Better forestry trees for agroforestry lines

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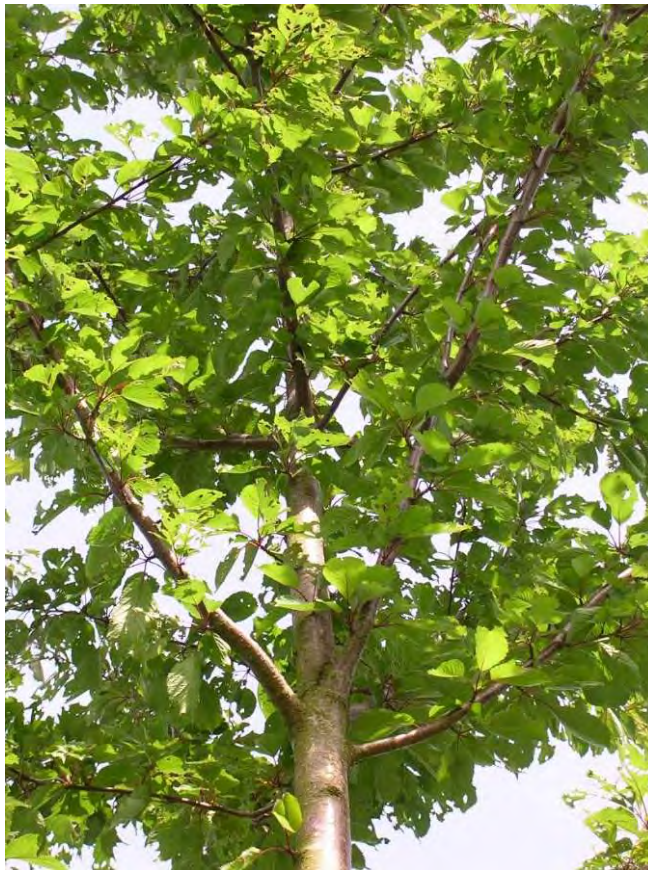
INRA
SCIENCE & IMPACT

Few available French angiosperm forest tree varieties to plant on agroforestry lines

- ✓ Seeds of most species are collected in forests, without much knowledge
- ✓ Very few of the best categories: qualified or tested
- ✓ Hybrids: Populus, Castanea, Juglans, Ulmus, Platanus, Pyrus (from Spain)
- ✓ Other clonal varieties: Prunus avium, Populus, horticultural varieties
- ✓ Seed orchards: Juglans x, Prunus avium
- ✓ Conservation-oriented seed orchards: Malus sylvestris, Sorbus domestica

→ How quickly increase the number of good varieties ?

→ Meanwhile, how improve the quality of the trees ?



Collecting ressources for numerous forestry species

- ✓ Goal of 2 seed orchards for each yet non-breed species
- ✓ Low cost strategy, without selections in forests, graftings or cuttings: selection each year of the very best plants in commercial nurseries, direct plantation in one test, second-stage selection
- ✓ Research based on the collaboration between INRAE (manpower for selection) and forestry nurseries (provide plants, manpower for plantations)
- ✓ The resulting tests will be at least collections, at best seed orchards

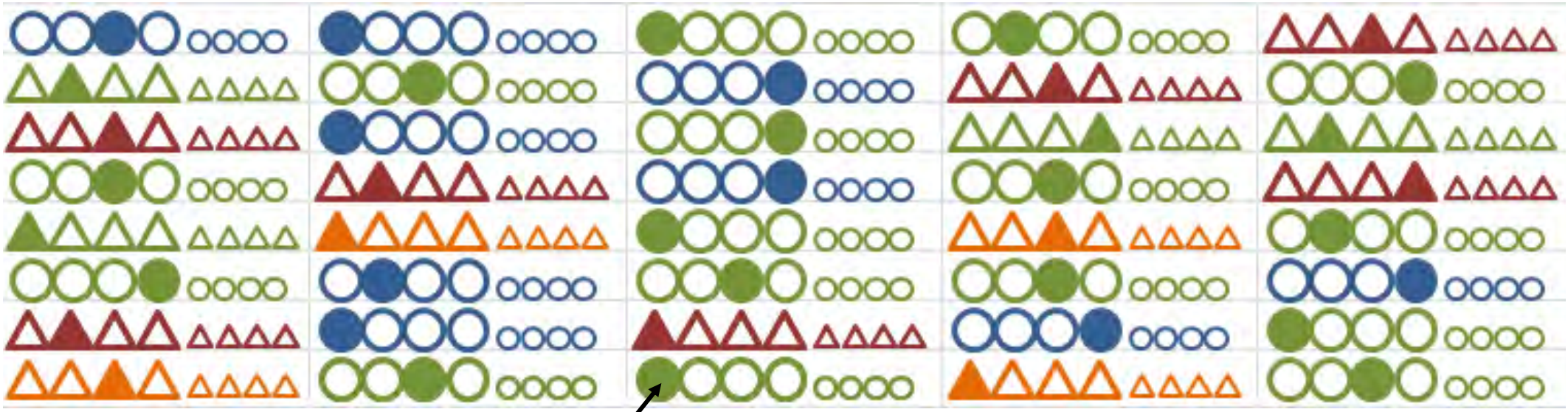
SNPF
Le berceau de la forêt
Pépiniéristes forestiers français


Sorbus domestica, pépinière de Claireau


Castanea sativa, pépinière Wadel-Wininger

Phase 1: one selected plant out of 50 - 10 000 in nurseries

Planted in plots = 4 or 8 selected + 4 or 8 standards



Phase 2: in each plot, one left out of the 4 or 8 selected

Standards and selected are compared, then standards are also eliminated

Sélection intensive (1/100 to 1/10.000) en pépinières	○ △
Puis sélection (1/4) après croissance dans le verger putatif	● ▲
Témoins : plants de catégorie moyenne des même planches	○ △

Zone de provenance	1	2
Pépinière 1	○ ○	
Pépinière 2	○ ○	△ △
Pépinière 3		△ △
Pépinière 4		△ △

23 established tests: 9 filled, 6 almost filled…
But new species and tests yet to begin !

