

Poplar Cultivar 'BAKAN'

Passport

Interspecific hybrid	<i>Populus trichocarpa x Populus maximowiczii</i>		
Parents	Mother	P.trichocarpa 'S.724-116'	
	Father	P. maximowiczii 'S.122-3' (Japan)	
		S.724 = V.235 (Fritzi Pauley) x V.24 (Columbia River) S.122 = P. maximowiczii, Hokkaido, Japan	
Creation	1970, by controlled crossing at INBO, Geraardsbergen, Belgium		
Plant Variety Protection Certificate	EU 44786 from 17/10/2016		
Gender	Male		
INBO Breeding N°	75.023/18		

Phenotype

CULTIVAR	TRUNK FORM & COLOR	FORM OF TREE CROWN	BRANCHINESS
Bakan	Light flexible trunk smooth, pale bark	<i>elongated, egg-shaped crown (wider than Dender & Marke)</i>	<i>fairly thin branches</i>
Skado	Light flexible trunk smooth, pale bark	<i>elongated, egg-shaped crown (wider than Dender & Marke)</i>	<i>fairly thin branches</i>
Dender	Straight to light flexible trunk smooth, pale bark	<i>elongated, egg-shaped crown</i>	<i>Fairly thin branches heavy branch at a height of 6 to 8 m</i>
Marke	Straight to light flexible trunk smooth, pale bark	<i>elongated, egg-shaped crown</i>	<i>Fairly thin branches heavy branch at a height of 6 to 8 m</i>

Important: Requires early monitoring and shape correction



Bakan – tree form and branchiness



Bakan – trunk form and color

Phenology

At the INBO nursery in Geraardsbergen (50° 48' N, 3° 57' E) , the cultivar 'Bakan' reaches bud burst in the last week of May and the timing of bud set in autumn is the third week of September. (Fig. 1).

Bud burst is one week earlier than Dender and Marke and bud set is one week later.

Fig 1. Phenology of the cultivar Bakan compared to the INBO cultivars Dender, Marke, Skado and Vesten and observed in the INBO nursery at Geraardsbergen (2015)

	Bud burst											Bud set						
	17-march	24-march	31-march	7-april	14-april	21-april	28-april	5-may	11-may	18-may	juin	july	august	7-sep.	14-sep.	21-sep.	28-sep.	5-oct
Dender				■	■	■	■	■	■	■	■	■	■	■	■			
Marke				■	■	■	■	■	■	■	■	■	■	■	■			
Bakan			■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Skado			■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Vesten						■	■	■	■	■	■	■	■	■	■			

Growth characteristics

Fig 2. Height and diameter of two-year-old trees of the cultivar Bakan in the INBO nursery at Geraardsbergen, compared to the INBO cultivars Dender, Marke and Skado.

Cultivar	# trees	Height(cm)	Category 1 (D25-30mm) (%)	Category 2 (D30-40mm) (%)	Category 3 (D40-50mm) (%)
Dender	27	424	0	37	63
Marke	21	406	0	29	71
Bakan	32	523	16	72	13
Skado	37	556	40	57	3

The trees of Bakan are longer but on average less thick than those of the cultivars Dender and Marke.

Mean Annual Increment (MAI) - circonference

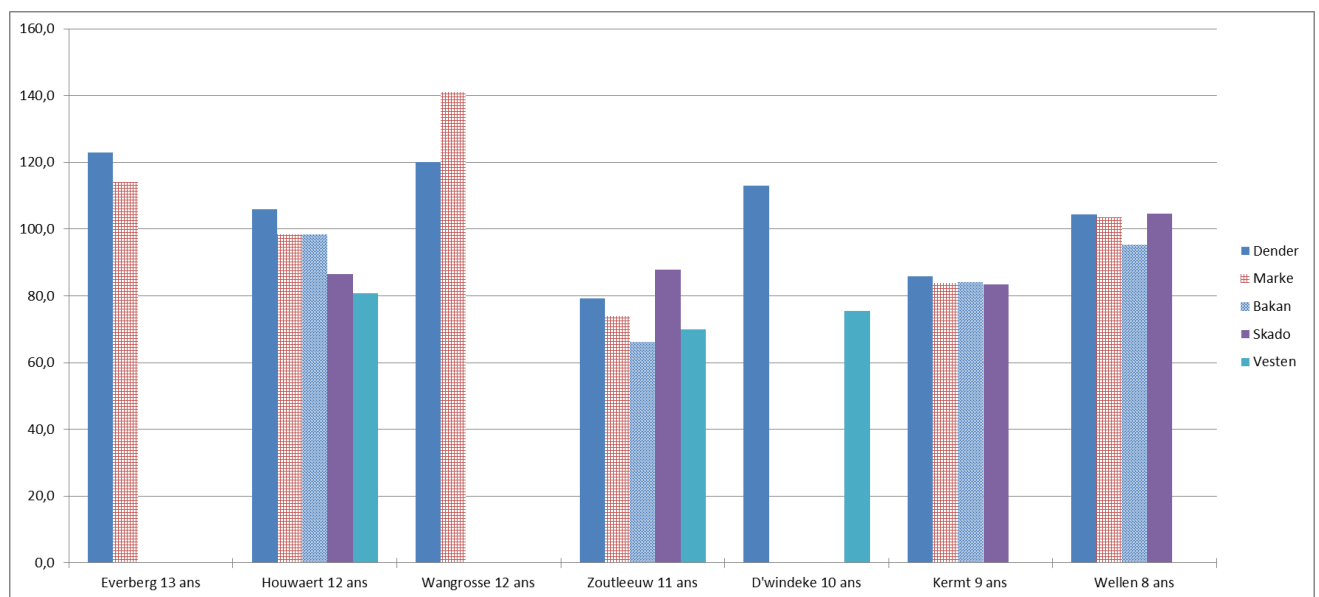
MAI has been measured in 7 field trials aging from 8 to 13 years and installed in the north of Belgium on different soil types – planting distance 8m x 8m



Fig 3. Soil properties of the 7 field sites mentioned below

Fieltrial name	Everberg	Houwaert	Wangrosse	Zoutleeuw	Denderwindeke	Kermt	Wellen
Soil profile	No profile	B-horizont	No profile	B-horizont/ No profile	No profile	No profile	
Soil texture	very strong gleying clay soil	moderate gleying sandy loam soil	strong gleying loam soil	Weak/modera te gleying loam soil	strong gleying loam soil	strong gleying loam soil	peat

Fig 4. Mean annual increment (circumference in cm)



Wood technology

Wood properties were obtained from the Laboratory for wood technology, University of Ghent, Belgium.

