How changes in thinning treatments impact tree growth, biomass and carbon sequestration in spotted gum (*Corymbia citriodora* subsp. *variegate*) plantations

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Spotted gum:
An important species for timber and carbon sequestration

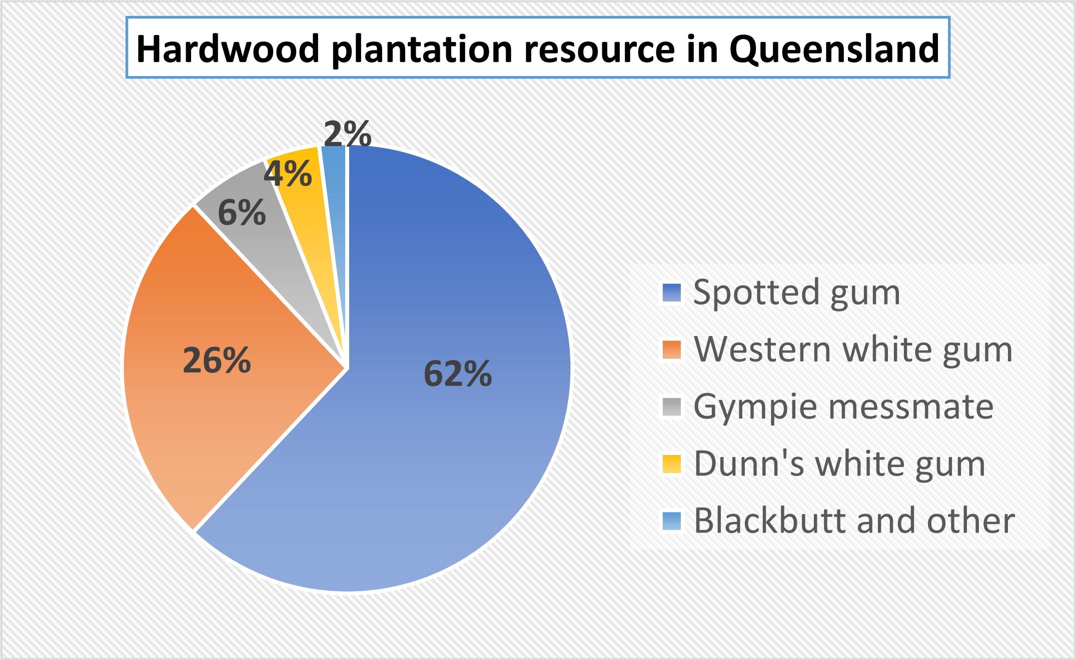


Fig. adapted from FWPA (Mcgavin et al. 2020)

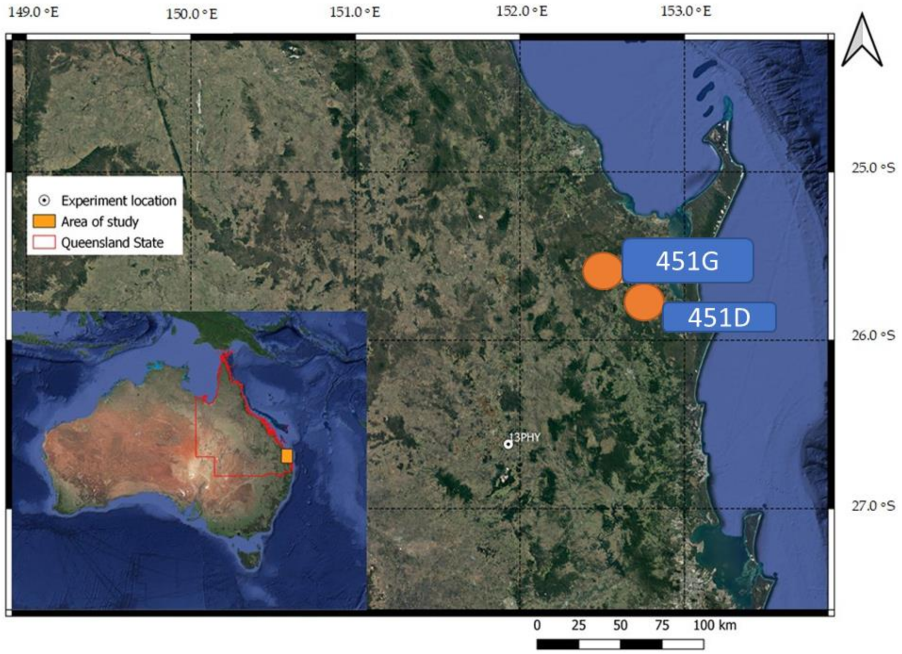
Study objectives

The effects of thinning treatment on individual tree and stand level changes in tree growth, biomass and carbon

Same thinning treatment in different landscape positions

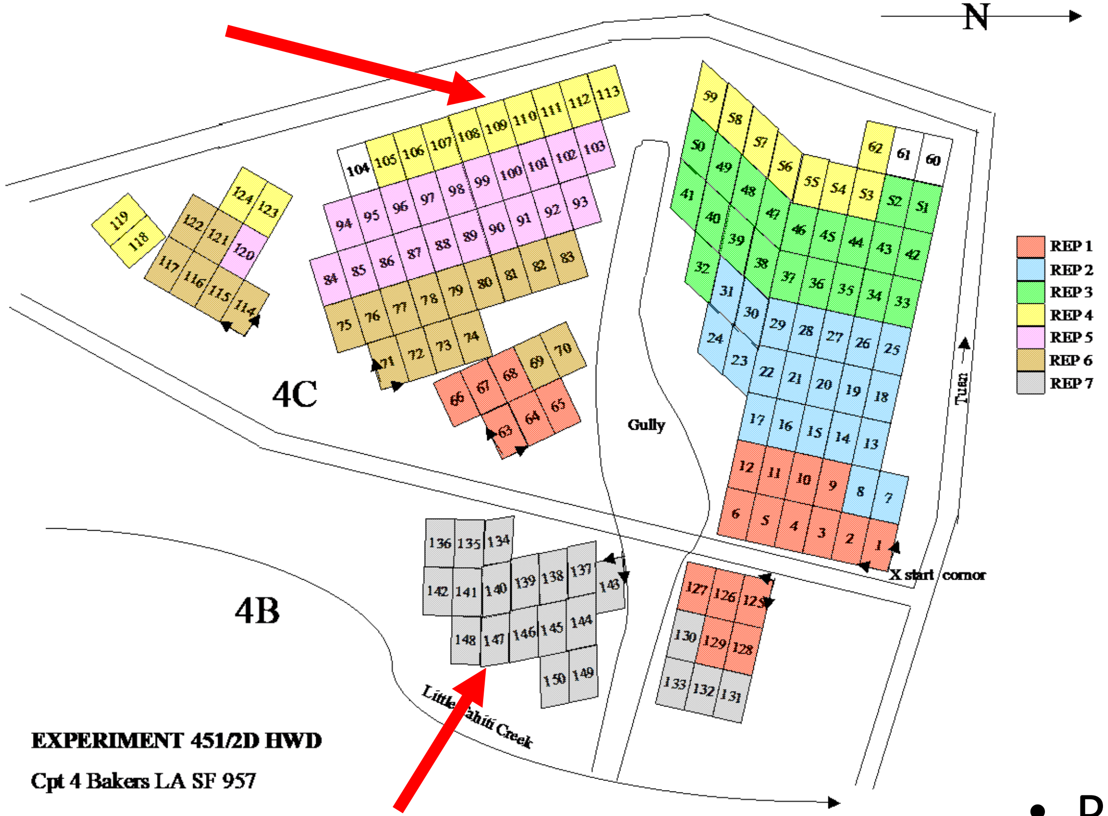
The effects of different thinning treatments