Tests = Seed orchards		Number of 4/8 selected-4/8-standard-plots Plantation distances 1 m x 4 m or 1 m x 8 m - Final distance roughly 8 m x 8 m											Origins
Nurseries	Species	2013	2014	2015	2016	2017	2018	2019	2020	2021	***2022+***	***Objectif***	
Crété	Acer campestre					1	7	7	10	16	***8***	***49***	ACA130
Wadel	Acer campestre				3	1		7			***41***	***52***	ACA901
Naudet	Acer monspessulanum	6	4	3				5	7	6		***31***	Southern France
Naudet	Acer platanoides	12	7	12	2	1	3	6		2		***45***	APL901
Crété	Acer pseudoplatanus			12	10	8		2	1	4	***9***	***46***	APS101
Wadel	Acer pseudoplatanus				25	8	16	6				***55***	APS200-500
Crété	Alnus cordata					6	2	3	6	5	***29***	***51***	ACO901
Naudet	Alnus glutinosa	9	4	16	4	9	4	3		1		***50***	AGL130-901
Claireau	Alnus glutinosa			12		2		7	8	5	***2***	***36***	AGL130
Crété	Betula pendula			3	2	10	1	5	2	13	***9***	***45***	BPE130-901
Crété	Carpinus betulus			8	4	17	8	13				***50***	CBE130
Crété	Castanea sativa			23	23	46	35	24	24	13		***188***	CSA101-102-201
Crété	Corylus colurna								9	6	***30***	***45***	Europe
Crété	Fraxinus ornus			12			3	2	1	4	***16***	***38***	Italy France
Crété	Gleditsia triacanthos								3	1	***32***	***36***	Europe
Crété	Malus sylvestris					3		4	5	14	***5***	***31***	MSY901
Crété	Pyrus sylvestris					4	2	23	3	11	***3***	***46***	Western France
Crété	Quercus pubescens							10	18	30	***16***	***74***	QPU360
Claireau	Sorbus domestica			16	5	9	3	14	5			***52***	SDO900
Naudet	Sorbus torminalis	8		14	11	16	4					***53***	STO901
Crété	Sorbus torminalis					9	15	12	12	1		***49***	STO901-902
Crété	Tilia cordata			4		12	6	6	9	6	***5***	***48***	TCO130-200
Naudet	Tilia platyphyllos	6	2	17			4	2	2	2		***35***	TPL901 Europe

Perspectives

- ✓ In some cases, plots have been cleared and replaced
- ✓ Heigths mesured in 2020 in oldest plots: generally, selected > standards
- ✓ For several species, planned genetic testings with microsatellite markers to detect individuals of the same families thus avoiding consanguinity while thinning
- ✓ New species added each year

	T	T	T	T	**C**	**C**	**C**	**C**	moyenne T	**moyenne C**
CBE29	230	200	200	195	**245**	**260**	**245**	**200**	206	**240**
	190	216	200	216	**270**	**270**	**220**	**210**		
CBE30	230	165	214	180	**220**	**270**	**250**	**250**	207	**252**
	210	180	230	250	**270**	**280**	**265**	**210**		

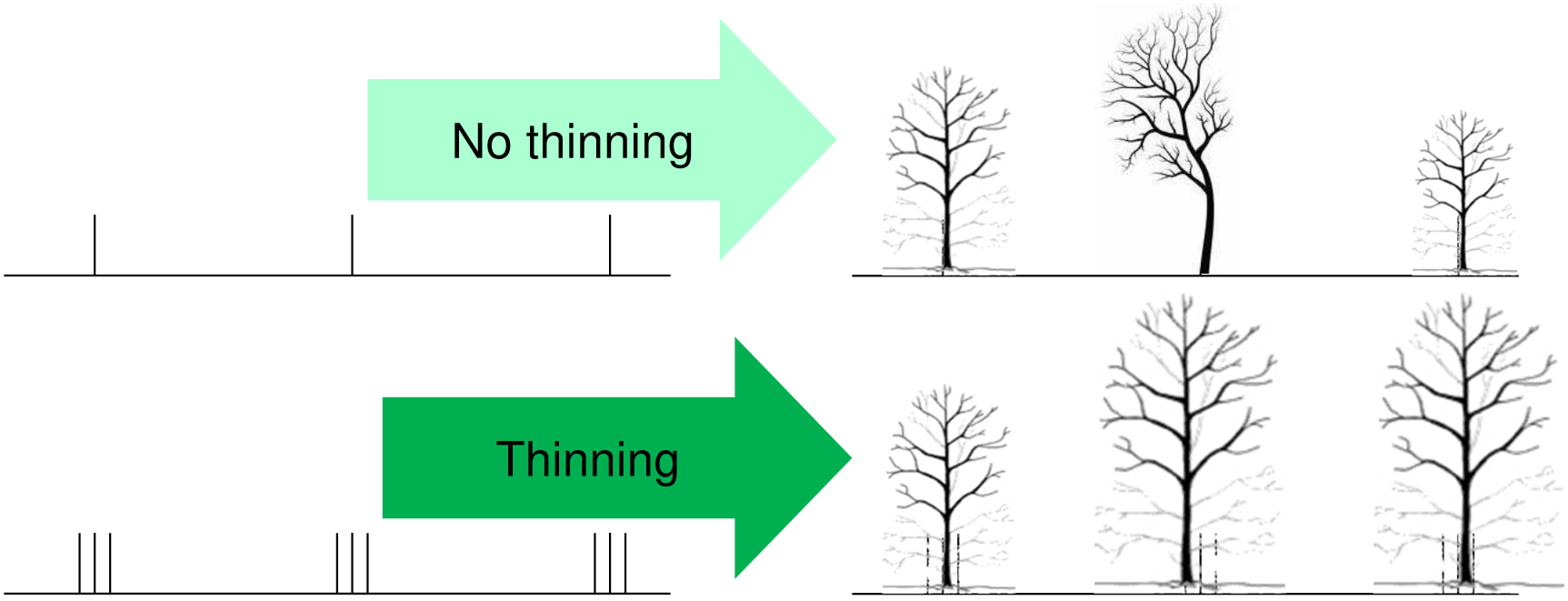
	C	**C**	**C**	**C**	T	T	T	T	**moyenne C**	moyenne T
CBE03	**290**	**285**	**250**	**310**	280	240	255	230	**287**	257
	320	**300**	**260**	**280**	245	225	270	310		
CBE04	**245**	**280**	**250**	**200**	210	220	245	215	**243**	209
	244	**175**	**280**	**270**	204	232	216	130		

	C	**C**	**C**	**C**	T	T	T	T	**moyenne C**	moyenne T
APS01	**310**	**291**	**229**	**290**	206	212	200	200	**259**	203
	212	**270**	**254**	**215**	222	204	210	170		
APS02	**246**	**220**	**199**	**113**	164	179	190	245	**204**	164
	240	**212**	**240**	**164**	190	150	134	62		

