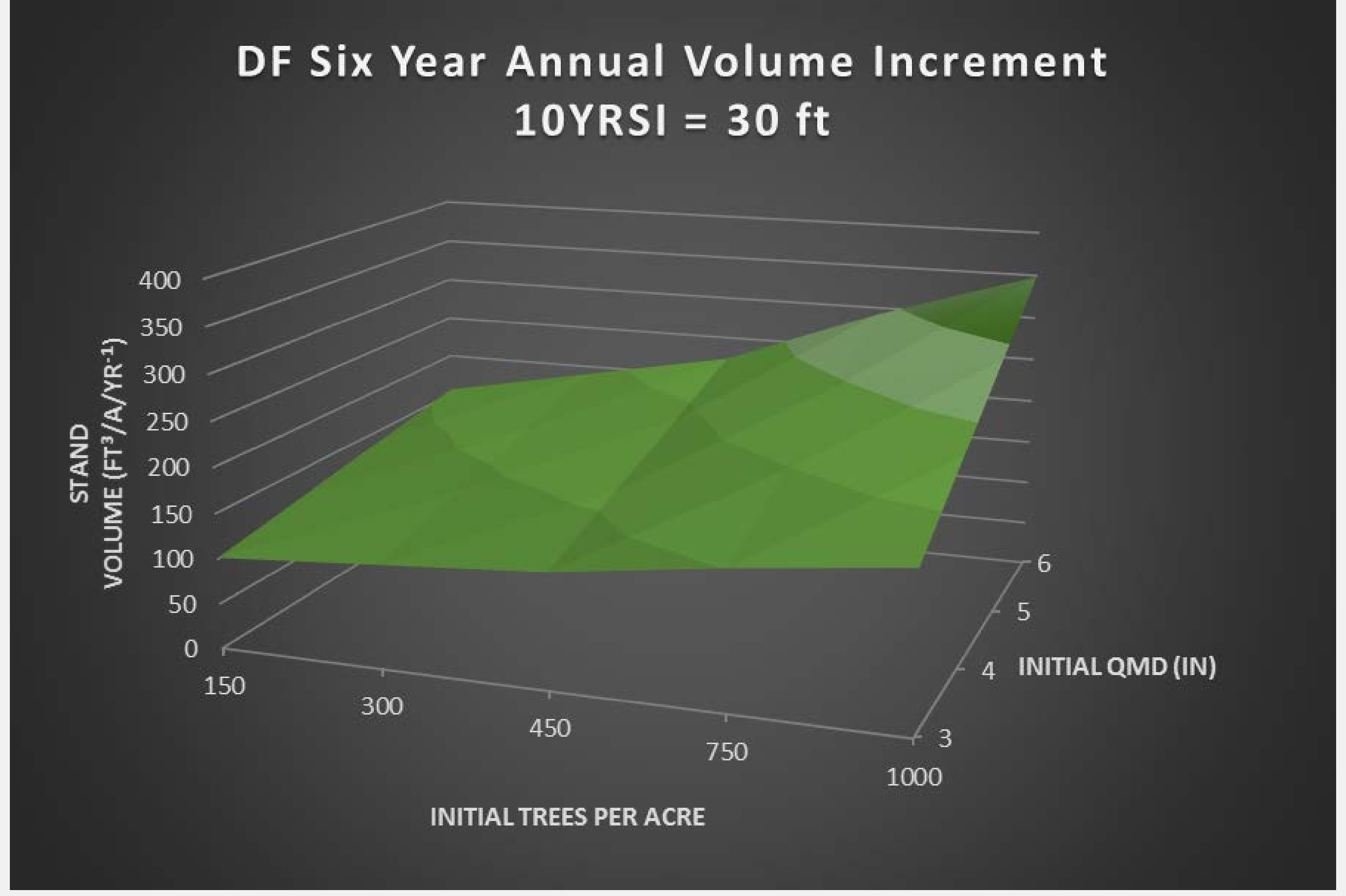
4YR STAND RESPONSE





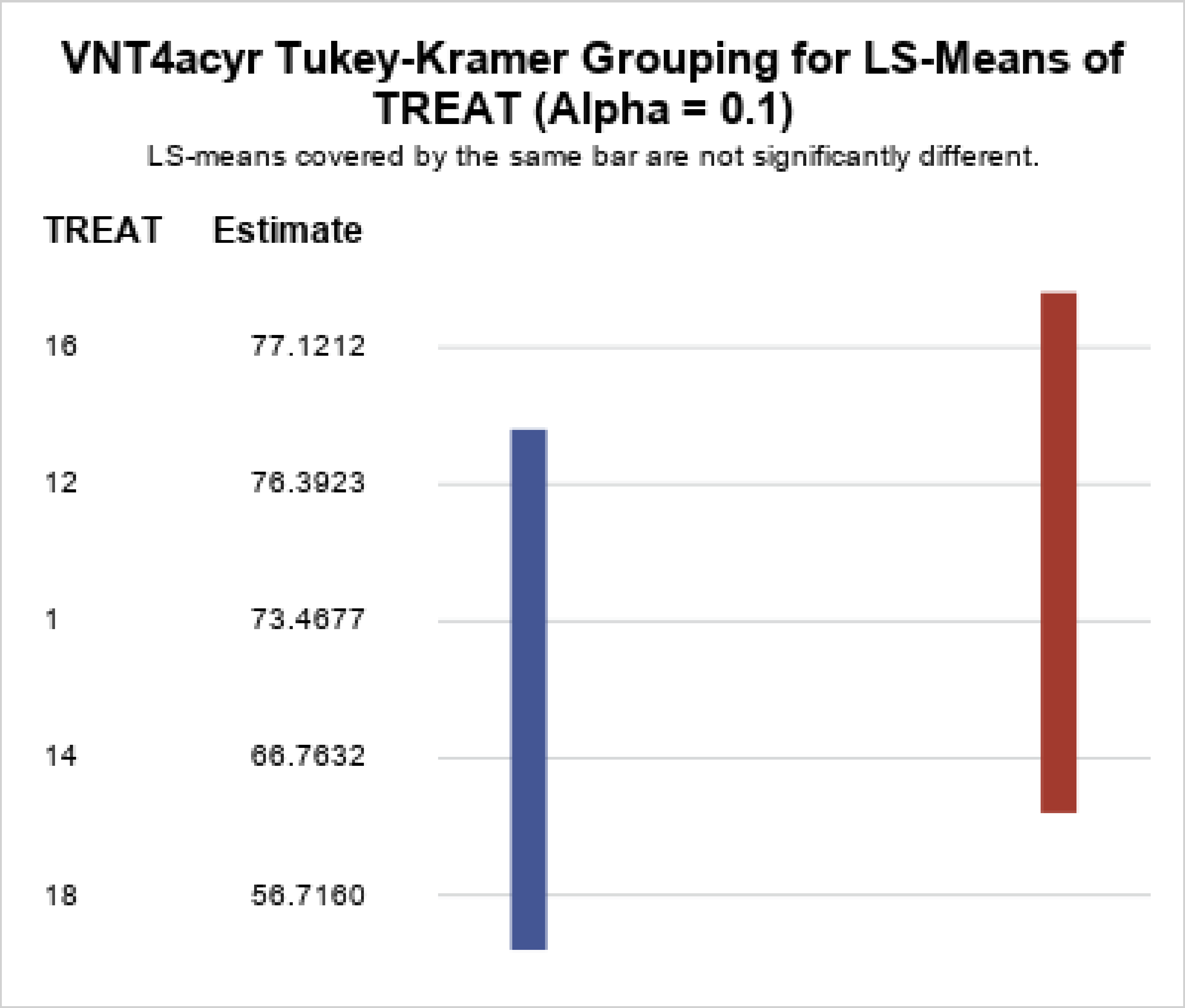
6YR STAND RESPONSE



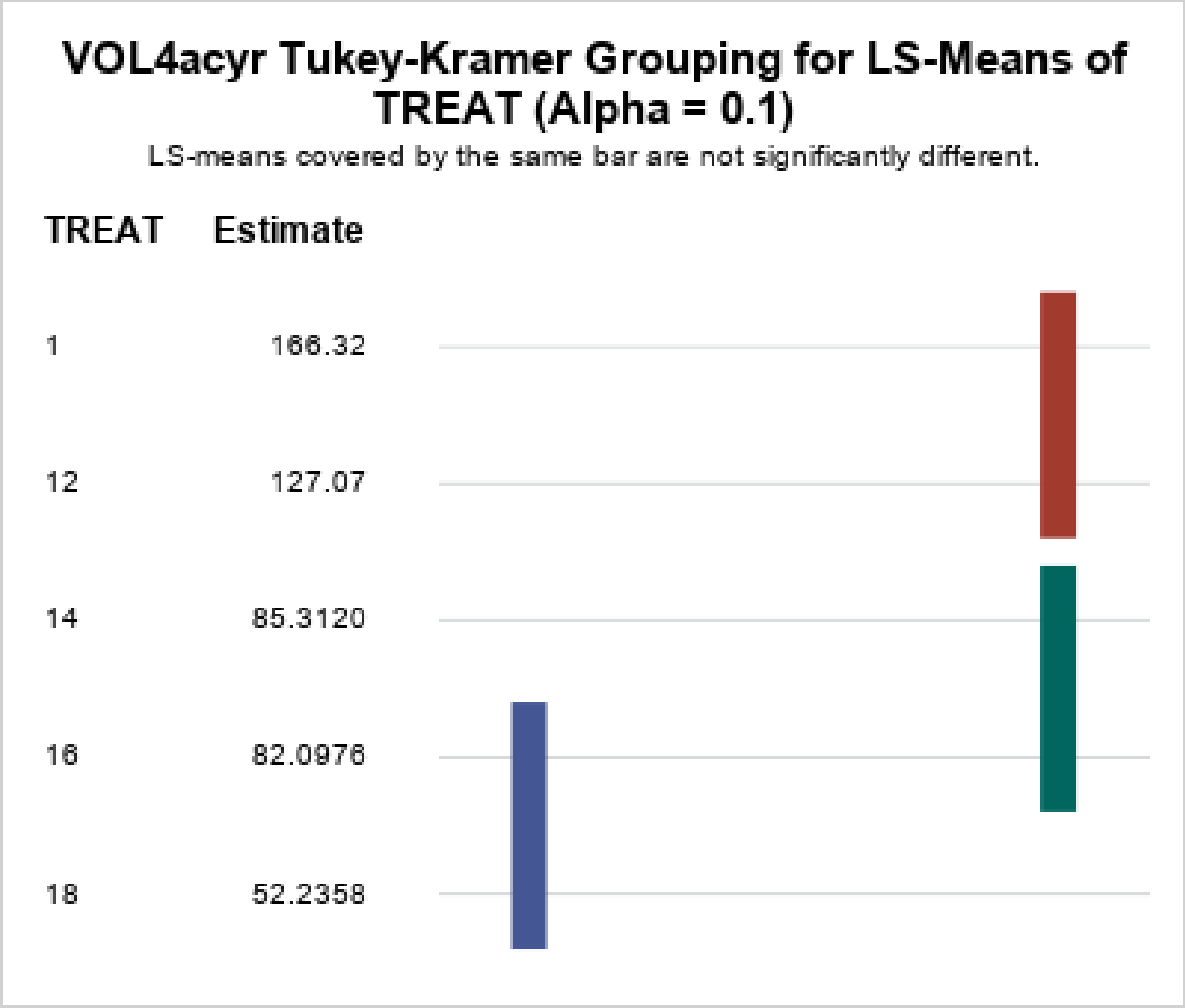


P. PINE – 4YR STAND VOLUME

CROP TREE RESPONSE



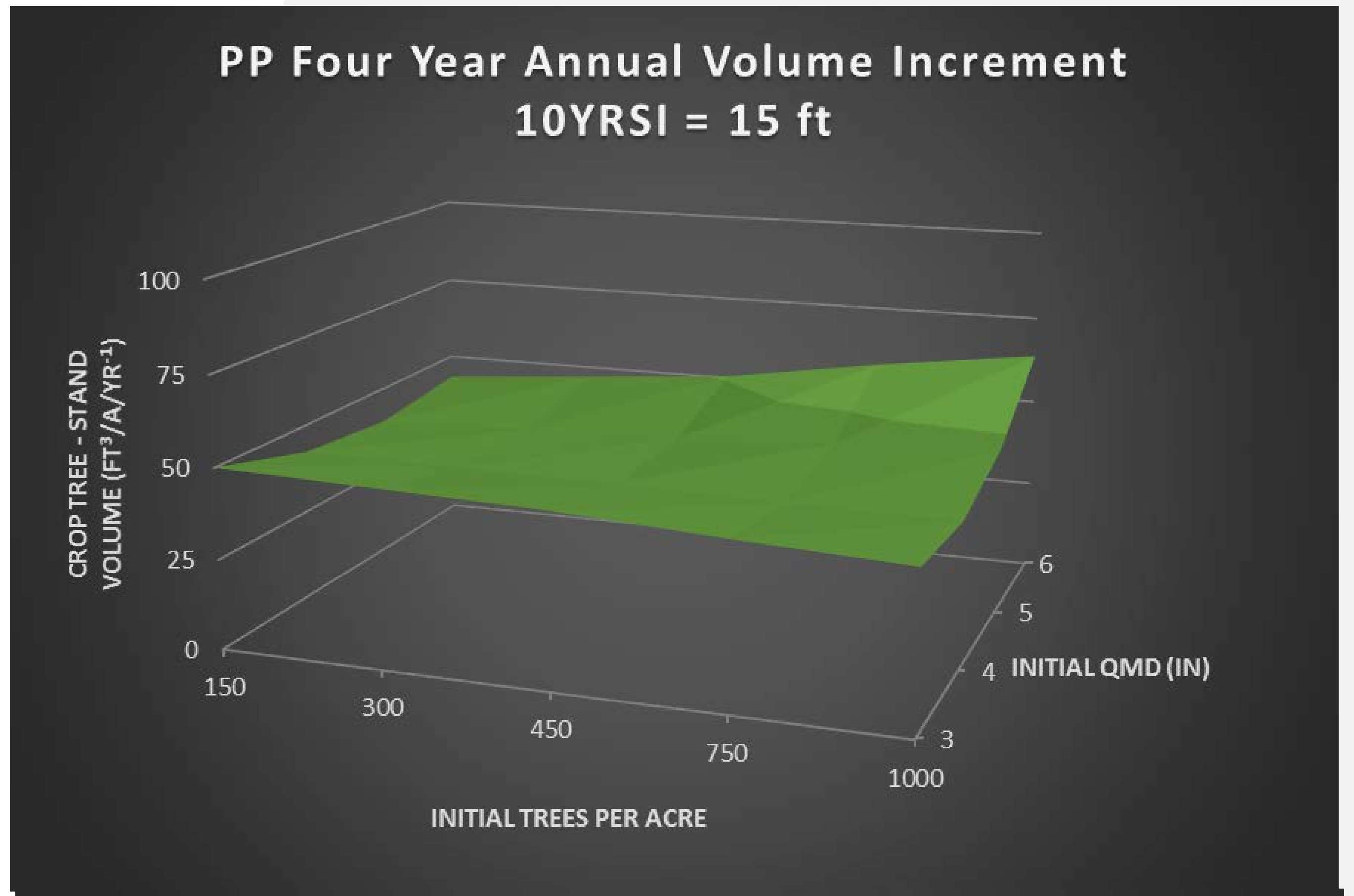
STAND RESPONSE

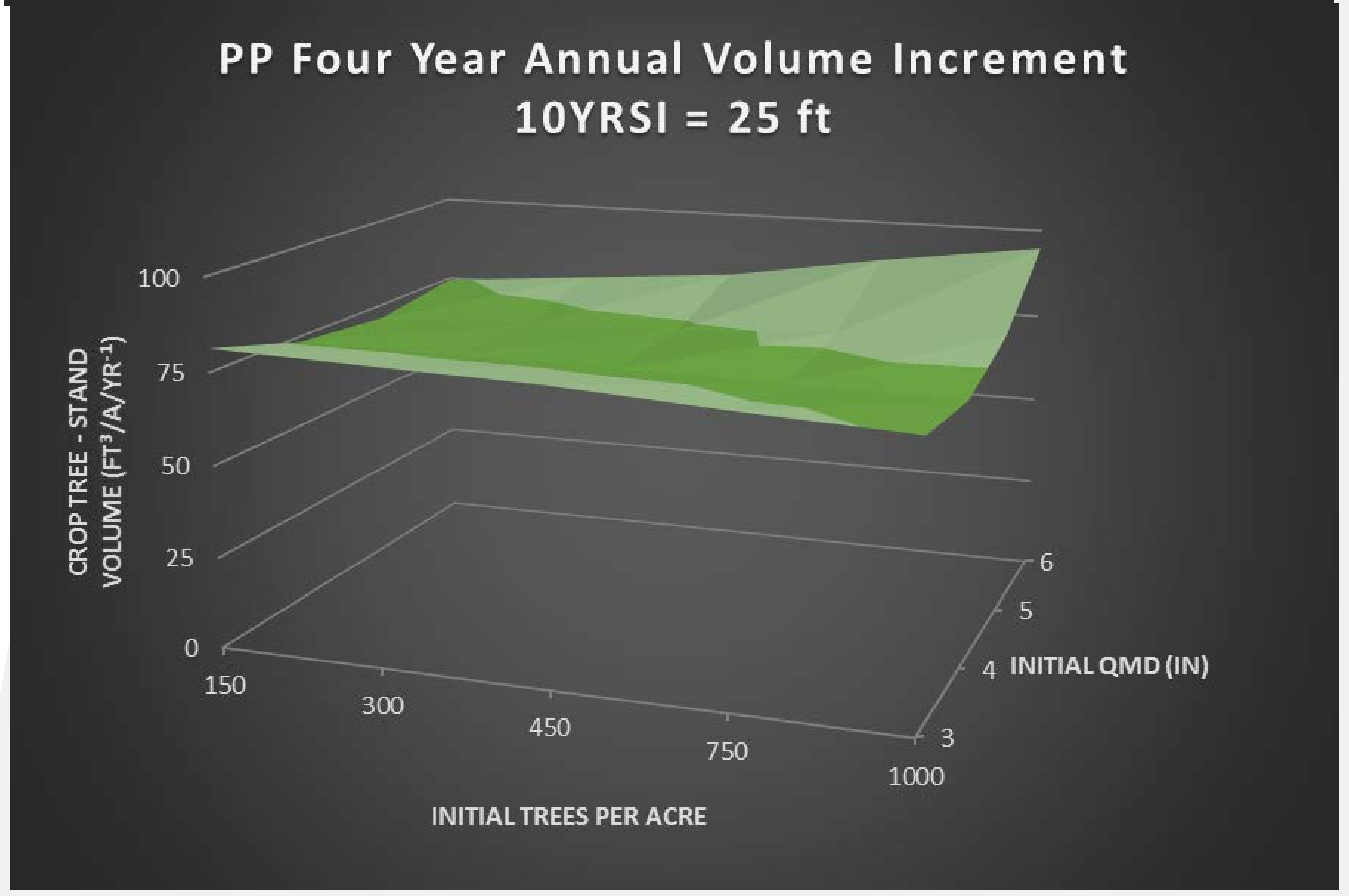