Study site



Characteristics of two research sites: 451D and 451G.

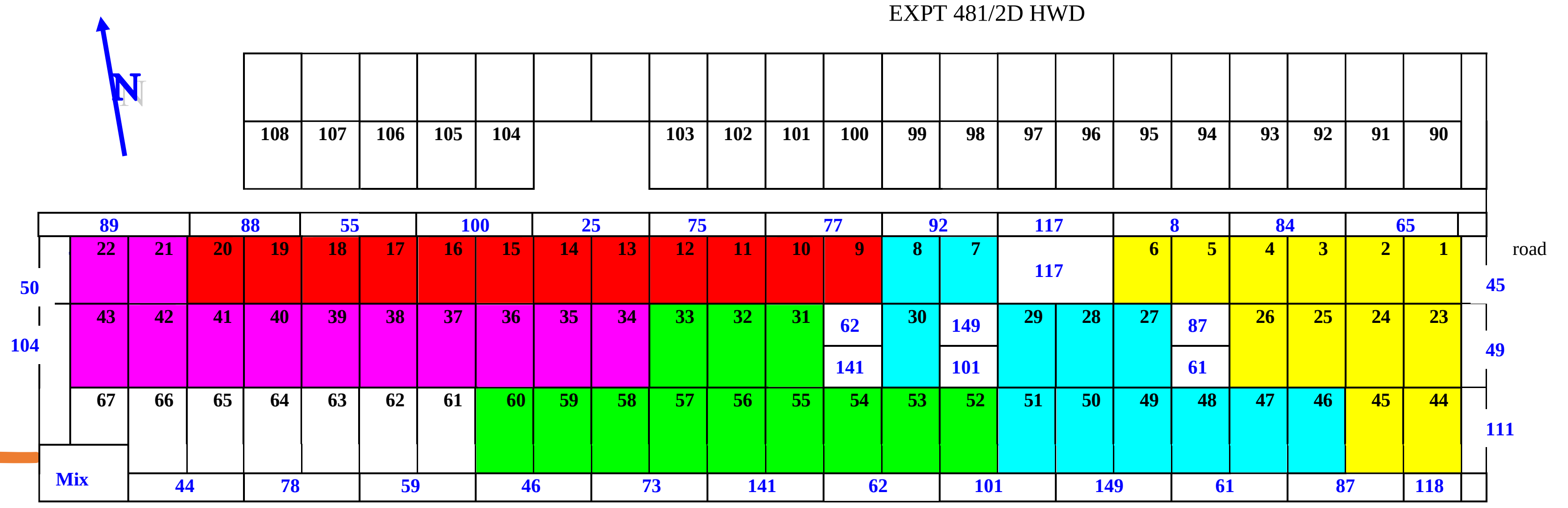
Characteristics	451D	451G
No. of replications	7	5
No. of plots	150	60
Experiment area (ha)	10.7 ha	2.8
Plot area (ha)	0.048 ha	0.043 ha
Spacing (m)	5 m × 2 m	5 m × 1.8 m
Fertilisation(gram tree^{-1})	Year 0: 26.2 g N, 29.4 g P, 24.6 g K Year 1: 174 g N	Year 0: 26.2 g N, 29.4 g P, 24.6 g K Year 1: 174 g N
Initial stocking	1000 trees ha^{-1}	1111 trees ha^{-1}



Site 451D

- Planted in **2000**
- **Slope ~ 3^0 and 5^0**
- Soil types: Grey, Yellow and Brown
  - Sandy loam A horizon; sandy clay B horizon;
  - pH = 4.5 – 5.5
- Stocking = **1000 trees/ha**;
- Thinning at 7 years old to 250 – 300 trees/ha

Site 451G



- Rep 1
- Rep 2
- *Rep 3*
- Rep 4
- *Rep 5*

- Soil types: Red Kurosol and Red Kandosol;
- pH = 5.5
- Stocking: 1111 trees/ha (6 rows x 8 trees)
- 1st thinning: 4Y: all REP to ~ 500 trees/ha
- 2nd thinning: 10Y:
  - *REP 1 + 2 + 4: low stocking (~ 200 trees/ha)*
  - *REP 3 + 5: high stocking (~ 400 trees/ha)*

	D (cm)				H (m)			
Stand age	Mean	Min.	Max.	SD	Mean	Min.	Max.	SD
451D								
3	6.3	0.1	15.7	2.5	6.8	0.2	13.5	2.6
6	9.5	0.5	23.0	4.2	11.1	0.4	22.4	4.7
9	17.2	9.1	30.8	2.9	17.7	10.1	25.1	2.2
14	21.9	10.5	36.0	3.8	22.6	12.1	30.4	2.9
20	24.5	10.7	42.3	4.7	25.4	13.2	34.9	3.4
451G								
3	7.8	0.1	17.5	4.1	7.6	0.1	14.2	3.3
7	15.7	3.9	27.6	4.9	16.2	3.0	24.8	4.2
10	18.2	4.0	33.1	6.1	19.7	5.0	31.0	5.6
18	25.9	7.3	42.9	6.2	25.8	7.9	34.9	4.4