	C	**C**	**C**	**C**	T	T	T	T	**moyenne C**	moyenne T
CSA06	**270**	**235**	**260**	**300**	175	175	203	250	**281**	215
	340	**270**	**270**	**300**	245	230	225	-		
CSA05	**290**	**290**	**290**	**265**	270	245	260	221	**299**	264
	300	**340**	**280**	**340**	270	280	-	300		

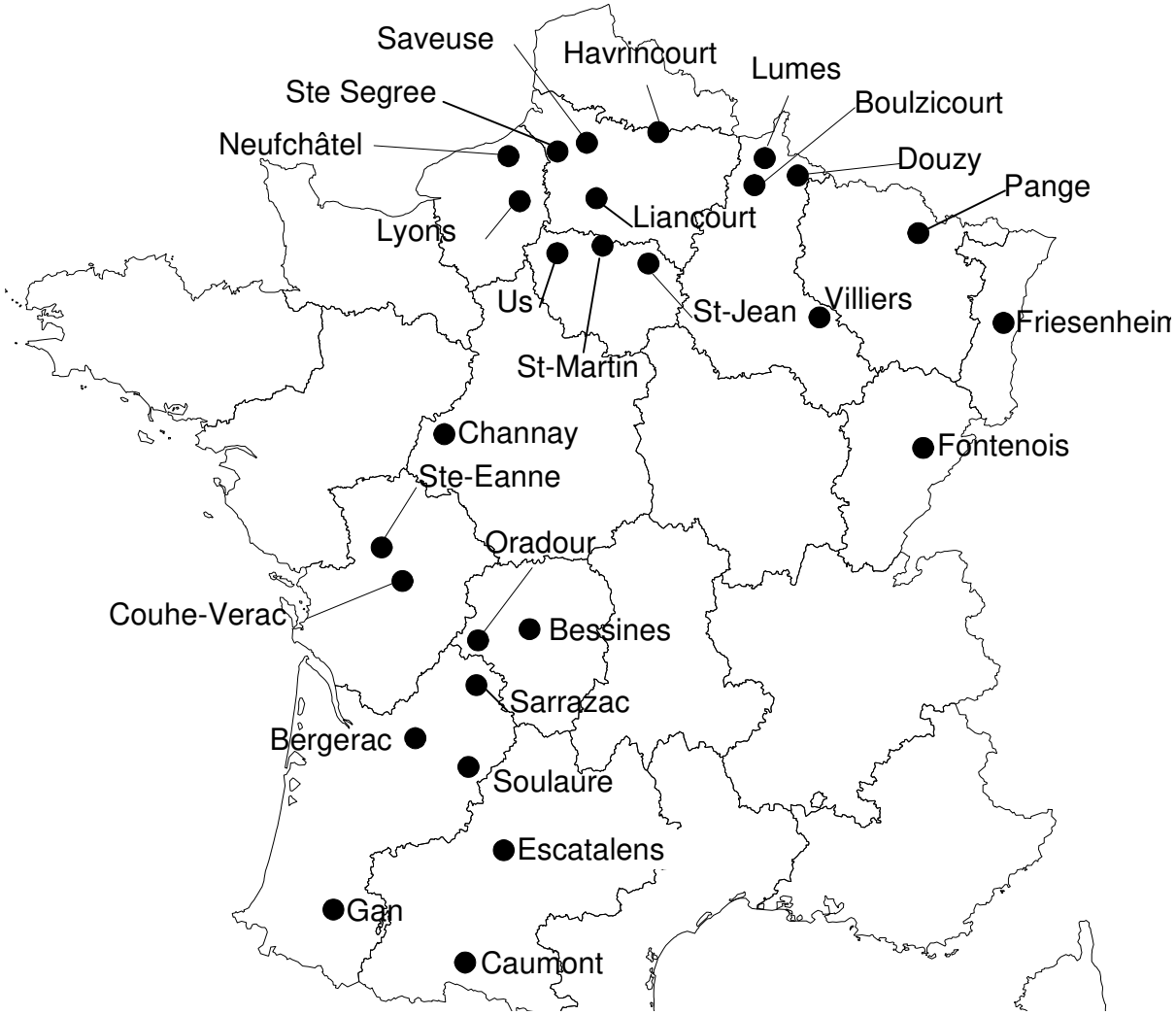
Encourage thinning to improve the quality

- ✓ Average planting density is usually 1 tree for each 8/12 m agroforestry sequence
- ✓ Densification is directly tested in agroforestry lines, for example in INRAE Lusignan, though trees are yet too young for an estimation of differences between densified/simple plantations
- ✓ Simulation has been used to show the possible economic gains