Physical properties	
Wood density (60%RV)	420
Heartwood proportion (%)	24
Tension wood proportion (%)	20
Mechanical properties	
Modulus of elasticity (N/mm ²)	10200
Modulus of rupture (N/mm ²)	70
Industrial processes	
veneer A/B-grade (%)	25
C1-grade (%)	75
The wood is suitable for	
Veneer **	Due to the low share of heartwood and tensionwood, this clone is very suitable for the production of veneer. Where also comes the high degree of whiteness, also with the C1 veneer. The larger proportion of C1 veneer is due to the presence of many small brushes that can easily be avoided by good pruning.
Saw wood	This clone has a very favorable strength-density ratio, which also makes it possible to produce quality saw wood.

Disease resistance

The cultivar 'Bakan' has been tested and selected for its good resistance/tolerance to the leaf rust *Melampsora larici-populina*, leaf spot disease caused by *Marssonina brunnea*, bacterial canker caused by *Xanthomonas populi* and woolly aphid, caused by *Phloemyzus passerinii*.

- Resistance to *Melampsora larici-populina* and *Marssonina brunnea* has been observed during several consecutive years at the INBO nursery in Geraardsbergen.
- Resistance to *Xanthomonas populi* has been tested by artificial infection on five 2-year-old trees
- Resistance to *Phloemyzus passerinii* has been tested by artificial infection at the CREA Centro di ricerca Foreste e Legno ,Casale Monferrato, Italy

Fig 5. Resistance of the cultivar Bakan to the most important poplar diseases in Europe

Cultivar	Leaf rust (<i>Melampsora larici-populina</i>)	Leaf spot disease (<i>Marssonina brunnea</i>)	Bacterial canker (<i>Xanthomonas populi</i>)	Woolly aphid (<i>Phloemyzus passerinii</i> (Sign.))
Vesten	tolerant	tolerant	tolerant	tolerant
Bakan	tolerant	tolerant	tolerant	tolerant
Skado	tolerant	tolerant	tolerant	tolerant
Dender	Very tolerant	tolerant	tolerant	tolerant
Marke	Very tolerant	tolerant	tolerant	tolerant

Biomass production under short rotation coppice

Realized dry weight (ton/ ha/ y) for the cultivar Bakan under short rotation coppice in two experimental sites

Experimental site 1

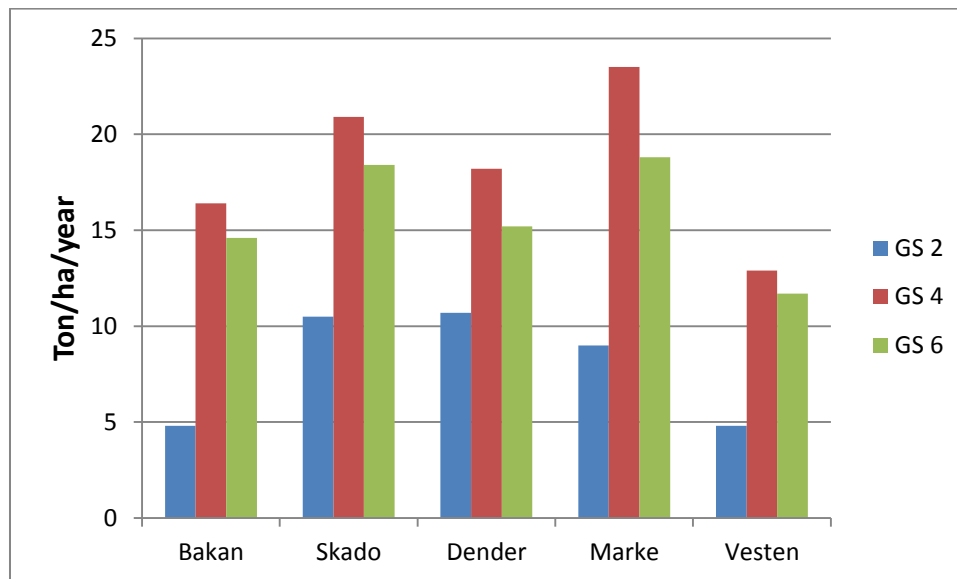
Location: Grimminge (Belgium, Lat. 50.7878759; Long. 3.938241)

Planting density: 10.000 cuttings/Ha.

Soil texture : *moderate gleying loam soil*; Soil profile: *B-horizont*

The plantation has been harvest after 2, 4 and 6 years.

Fig.6 Realized dry weight after 2, 4 and 6 years. Bakan is producing 16.4 ton/ha/y after the second harvest and 14.6 ton / ha/ y after the third harvest.



Ir. Linda Meiresonne, 2018 (INBO)

Experimental site 2

Location: Lochristi, Flanders (Belgium, Lat. 51.11194444; Long. 3.85055556)