Data analysis

- Models for estimation of biomass, carbon and total stem volume

$$AGB = a \times D^b$$

where $a = 0.082$, $b = 2.641$

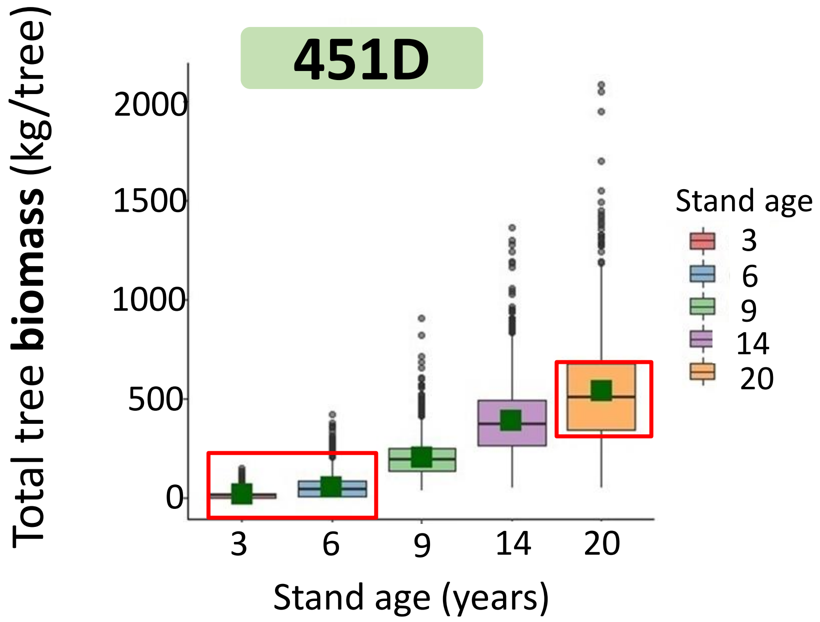
$$BGB = a \times D^b$$

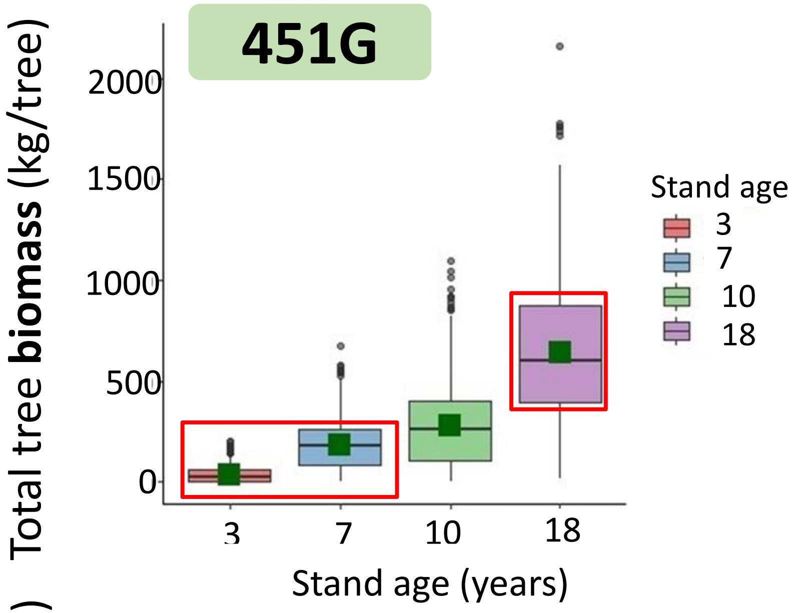
where $a = 0.029$, $b = 2.580$

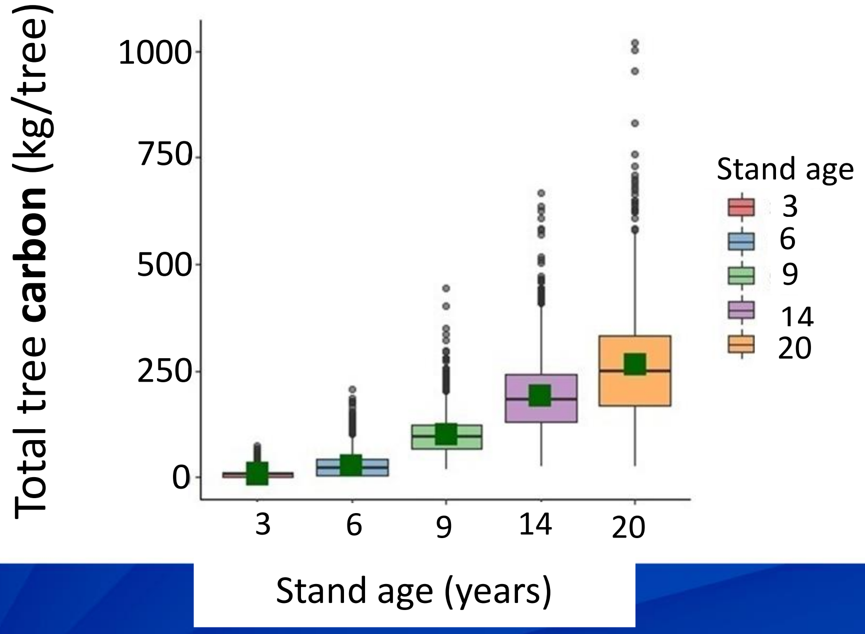
$$Vt = a \times (D^2H)^b$$

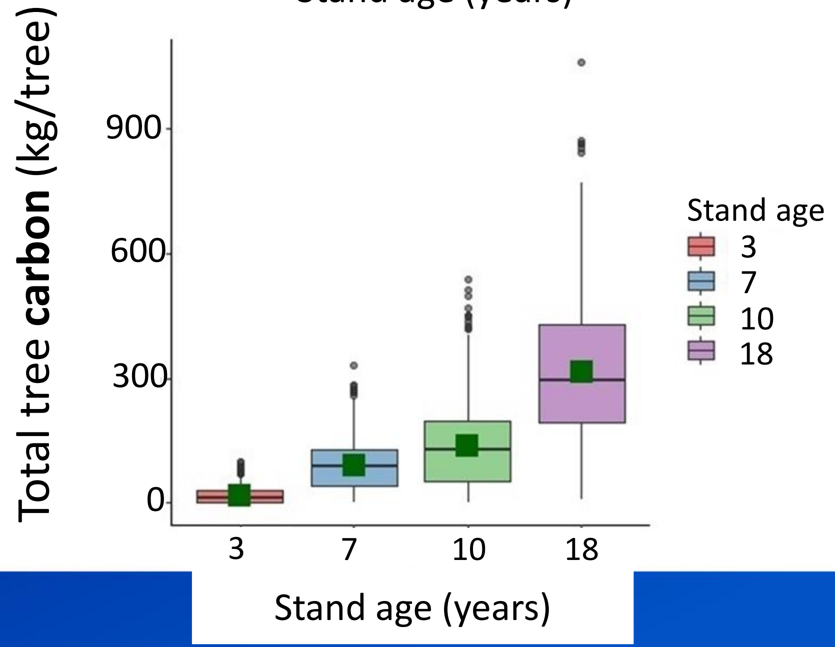
where $a = 4.73 \times 10^{-5}$, $b = 1.033$