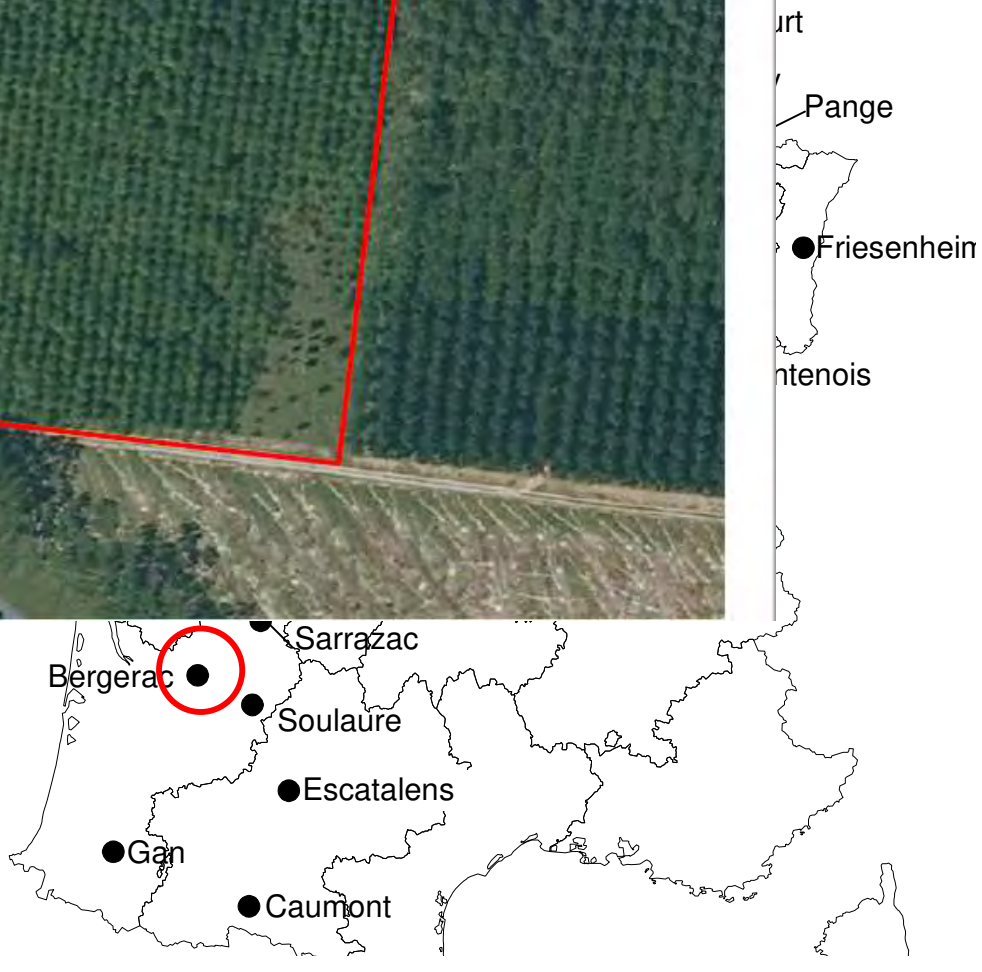


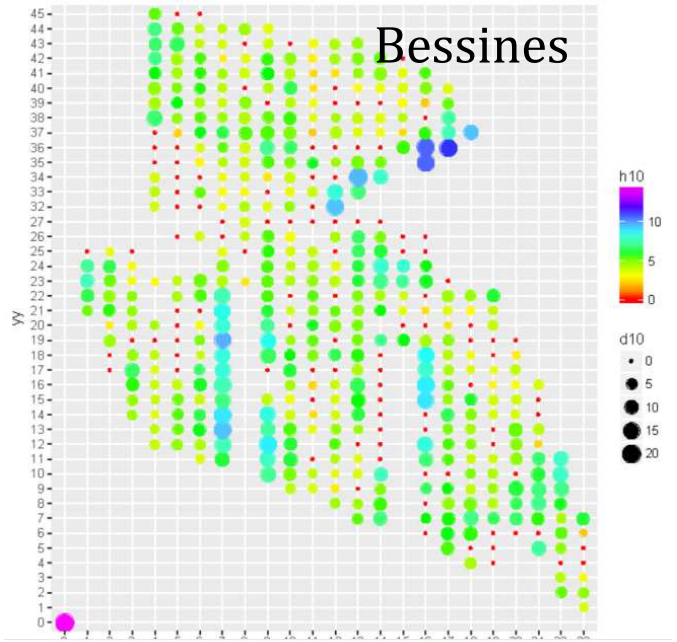
Possible use of old wild cherry genetic tests

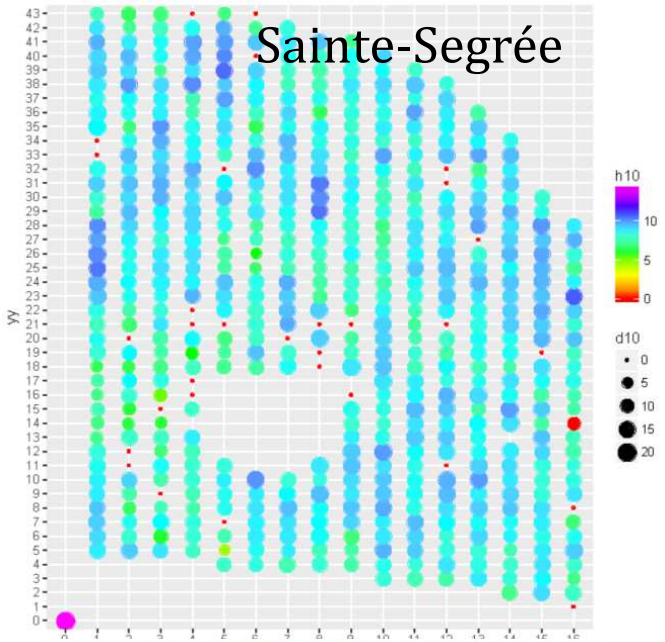
- ✓ Initial gathering of the wild cherry collection resulted in numerous clonal tests
- ✓ Growth mesures from 0 to more than 15 years after plantation