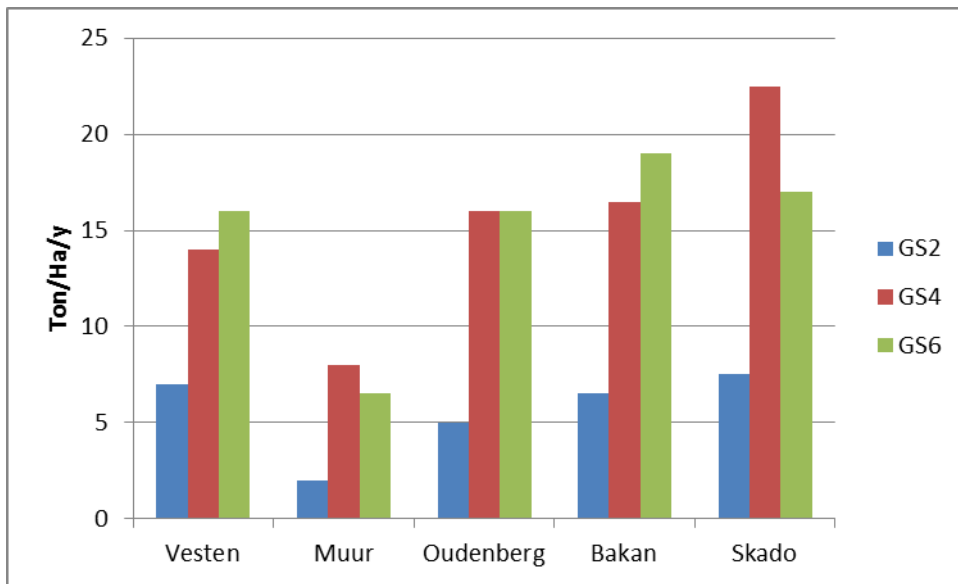
Soil texture: loamy sand (clay content of 11% between 30–60 cm depth) with deeper clay-enriched sand layers (~75 cm),

Planting density : 8.000 cuttings/Ha.

Planting design: double rows with alternating distances of 0.75 and 1.50 m between the rows and 1.1 m within the row.

The plantation has been harvest after 2, 4 and 7 years.

Fig 6. Realized dry weight for each second growing season (GS2, GS4 and GS7) of each 2-year-rotation. Bakan is producing 18,5 Ton /ha /y after the third harvest.



Bakan, 15 years, Zoutleeuw (Belgium)

Poplar Cultivar 'DENDER'

Passport

Interspecific hybrid	<i>Populus.deltoides</i> x (<i>Populus trichocarpa</i> x <i>Populus maximowiczii</i>)		
Parents	Mother	<i>P.deltoides</i> 'S.333-44' (Michigan)	
	Father	'S.725-37' = <i>P.trichocarpa</i> 'S.3-5'* x <i>P.maximowiczii</i> (Japan)	
		<i>P.trichocarpa</i> 'S.3-5' * = <i>P.trichocarpa</i> 'V.26' (Washington) x <i>P.trichocarpa</i> 'V.23' (Idaho)	
Creation	1970, by controlled crossing at INBO, Geraardsbergen, Belgium		
Plant Variety Protection Certificate	EU 44784 from 17/10/2016		
Gender	male		
INBO Breeding nb	70.078/2		

Phenotype

Stem form	straight
Forking	rarely
Branch thickness	forming of a few thick branches at a height of 6m or more
➤ sidewalk clearance starts at the tree age of 4-5 years	



Phenology

At the INBO nursery in Geraardsbergen (50° 48' N, 3° 57' E) , the cultivar 'Dender' reaches bud burst in the first week of April and the timing of bud set in autumn is mid September. (Fig. 1).

Fig 1. Phenology of the cultivar Dender in comparison to the INBO cultivars Marke, Bakan, Skado and Vesten and observed in the INBO nursery at Geraardsbergen (2015)

	Bud burst										Bud set							
	17-march	24-march	31-march	7-april	14-april	21-april	28-april	5-may	11-may	18-may	juin	july	august	7-sep.	14-sep.	21-sep.	28-sep.	5-oct
Dender				■	■	■	■	■	■	■	■	■	■	■	■			
Marke				■	■	■	■	■	■	■	■	■	■	■	■			
Bakan			■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Skado			■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Vesten						■	■	■	■	■	■	■	■	■	■			

Growth characteristics

Fig 2. Height and diameter of two-year-old trees of the cultivar Dender in the INBO nursery at Geraardsbergen, compared to the INBO cultivars Marke, Bakan and Skado

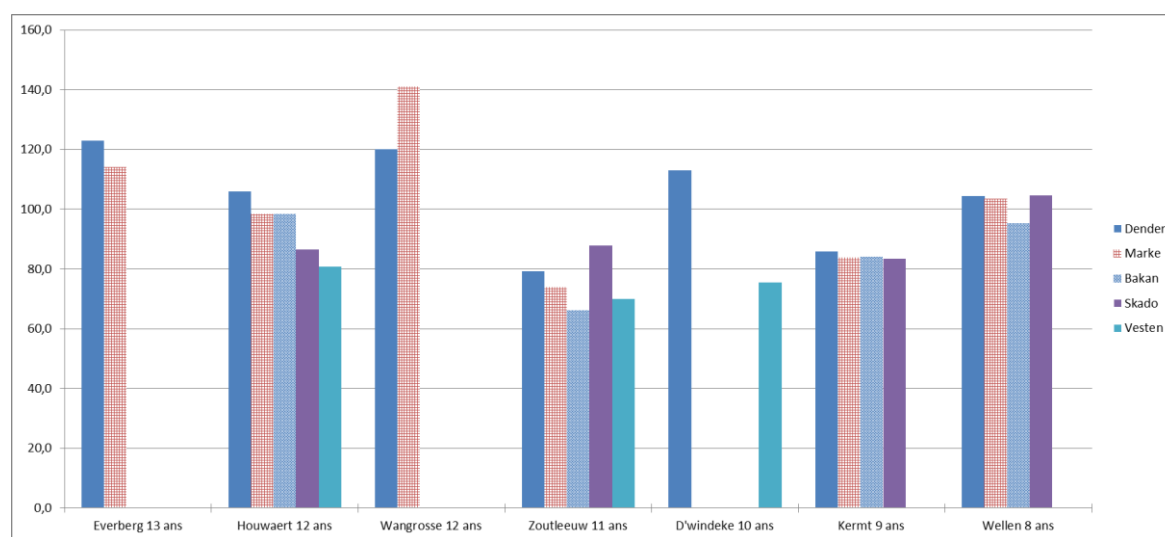
Cultivar	# trees	Height(cm)	Category 1 (D25-30mm) (%)	Category 2 (D30-40mm) (%)	Category 3 (D40-50mm) (%)
Dender	27	424	0	37	63
Marke	21	406	0	29	71
Bakan	32	523	16	72	13
Skado	37	556	40	57	3

The *Mean Annual Increment* (MAI) – circumference- has been measured in 7 field trials installed in the north of Belgium on different soil types (Fig.3) and ranges between 8 cm and 12,2 cm.