- Biomass converted to carbon
- Mean annual carbon increment (MAI)
- Periodic annual carbon increment (PAI)
- Analysis of variance (ANOVA)

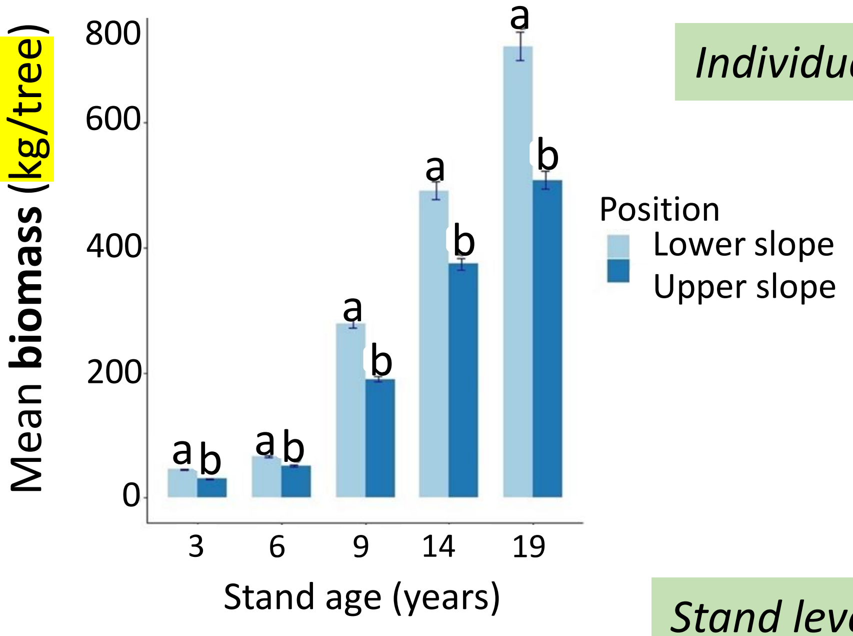

451D
Total tree biomass (kg/tree)
2000
1500
1000
500
0
3
6
9
14
20
Stand age (years)
Stand age
3
6
9
14
20

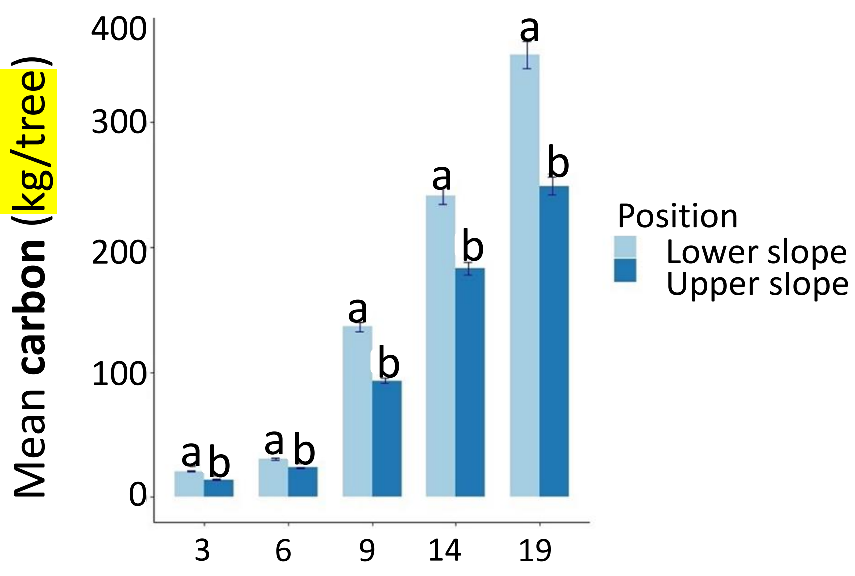

451G
Total tree biomass (kg/tree)
2000
1500
1000
500
0
3
7
10
18
Stand age (years)
Stand age
3
7
10
18


Total tree carbon (kg/tree)
1000
750
500
250
0
3
6
9
14
20
Stand age (years)
Stand age
3
6
9
14
20


Total tree carbon (kg/tree)
900
600
300
0
3
7
10
18
Stand age (years)
Stand age
3
7
10
18