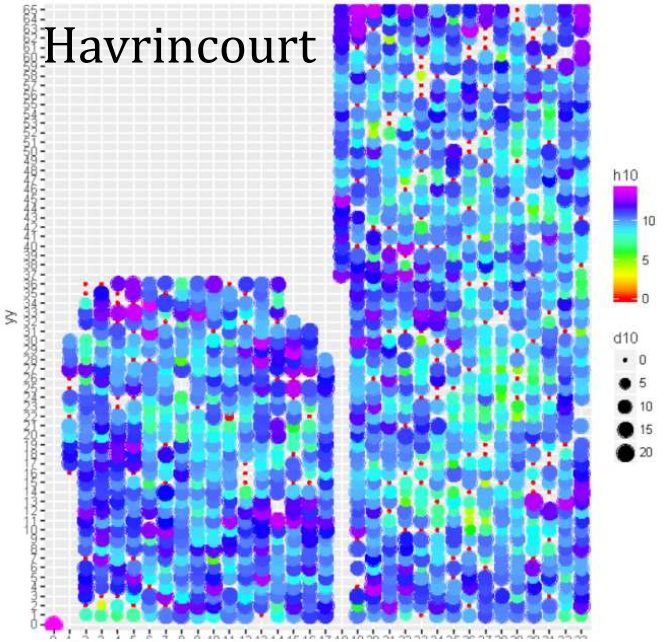


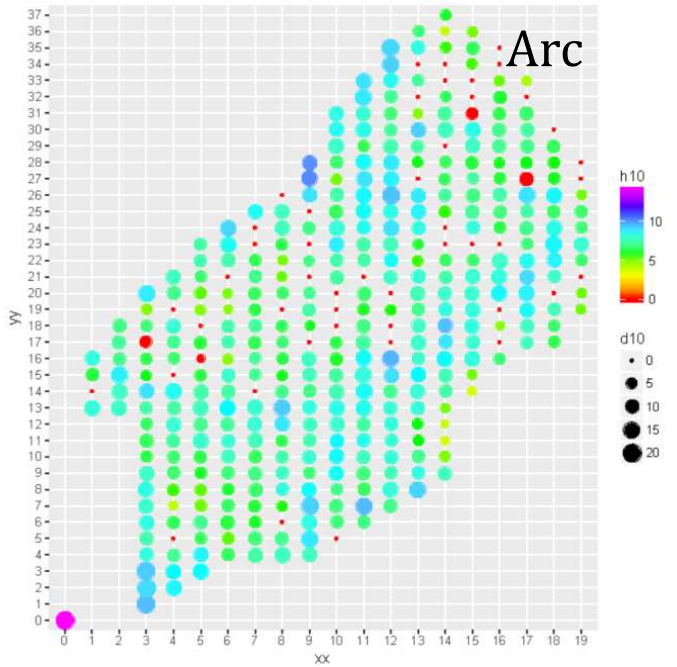

Bergerac
x=1 y= 25
0
60 m

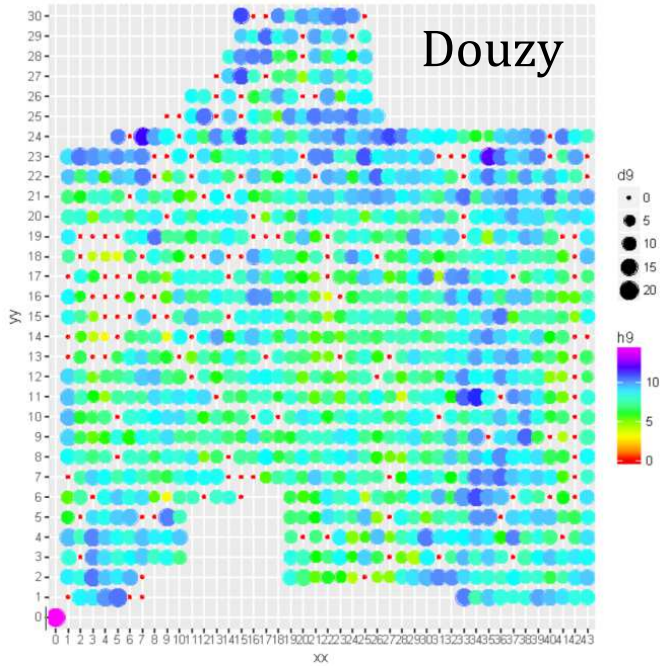

urt
Pange
Friesenhein
ntenois
Sarrazac
Bergerac
Soulaure
Escatalens
Gan
Caumont

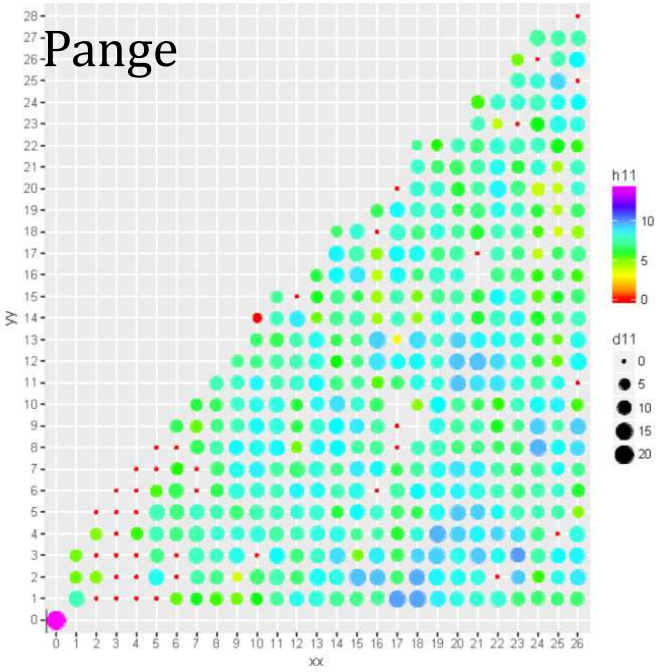

Bessines
yy
xx
h10
d10


Sainte-Segrée
yy
xx
h10
d10


Havrincourt
yy
xx
h10
d10


Arc
yy
xx
h10
d10

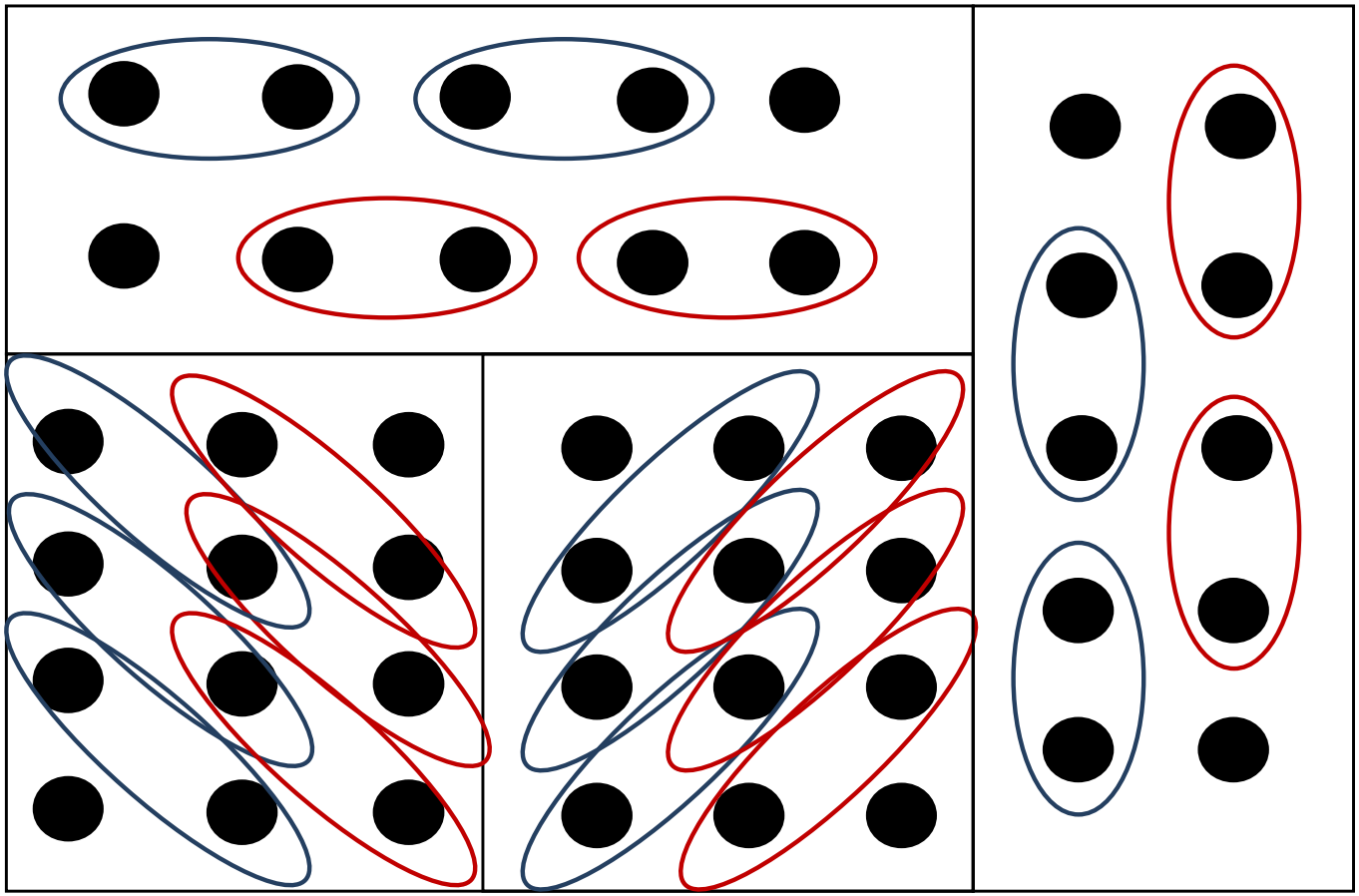

Douzy
yy
xx
d9
h9