Means adjusted for SI10YR, initial TPA and initial QMD

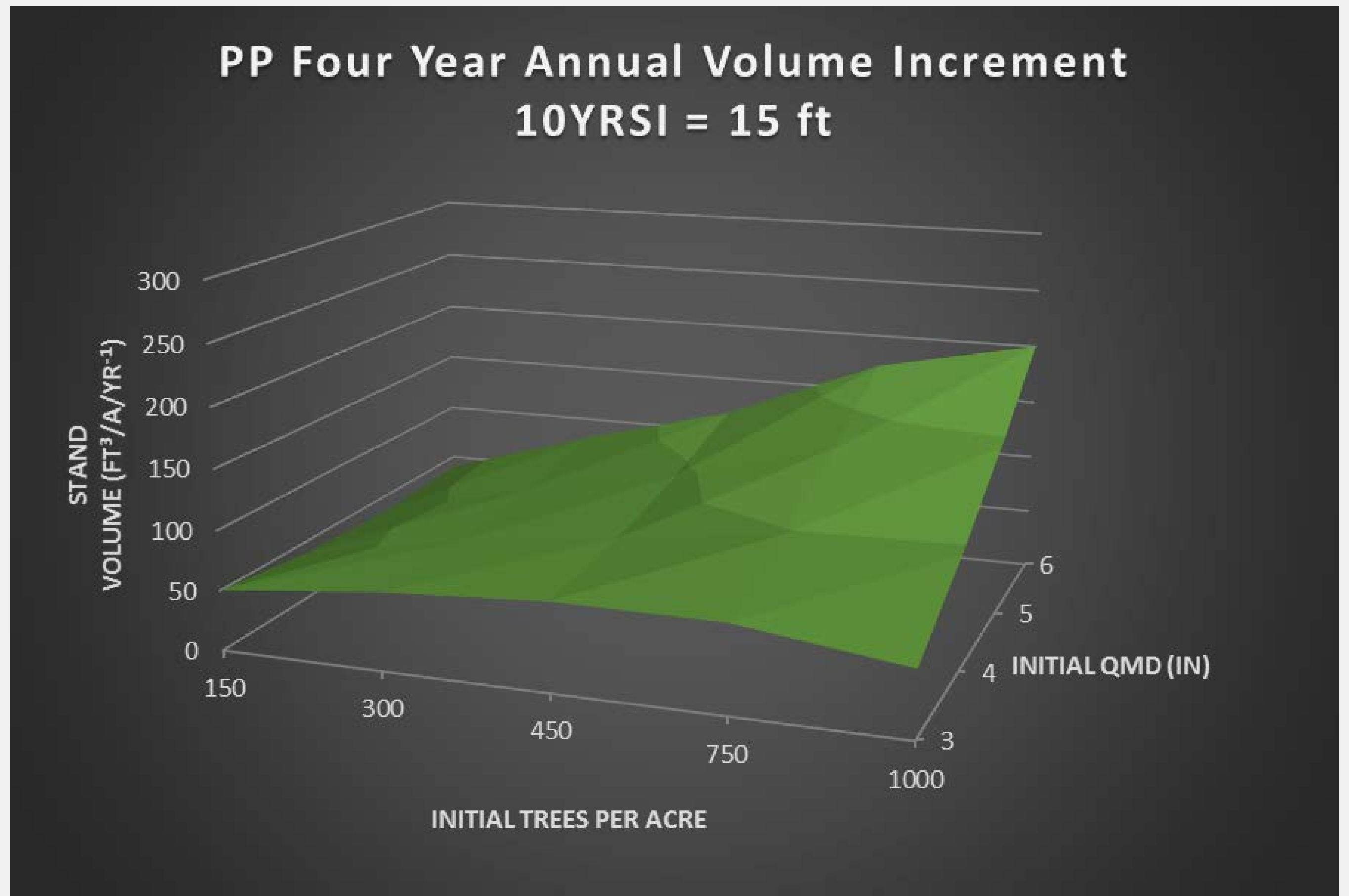
P. PINE – 4YR VOLUME REGRESSION

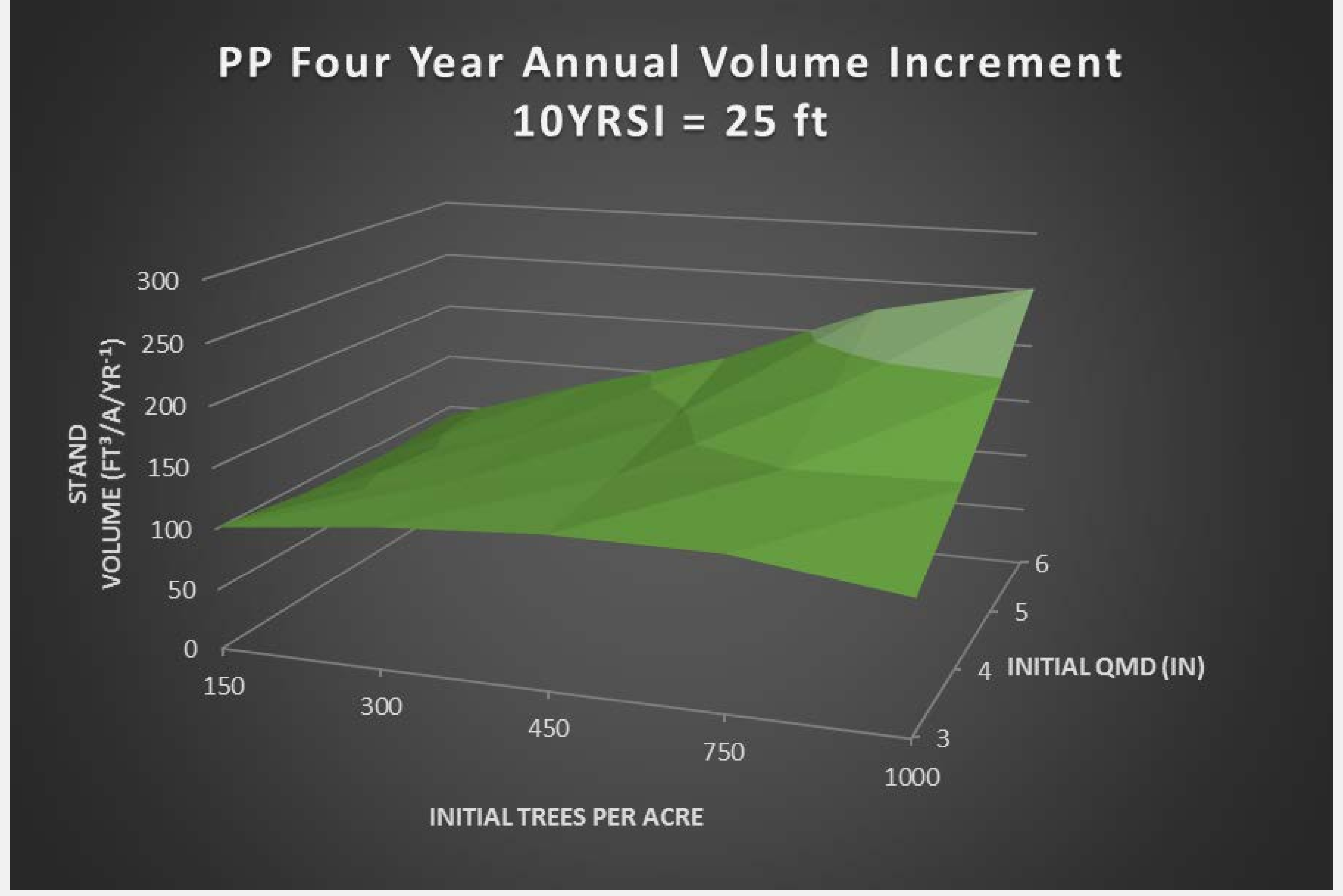
CROP TREE RESPONSE





STAND RESPONSE





SUMMARY

BROAD OUTCOMES TO DATE

- Current ten-year height growth method robust in stratifying tree-stand response to thinning for both D. fir and P. pine
- 4Yr and 6Yr data illustrate vigorous early growth stages across all stands and densities
  - DBH/HT/Volume response a direct factor of site type and initial diameter/density stand relationships
  - Data suggests that we will have an excellent range of stand entry timings and stand conditions to define optimal thinning window by site type, species and stand density/diameter relationships as we capture future periodic growth/mortality
- Density dependent mortality fairly insignificant or non-existent in all but the highest density plots (not presented)
  - Primary mortality at this juncture is thinning related acerbation of root-rot pockets

CONCLUDING STATEMENTS

THE FUTURE OF PPDM

- Validate SDImax models
- Validate G&Y models
- Develop growth and mortality multipliers by site quality, stand density, and species composition
- Calibrate G&Y software packages for thinning response by site/species
- Develop silvicultural guidelines for targeting optimal timing window for thinning to maximize growth response on crop trees while minimizing mortality

THANK YOU

TO ALL CONTRIBUTING MEMBERS & STAFF

- This project would not have been possible without the strong support from the front office to the field forester

- And in particular we wish to thank all those field foresters that put up with our discriminating taste for candidate stands – this network will be a gift that keeps giving for a generation