Individual tree

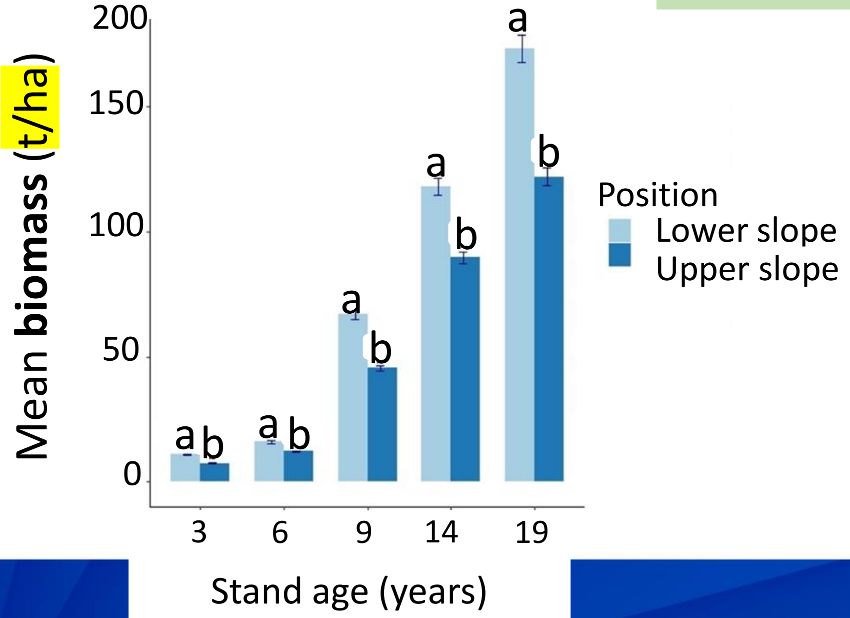


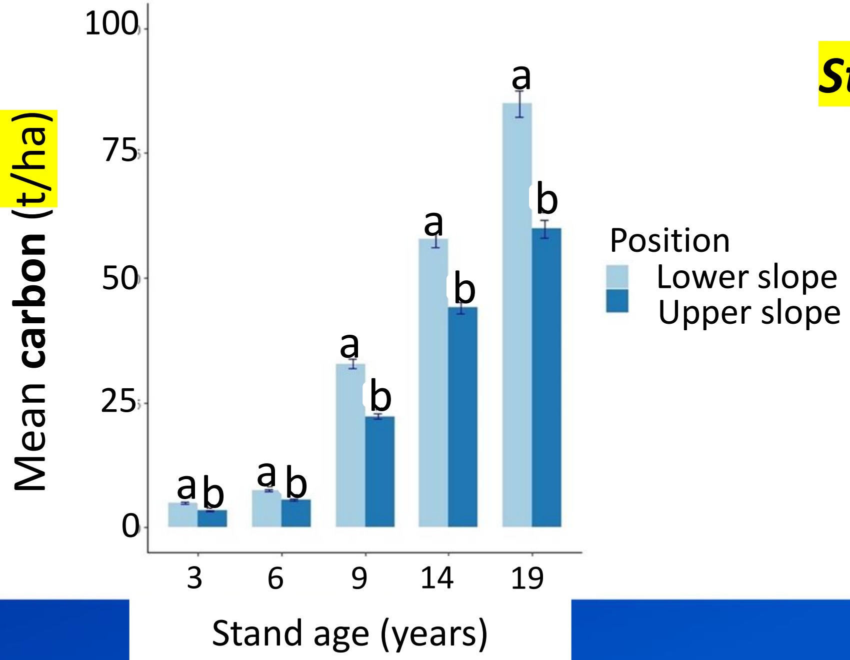


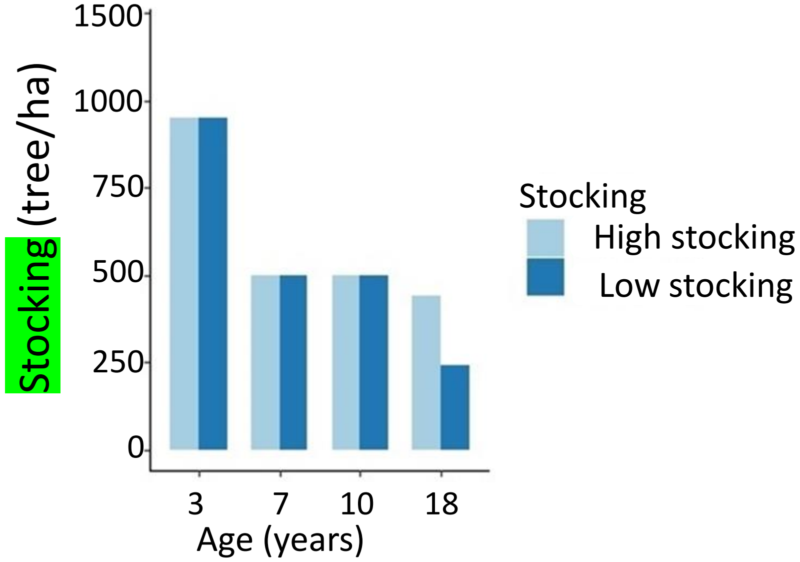
451D

Stocking ~ 240 trees/ha

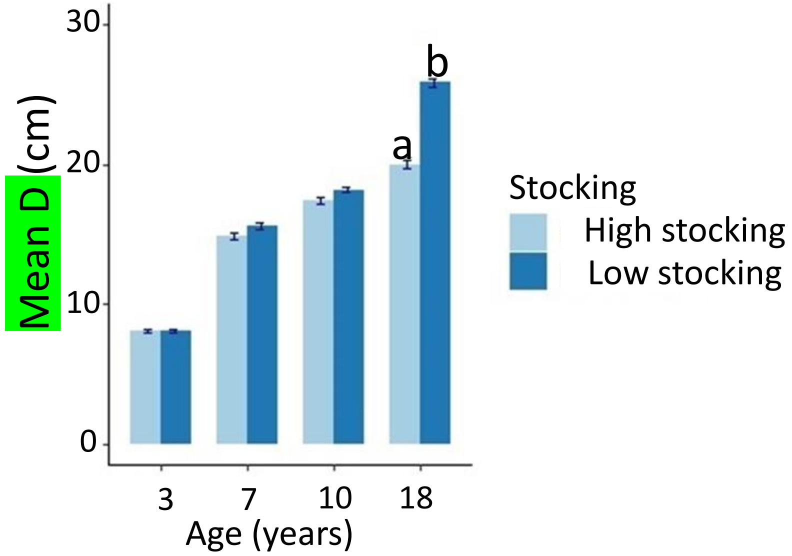
Stand level

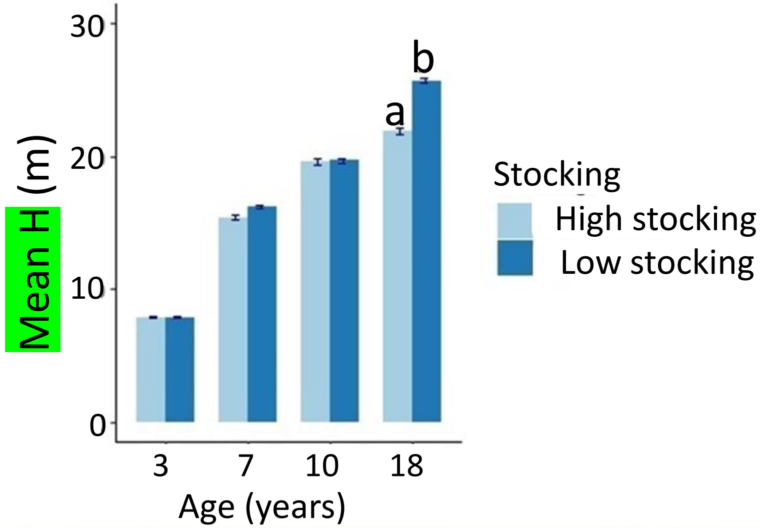


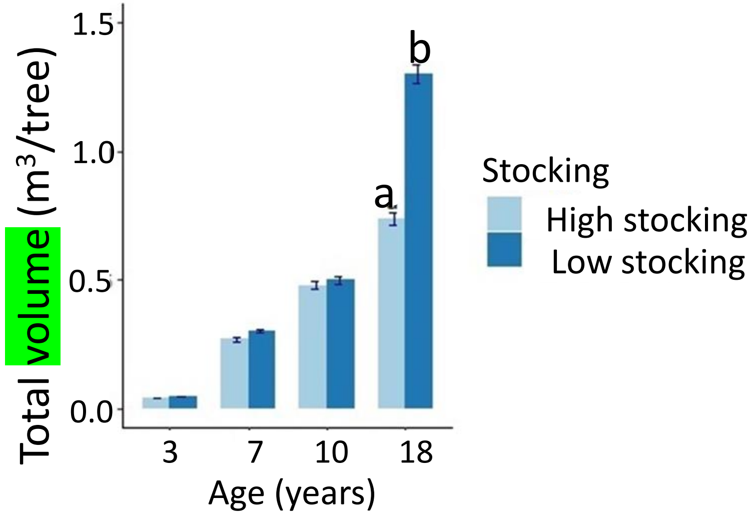