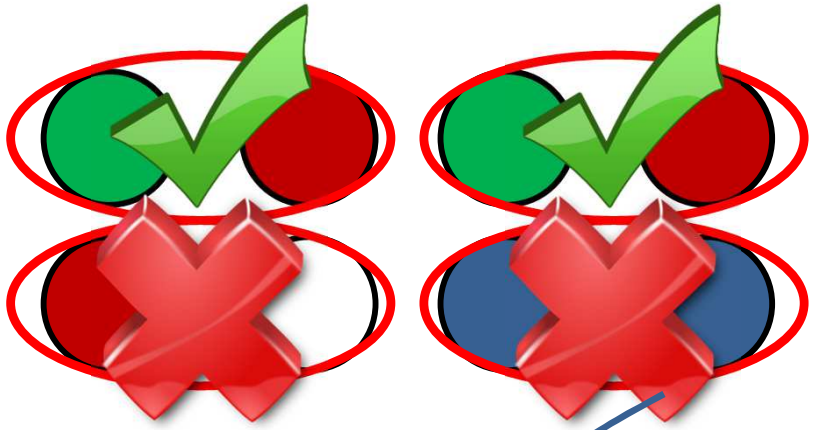

Pange
yy
xx
h11
d11

Simulation method

- ✓ Group trees in continuous couples (ou trios)

- ✓ Simulate the choice of the better of each group, on the basis of 5-year-old diameter: densified reference
- ✓ Sampling one tree inside each group: simulation of undensified plantations
- ✓ Compare the 15 year-old growths between densified/simple plantations, and using linear projection, the 40 year-old growths