Fig 3. Soil properties of the 7 field sites mentioned below

Fieltrial name	Everberg	Houwaert	Wangrosse	Zoutleeuw	Denderwindeke	Kermt	Wellen
Soil texture	No profile	B-horizont	No profile	B-horizont/ No profile	No profile	No profile	
Soil profile	very strong gleying clay soil	moderate gleying sandy loam soil	strong gleying loam soil	Weak/modera te gleying loam soil	strong gleying loam soil	strong gleying loam soil	peat

Fig 4. Mean annual increment (circumference in cm) of the cultivar Dender in seven field trials aging from 8 to 13 years compared the INBO cultivars Marke, Bakan, Skado and Vesten (planting distance - 8m x 8m)



Marke = *P.deltoides* x *P.trichocarpa* x *P.maximowiczii*

Bakan = *P.trichocarpa* x *P.maximowiczii*

Skado = *P.trichocarpa* x *P. maximowiczii*

Vesten = *P.deltoides* x *P.nigra*

Wood technology

Wood properties were obtained from the Laboratory for wood technology, University of Ghent, Belgium.

Physical properties	
Wood density (60%RV)	405 ± 41 kg/m ³
Heartwood proportion (%)	20-40
Tension wood proportion (%)	20-36
Mechanical properties	
Modulus of elasticity (N/mm ²)	5200-8200
Modulus of rupture (N/mm ²)	40-45
Industrial processes	
veneer A/B-grade (%)	35-40
C1-grade (%)	60-65
The wood is suitable for	
Veneer **	Good / very good (even for CE multiplex)
Saw wood	Good/very good

Disease resistance

The cultivar 'Dender' has been tested and selected for its good resistance/tolerance to the leaf rust *Melampsora larici-populina*, leaf spot disease caused by *Marssonina brunnea*, bacterial canker caused by *Xanthomonas populi* and woolly aphid, caused by *Phloemyzus passerinii*.

- Resistance to *Melampsora larici-populina* and *Marssonina brunnea* has been observed during several consecutive years at the INBO nursery in Geraardsbergen.
- Resistance to *Xanthomonas populi* has been tested by artificial infection on five 2-year-old trees
- Resistance to *Phloemyzus passerinii* has been tested by artificial infection at the CREA Centro di ricerca Foreste e Legno, Casale Monferrato, Italy

Fig 5. Resistance of the cultivar Dender to the most important poplar diseases in Europe

Cultivar	Leaf rust (<i>Melampsora larici-populina</i>)	Leaf spot disease (<i>Marssonina brunnea</i>)	Bacterial canker (<i>Xanthomonas populi</i>)	Woolly aphid (<i>Phloomyzus passerinii</i> (Sign.))
Vesten	tolerant	tolerant	tolerant	Field tolerant
Bakan	tolerant	tolerant	tolerant	tolerant
Skado	tolerant	tolerant	tolerant	tolerant
Dender	Very tolerant	tolerant	tolerant	tolerant
Marke	Very tolerant	tolerant	tolerant	tolerant

Biomass production under short rotation coppice

Realized dry weight (ton/ ha/ y) for the cultivar Dender under short rotation coppice has been measured in an experimental site located in Grimminge (Belgium) and planting density of 10.000 cuttings/Ha.

The plantation has been harvest after 2, 4 and 6 years. Fig 6. shows realized dry weight after the last harvest. Dender is producing 24,5 ton / ha/ y after the third harvest.

Fig 6. Biomass production (dry weight) after three 2-year coppice rotations

CULTIVAR	Realized dry weight ton/jr.ha	Mean height/shoot (cm)	mean diameter/shoot (cm)	# shoots/stool
Dender	24,5	435	2,8	4,2
Marke	19,9	396	2,4	5,1
Bakan	17,4	397	2,4	3,4
Skado	18,4	360	2,0	5,0

Ir. Linda Meiresonne, 2018 (INBO)



Dender, Zoutleeuw (Belgium)

Poplar Cultivar 'MARKE'

Passport

Interspecific hybrid	<i>Populus.deltoides</i> x (<i>Populus trichocarpa</i> x <i>Populus maximowiczii</i>)		
Parents	Mother	<i>P.deltoides</i> 'S.333-44' (Michigan)	
	Father	'S.725-37' = <i>P.trichocarpa</i> 'S.3-5'* x <i>P.maximowiczii</i> (Japan)	
		<i>P.trichocarpa</i> 'S.3-5' * = <i>P.trichocarpa</i> 'V.26' (Washington) x <i>P.trichocarpa</i> 'V.23' (Idaho)	
Creation	1970, by controlled crossing at INBO, Geraardsbergen, Belgium		
Plant Variety Protection Certificate	EU 44786 from 17/10/2016		
Gender	Female		
INBO Breeding nb	70.078/2		

Phenotype

Stem form	straight
Forking	rarely
Branch thickness	forming of a few thick branches at a height of 6m or more
➤ sidewalk clearance starts at the tree age of 3-5 years	



Phenology

At the INBO nursery in Geraardsbergen (50° 48' N, 3° 57' E) , the cultivar 'Marke' reaches bud burst in the first week of April and the timing of bud set in autumn is mid September. (Fig. 1).