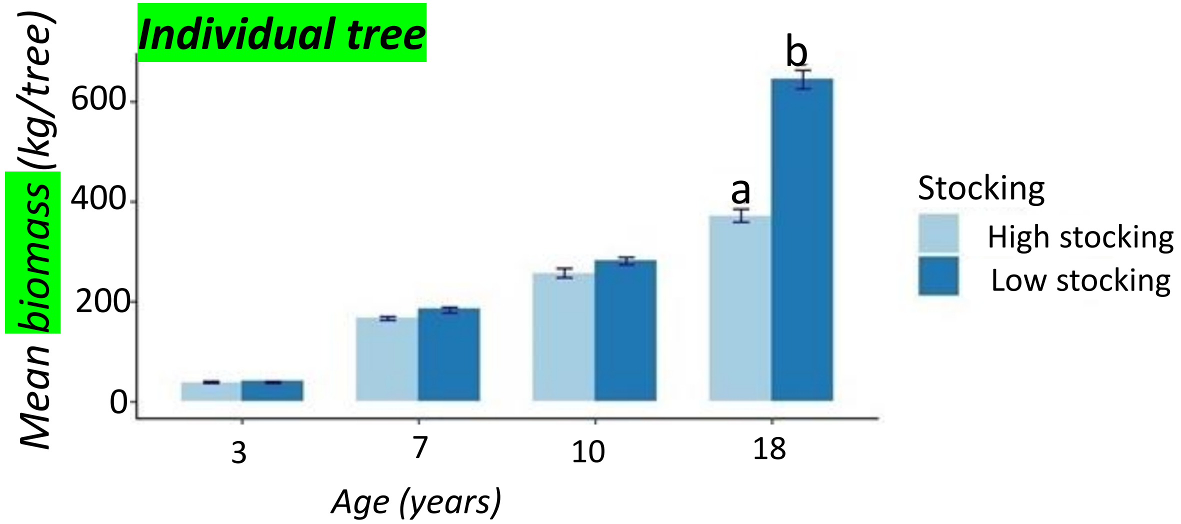

Stocking (tree/ha)
1500
1000
750
500
250
0
3
7
10
18
Age (years)
Stocking
High stocking
Low stocking

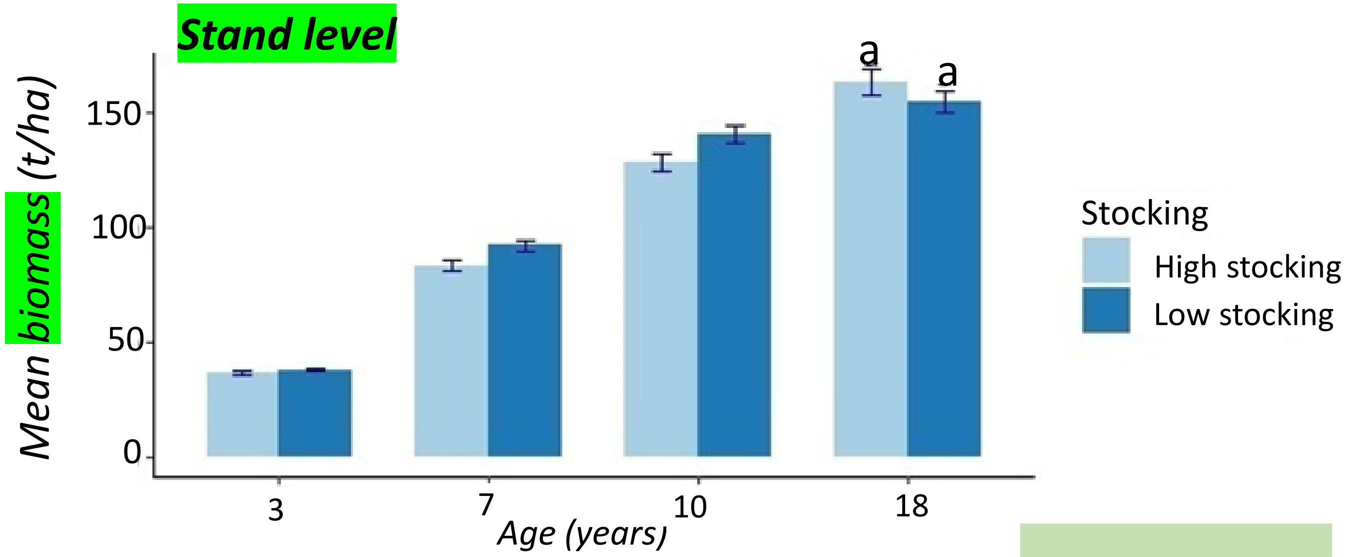
451G


Mean D (cm)
30
20
10
0
a
b
3
7
10
18
Age (years)
Stocking
High stocking
Low stocking