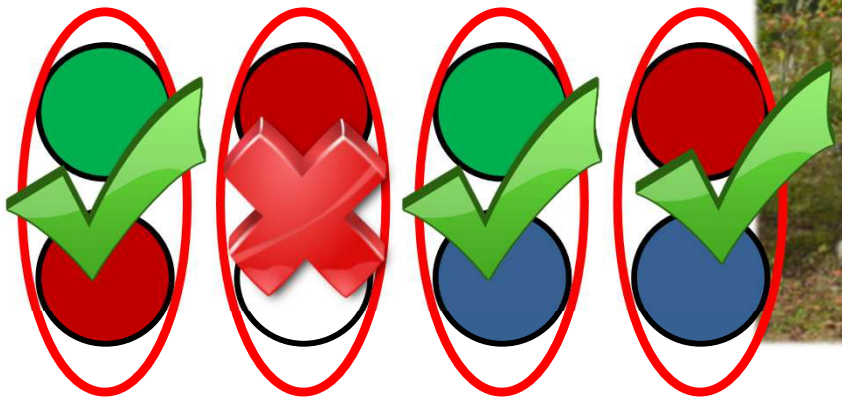


No tree

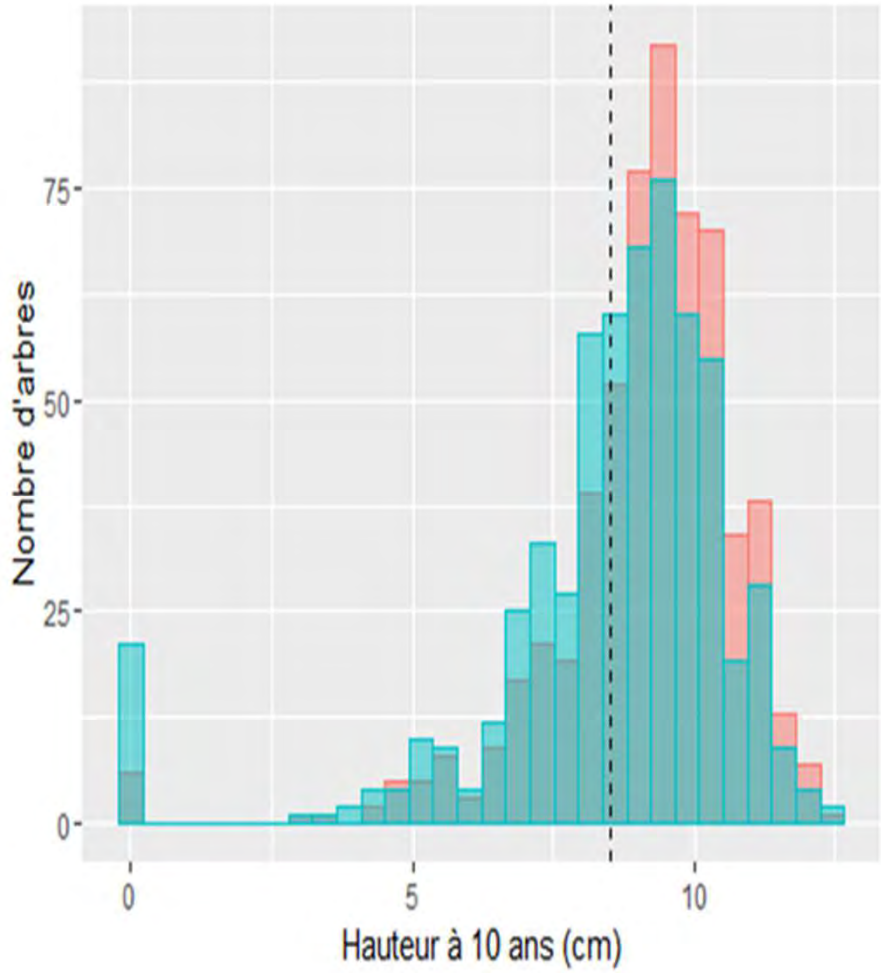
Clone A

Clone B

Clone C



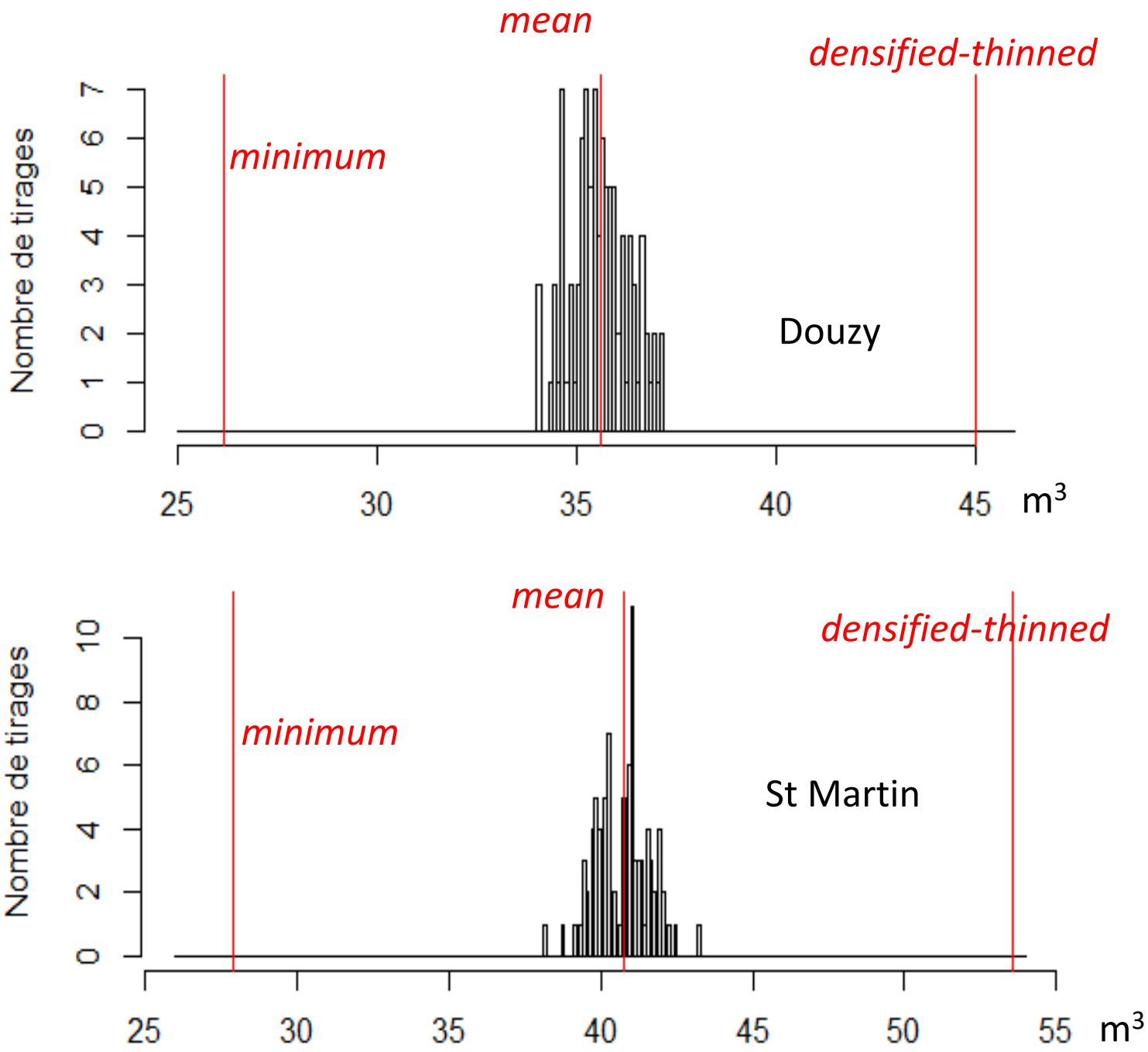
First gain: pruning finished ealier



…… = 8.5 m *(finished prunning) 10-year-old height, Bergerac*

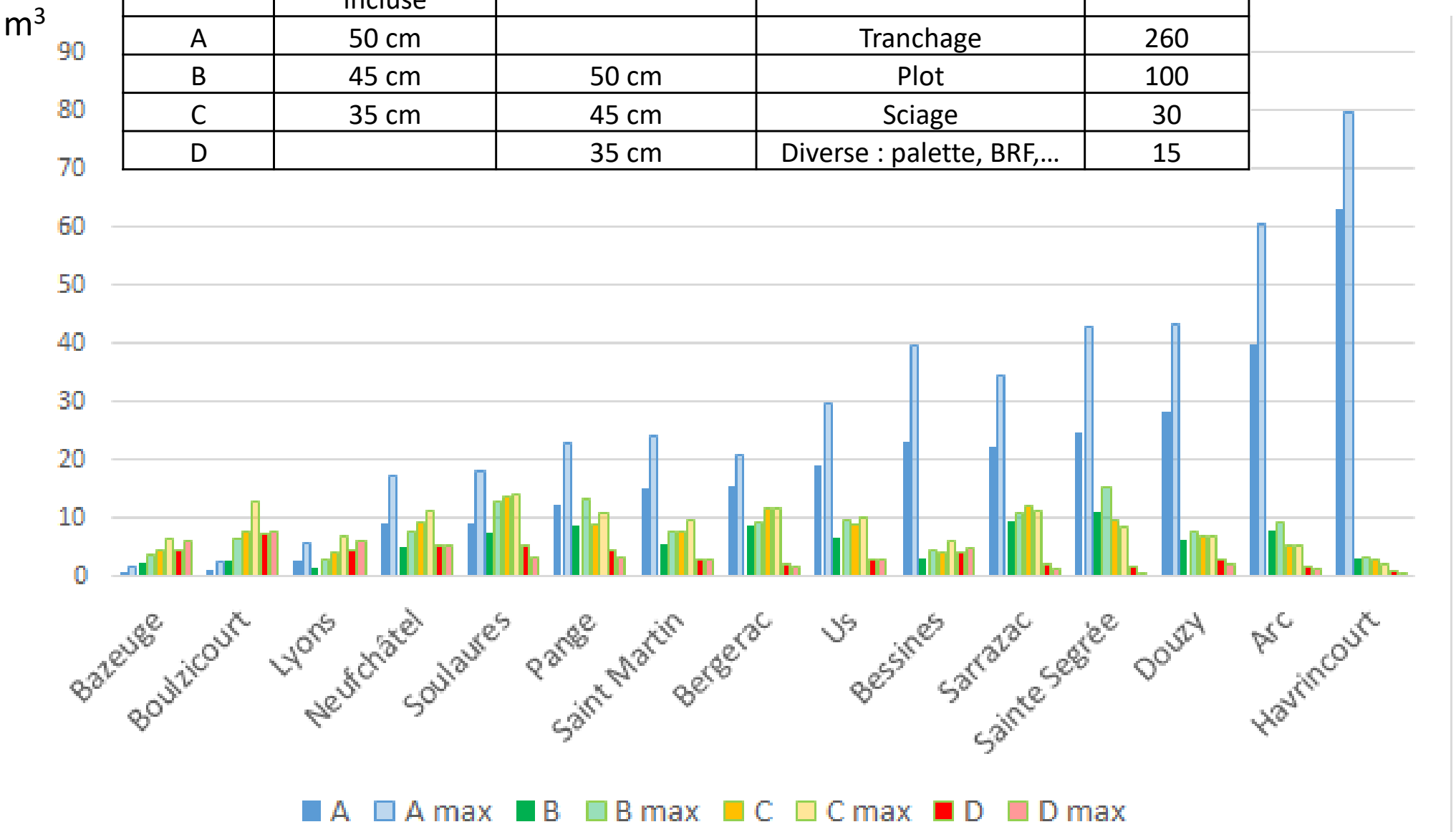
Undensified *Densified-thinned*

Far more total 15-year-old wood volume (5-meter-trunk) for the densified-thinned reference, whatever the test