Fig 1. Phenology of the cultivar Marke compared to the INBO cultivars Dender, Bakan, Skado and Vesten and observed in the INBO nursery at Geraardsbergen (2015)

	Bud burst											Bud set						
	17-march	24-march	31-march	7-april	14-april	21-april	28-april	5-may	11-may	18-may	juin	july	august	7-sep.	14-sep.	21-sep.	28-sep.	5-oct
Dender																		
Marke																		
Bakan																		
Skado																		
Vesten																		

Growth characteristics

Fig 2. Height and diameter of two-year-old trees of the cultivar Marke in the INBO nursery at Geraardsbergen, compared to the INBO cultivars Dender, Bakan and Skado

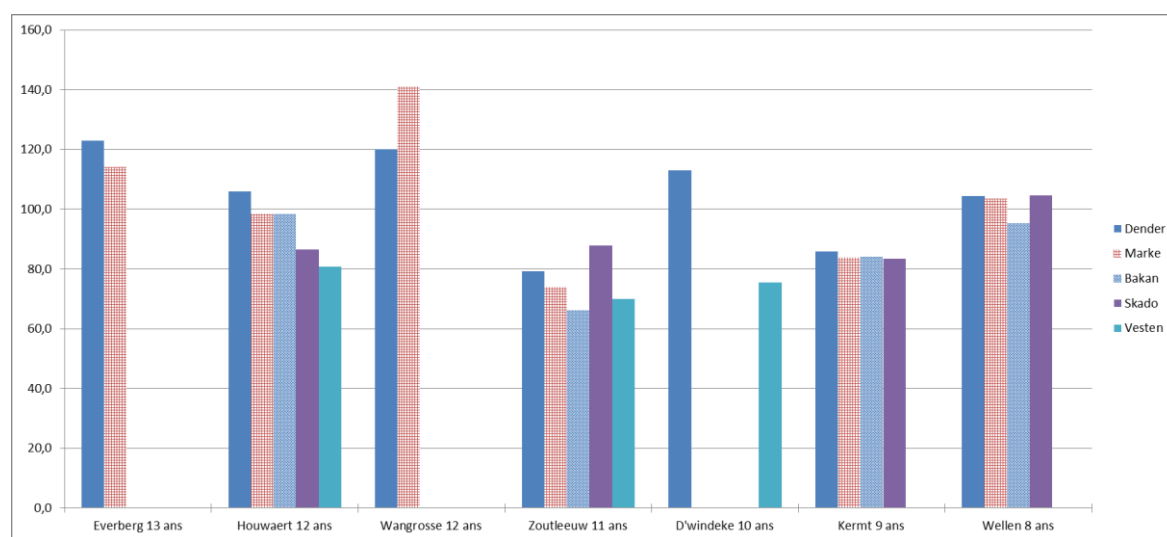
Cultivar	# trees	Height(cm)	Category 1 (D25-30mm) (%)	Category 2 (D30-40mm) (%)	Category 3 (D40-50mm) (%)
Dender	27	424	0	37	63
Marke	21	406	0	29	71
Bakan	32	523	16	72	13
Skado	37	556	40	57	3

The *Mean Annual Increment* (MAI) – circumference- has been measured in 7 field trials installed in the north of Belgium on different soil types (Fig. 3 below) and ranges between 8 cm and 12,2 cm.

Fig 3. Soil properties of the 7 field sites mentioned below

Fieltrial name	Everberg	Houwaert	Wangrosse	Zoutleeuw	Denderwindeke	Kermt	Wellen
Soil texture	No profile	B-horizont	No profile	B-horizont/ No profile	No profile	No profile	
Soil profile	very strong gleying clay soil	moderate gleying sandy loam soil	strong gleying loam soil	Weak/modera te gleying loam soil	strong gleying loam soil	strong gleying loam soil	peat

Fig 4. Mean annual increment (circumference in cm) of the cultivar Marke in seven field trials aging from 8 to 13 years compared the INBO cultivars Dender, Bakan, Skado and Vesten (planting distance - 8m x 8m)



Dender = *P. deltoides* x *P. trichocarpa* x *P. maximowiczii*

Bakan = *P. trichocarpa* x *P. maximowiczii*

Skado = *P. trichocarpa* x *P. maximowiczii*

Vesten = *P. deltoides* x *P. nigra*

Wood technology

Wood properties were obtained from the Laboratory for wood technology, University of Ghent, Belgium.

Physical properties	
Wood density (60%RV)	380 – 420 kg/m ³
Heartwood proportion (%)	15-55
Tension wood proportion (%)	20-36
Mechanical properties	
Modulus of elasticity (N/mm ²)	5000-8200
Modulus of rupture (N/mm ²)	40-56
Industrial processes	
veneer A/B-grade (%)	45
C1-grade (%)	55
The wood is suitable for	
Veneer **	Good / very good (even for CE multiplex)
Saw wood	Good/very good

Physical properties	
Wood density (60%RV)	405 ± 41 kg/m ³
Heartwood proportion (%)	20-40
Tension wood proportion (%)	20-36
Mechanical properties	
Modulus of elasticity (N/mm ²)	5200-8200
Modulus of rupture (N/mm ²)	40-45

Industrial processes	
veneer A/B-grade (%)	35-40
C1-grade (%)	60-65
The wood is suitable for	
Veneer **	Good / very good (even for CE multiplex)
Saw wood	Good/very good

Disease resistance

The cultivar 'Marke' has been tested and selected for its good resistance/tolerance to the leaf rust *Melampsora larici-populina*, leaf spot disease caused by *Marssonina brunnea*, bacterial canker caused by *Xanthomonas populi* and woolly aphid, caused by *Phloemyzus passerinii*.

- Resistance to *Melampsora larici-populina* and *Marssonina brunnea* has been observed during several consecutive years at the INBO nursery in Geraardsbergen.
- Resistance to *Xanthomonas populi* has been tested by artificial infection on five 2-year-old trees
- Resistance to *Phloemyzus passerinii* has been tested by artificial infection at the CREA Centro di ricerca Foreste e Legno ,Casale Monferrato, Italy

Fig 5. Resistance of the cultivar Marke to the most important poplar diseases in Europe

Cultivar	Leaf rust (<i>Melampsora larici-populina</i>)	Leaf spot disease (<i>Marssonina brunnea</i>)	Bacterial canker (<i>Xanthomonas populi</i>)	Woolly aphid (<i>Phloemyzus passerinii</i> (Sign.))
Vesten	tolerant	tolerant	tolerant	Field tolerant
Bakan	tolerant	tolerant	tolerant	tolerant
Skado	tolerant	tolerant	tolerant	tolerant
Dender	Very tolerant	tolerant	tolerant	tolerant
Marke	Very tolerant	tolerant	tolerant	tolerant

Biomass production under short rotation coppice

Realized dry weight (ton/ ha/ y) for the cultivar Marke under short rotation coppice has been measured in an experimental site located in Grimminge (Belgium) and planting density of 10.000 cuttings/Ha.