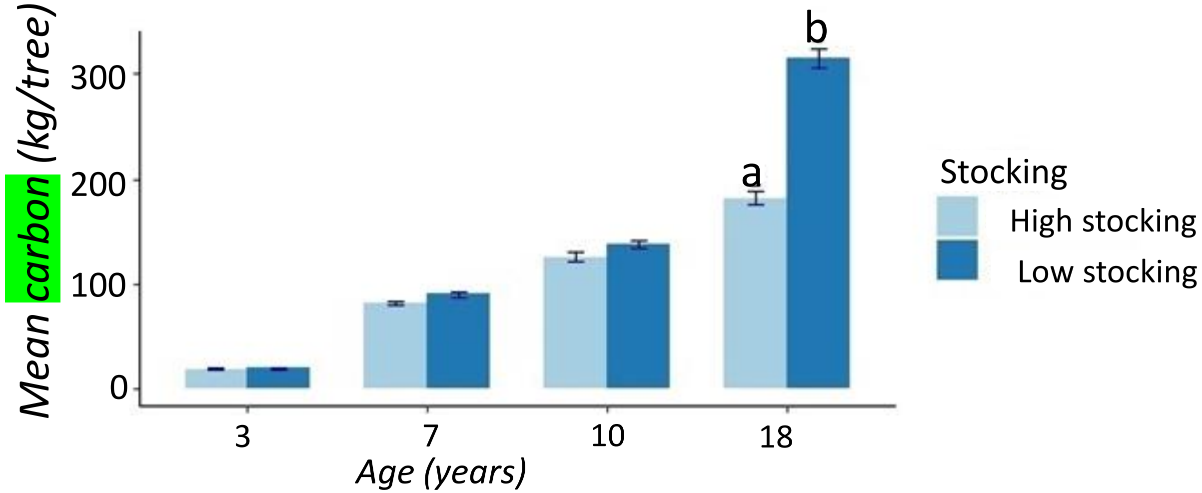

Mean H (m)
30
20
10
0
a
b
3
7
10
18
Age (years)
Stocking
High stocking
Low stocking

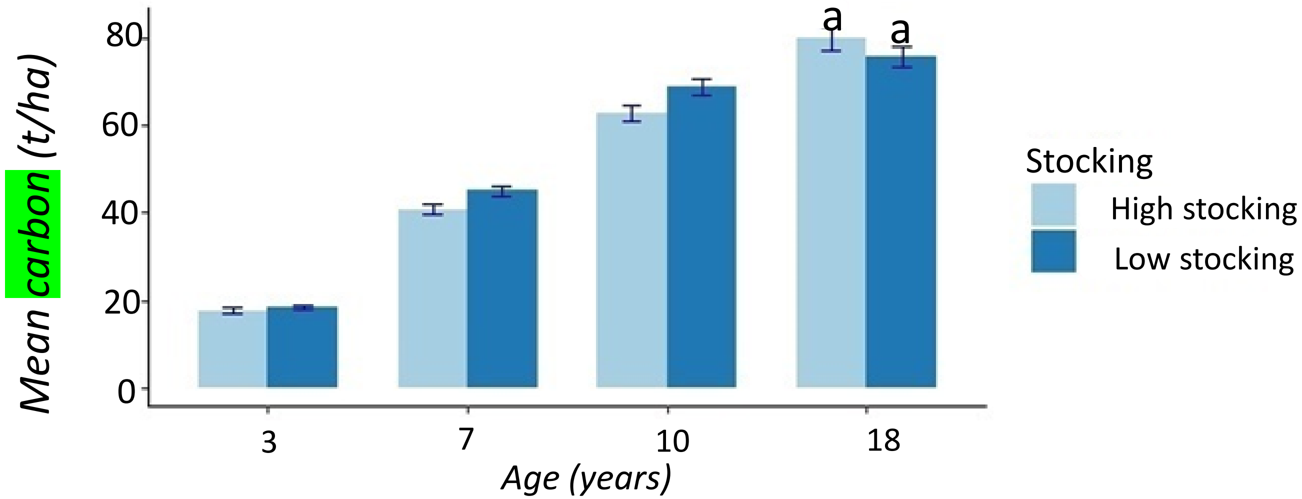

Total volume (m3/tree)
1.5
1.0
0.5
0.0
a
b
3
7
10
18
Age (years)
Stocking
High stocking
Low stocking


Individual tree
Mean biomass (kg/tree)
600
400
200
0
a
b
3
7
10
18
Age (years)
Stocking
High stocking
Low stocking

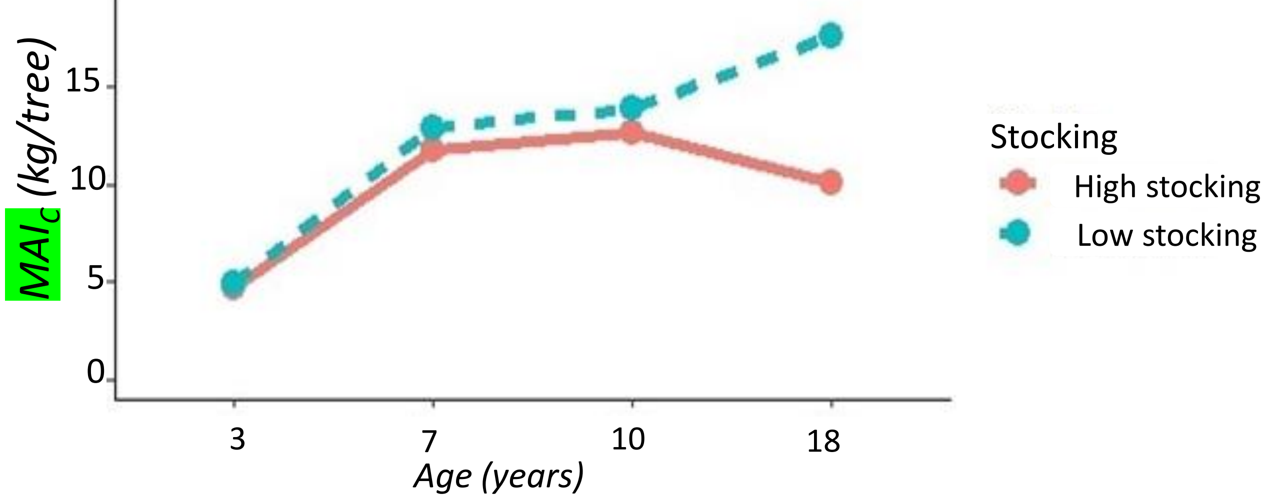

Stand level
Mean biomass (t/ha)
150
100
50
0
a
a
3
7
10
18
Age (years)
Stocking
High stocking
Low stocking