40-year-old wood volume (5-meter-trunk): most impact on the better class A

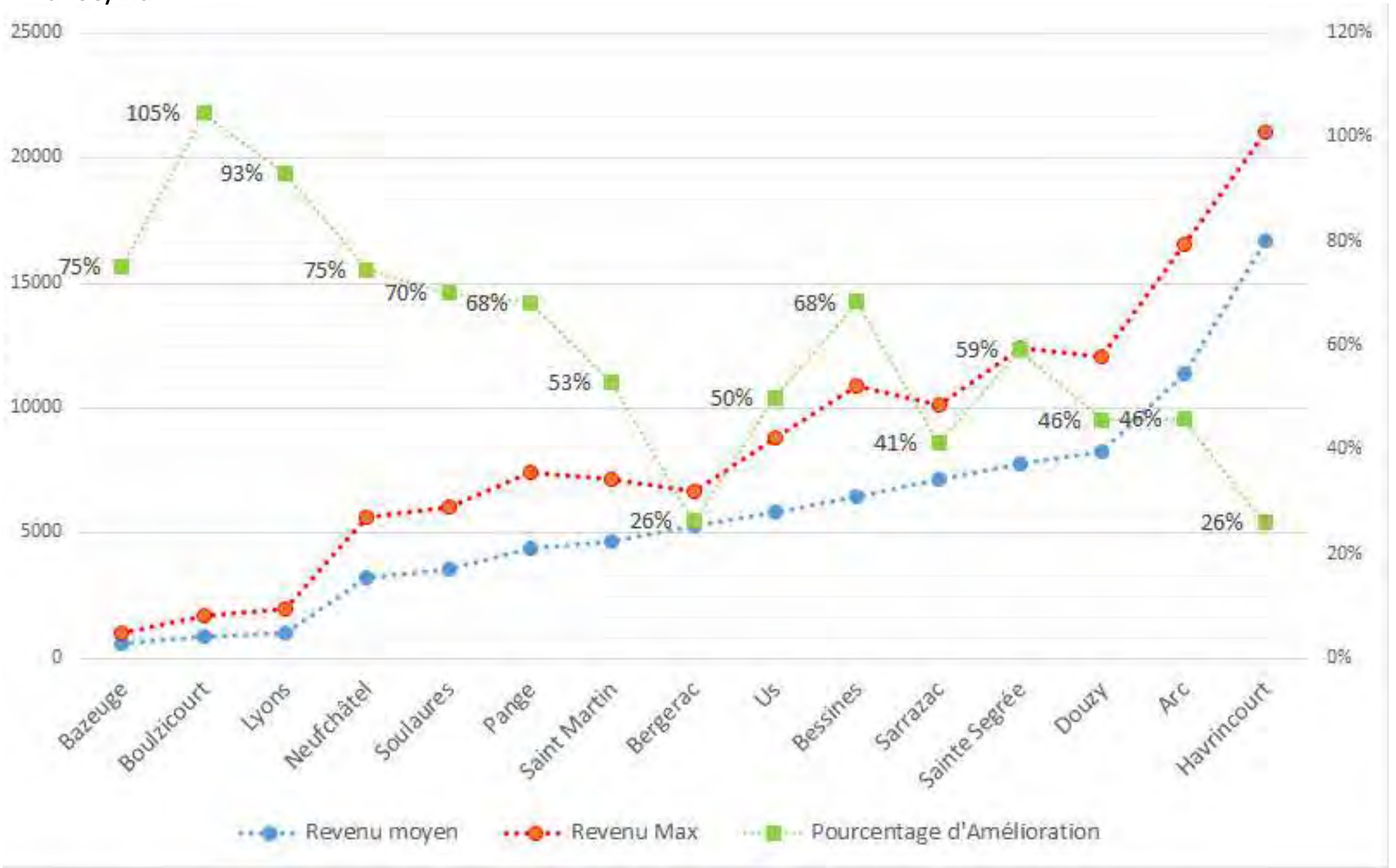
Catégorie	Diamètre borne inférieure incluse	Diamètre borne supérieure exclue	Utilisation	Prix (€/m³)
A	50 cm		Tranchage	260
B	45 cm	50 cm	Plot	100
C	35 cm	45 cm	Sciage	30
D		35 cm	Diverse : palette, BRF,…	15



+ no replanting, less pruning years, earlier crop

- 600 € more per ha from 50 to 100 plants/ha density

Euros/ha




Thank you !