The plantation has been harvest after 2, 4 and 6 years. Fig.6 shows realized dry weight after 6 years. Marke is producing 19.9 ton / ha/ y after the third harvest.

Fig 6. Biomass production (dry weight) after three 2-year coppice rotations

CULTIVAR	Realized dry weight ton/jr.ha	Mean height/shoot cm	mean diameter/shoot cm	# shoots /stool
Dender	24,5	435	2,8	4,2
Marke	19,9	396	2,4	5,1
Bakan	17,4	397	2,4	3,4
Skado	18,4	360	2,0	5,0

Ir. Linda Meiresonne, 2018 (INBO)

Poplar Cultivar ‘Muur’

Passport

Interspecific hybrid	<i>Populus.deltoides</i> x <i>Populus nigra</i>
Parents	<i>Populus deltoides</i> = <i>Populus deltoides</i> V.5 (Iowa) x <i>Populus deltoides</i> V.12 (Illinois) <i>Populus nigra</i> = <i>Populus nigra</i> S.132-4 = <i>Populus nigra</i> Casale 5 (Italy) x <i>Populus nigra</i> ‘Italica’ V.450
Creation	1978, by controlled crossing at INBO (Research Institute for Nature and Forest), Geraardsbergen, Belgium
Plant Variety Protection Certificate	EU 9263 – From 15/04/2002
Gender	Male
Cultivar number	78.017/164

Phenotype

Straightness of the stem	straight
Bark	rough; dark color
Crown	slim, egg-shaped
Tree form	fastigate
Forking	rarely
# branches	medium
Thickness of the branches	small

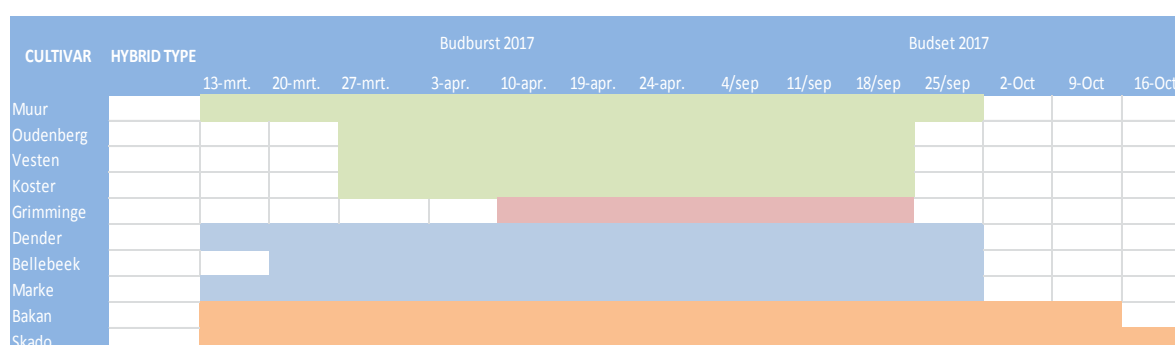


Cultivar “Muur”, 2005 Lommel (Belgium)
MAI (circumference) = 8,3 cm

Phenology

At the INBO nursery in Geraardsbergen (50° 48' N, 3° 57' E) in 2017, the cultivar 'Muur' starts to flush in the third week of March and the timing of bud set in autumn is the last week of September (Fig 1). Timing of bud burst and bud set is the same as for the cultivars Dender and Marke.

Fig 1. Phenology of the cultivar Muur compared to other INBO cultivars and Koster observed in the INBO nursery at Geraardsbergen (Belgium, 2017)



Growth characteristics

Nursery test

Fig 2. Height and DBH (diameter at breast height) of **two-year-old trees** of the cultivar Muur in the INBO nursery at Geraardsbergen (2015) compared to the *P. euramericana* cultivars Vesten and Oudenberg

Cultivar	#trees	Height (cm)	% trees cat1 (Ø <25 mm)	% trees cat2 (Ø 25-30 mm)	% trees cat3 (Ø 30-40 mm)	% trees cat4 (Ø 40-50 mm)
Muur	50	381	44	48	8	0
Vesten	63	466	0	11	80	9
Oudenberg	62	423	0	16	80	4

Field test

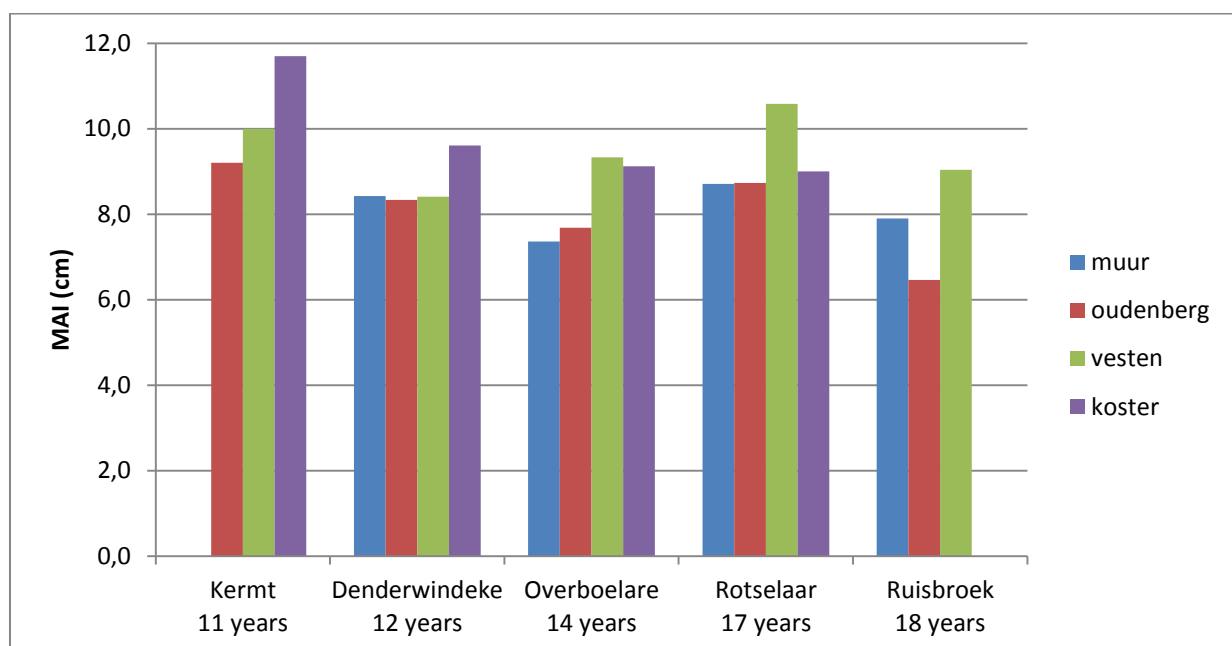
The *Mean Annual Increment (MAI)* – circumference- has been measured in five field trials installed in the north of Belgium on different soil types (Fig 3) and ranges between 7,4 cm and 8,7 cm. Muur gives good/very good results on good fertile soils with good water management. On less fertile soils the cultivar grows less well than the cultivars Vesten and Oudenberg.