451G

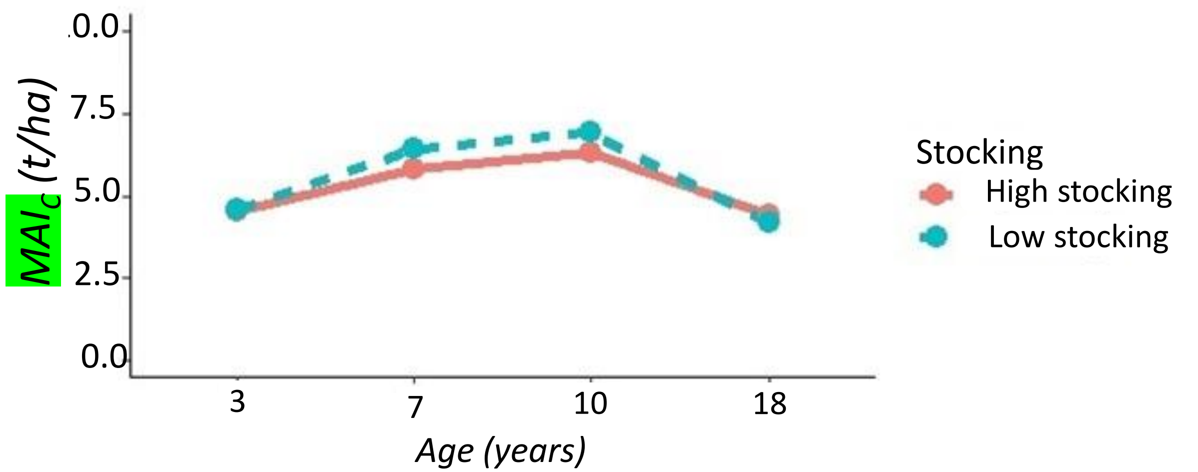

Mean carbon (kg/tree)
300
200
100
0
a
b
3
7
10
18
Age (years)
Stocking
High stocking
Low stocking

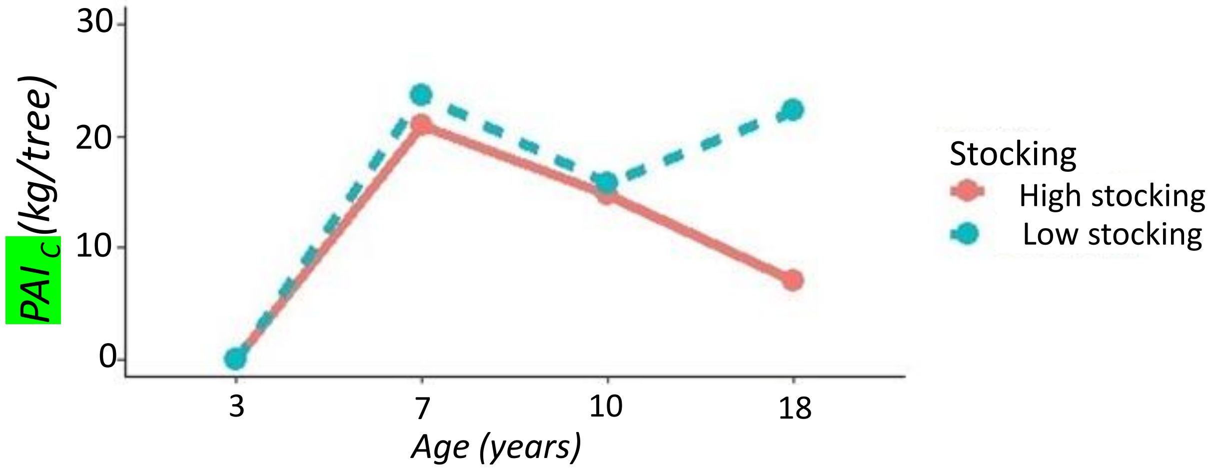

Mean carbon (t/ha)
80
60
40
20
0
a
a
3
7
10
18
Age (years)
Stocking
High stocking
Low stocking

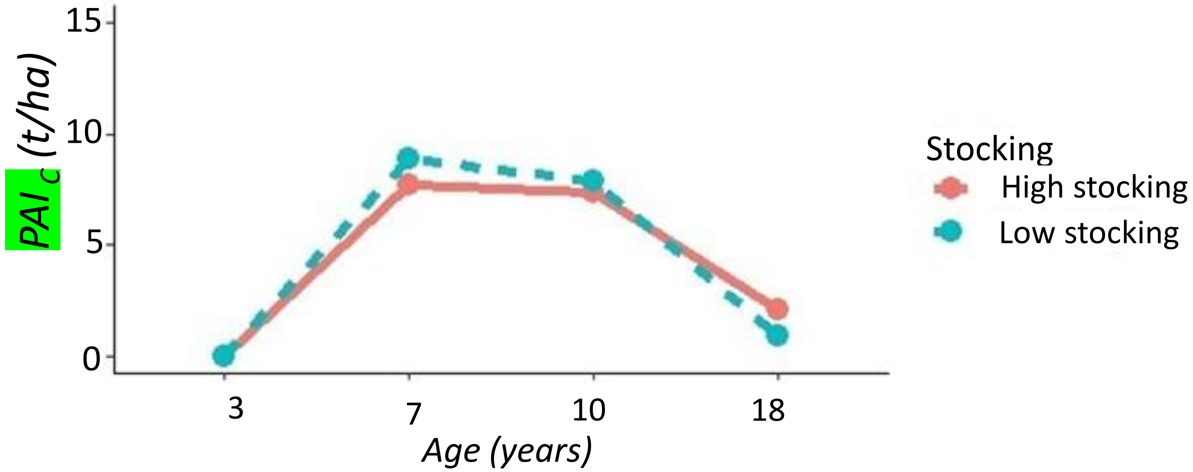
Individual tree



Stand level







Conclusion

- Appropriate stocking rates will have a significant influence on tree growth, biomass and carbon accumulation

- Thinning regimes, might differ depending on the sites, landscape positions or objective of the plantation (i.e. timber production or carbon credits)

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