Fig 3. Soil properties of the 5 field sites mentioned below

Test field	Overboelare	Ruisbroek	Rotselaar	Kermt	Denderwindeke
Soil texture	no profile	no profile	no profile	no profile	no profile
Soil profile	weak gleying sandy loam soil	very strong gleying sandy loam soil	very strong gleying clay soil	strong gleying loam soil	strong gleying loam soil

Test field	Overboelare
Soil texture	no profile
Soil profile	weak gleying sandy loam soil

Fig 4. MAI (Mean annual increment - circumference in cm) of the cultivar Muur in 5 field trials aging from 11 to 18 years and compared to the INBO cultivars Oudenberg and Vesten and cultivar Koster (planting distance - 8m x 8m)



Wood technology

Wood properties were obtained from the Laboratory for wood technology, University of Ghent, Belgium.

Physical properties	
Wood density (60%RV)	332 kg/m ³
Heartwood proportion (%)	31
Tension wood proportion (%)	17
Mechanical properties	
Modulus of elasticity (N/mm ²)	9670
Modulus of rupture (N/mm ²)	63
Industrial processes	
veneer A/B-grade (%)	82
C1-grade (%)	18
The wood is suitable for	
Veneer	good
Saw wood	The ratio of the wood density to the modulus of rupture makes the wood less favorable for use as saw timber

Disease resistance

The cultivar 'Muur' has been tested and selected for its good resistance/tolerance to the leaf rust *Melampsora larici-populina*, leaf spot disease caused by *Marssonina brunnea* and bacterial canker caused by *Xanthomonas populi*. According to laboratory tests carried out at the laboratory*, the clone Muur is field resistant to the woolly aphid, caused by *Phloemyzus passerinii*.

- Resistance to *Melampsora larici-populina* and *Marssonina brunnea* has been observed during several consecutive years at the INBO nursery in Geraardsbergen.
- Resistance to *Xanthomonas populi* has been tested by artificial infection on five 2-year-old trees

Fig 5. Resistance of the cultivar Muur to the most important poplar diseases in Europe

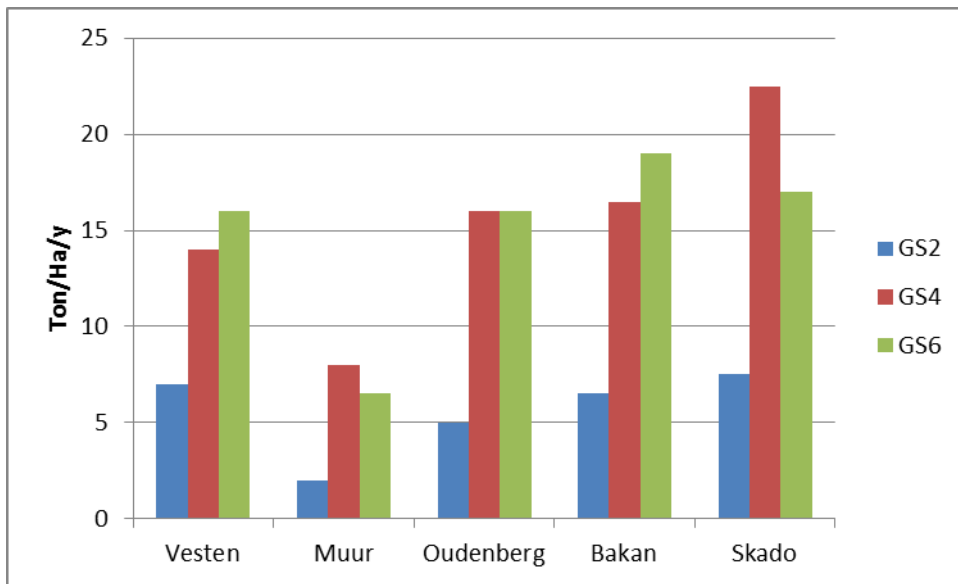
Cultivar	Leaf rust (<i>Melampsora larici-populina</i>)	Leaf spot disease (<i>Marssonina brunnea</i>)	Bacterial canker (<i>Xanthomonas populi</i>)	Woolly aphid (<i>Phloemyzus passerinii</i> (Sign.))
Vesten	tolerant	tolerant	tolerant	tolerant
Oudenberg	tolerant	tolerant	tolerant	tolerant
Muur	tolerant	tolerant	tolerant	tolerant

Biomass production under short rotation coppice

Realized dry weight (Ton /ha /y) for the cultivar Muur under short rotation coppice has been measured in an experimental site located in Lochristi, Flanders (Belgium, 51°06'44" N, 3°51'02" E) , planting density of 8.000 cuttings/Ha.

The plantation has been harvest after 2, 4 and 6 years. Fig 6. shows realized dry weight for each second growing season (GS2, GS4 and GS6) of each 2-year-rotation. Muur is producing 7 Ton /ha /y after the third harvest, which makes the clone not suitable for short rotation coppice.

Fig 6. Realized dry weight under short rotation coppice of the INBO poplar cultivar Oudenberg compared to the INBO cultivars Muur, Vesten, Bakan and Skado



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Muur, 15 years, Lommel (Belgium)

Poplar Cultivar 'Oudenberg'

Passport

Interspecific hybrid	<i>Populus deltoides</i> x <i>Populus nigra</i>
Parents	<i>Populus deltoides</i> = <i>Populus deltoides</i> S.513-60
	<i>Populus nigra</i> = <i>Populus nigra</i> S.157-3 = <i>Populus nigra</i> V220 Casale 1 (Italy) x <i>Populus nigra</i> 'Italica'
Creation	1978, by controlled crossing at INBO (Research Institute for Nature and Forest), Geraardsbergen, Belgium
Plant Variety Protection Certificate	EU 9264 – From 15/04/2002
Gender	Female
Cultivar number	78.017/164

Phenotype

Straightness of the stem	straight
Tree form	fastigiate
Forking	rarely
# branches	medium
Thickness of the branches	small

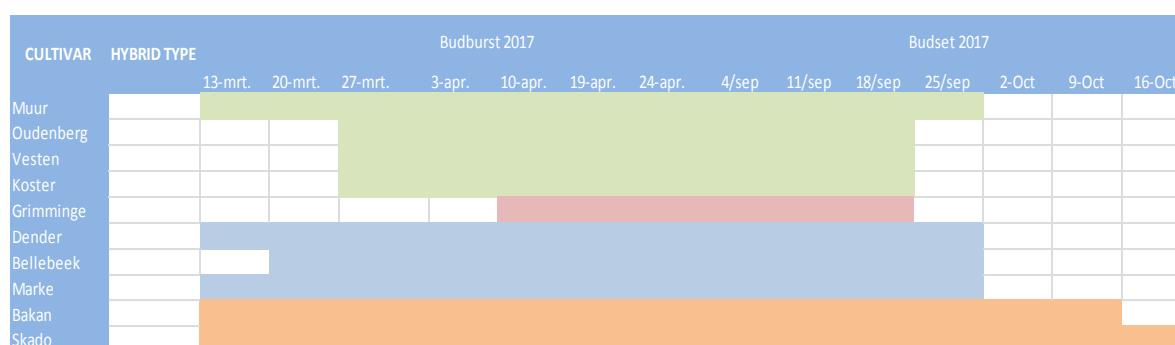


Oudenberg, 15 years

Phenology

At the INBO nursery in Geraardsbergen (50° 48' N, 3° 57' E) in 2017, the cultivar 'Oudenberg' starts to flush in the last week of April and the timing of bud set in autumn is the third week of September (Fig 1). Timing of bud burst and bud set is the same as for the cultivars Koster and Vesten.

Fig 1. Phenology of the cultivar Vesten compared to other INBO cultivars and Koster observed in the INBO nursery at Geraardsbergen (Belgium, 2017)



Growth characteristics

Nursery test

Fig 2. Height and DBH (diameter at breast height) of **two-year-old trees** of the cultivar Oudenberg in the INBO nursery at Geraardsbergen (2015) compared to the *P. euramericana* cultivars Vesten and Muur

Cultivar	#trees	Height (cm)	% trees cat1 (Ø <25 mm)	% trees cat2 (Ø 25-30 mm)	% trees cat3 (Ø 30-40 mm)	% trees cat4 (Ø 40-50 mm)
Muur	50	381	44	48	8	0
Vesten	63	466	0	11	80	9
Oudenberg	62	423	0	16	80	4



Two-year-old trees of Oudenberg (Picture: M. Steenackers)

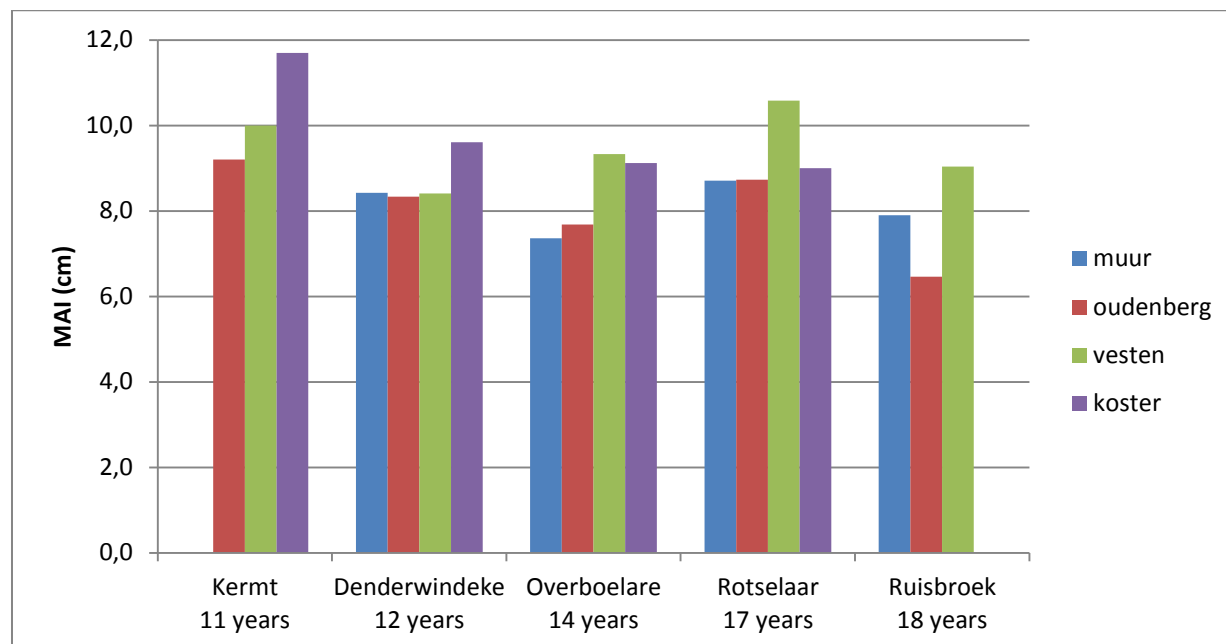
Field test

The *Mean Annual Increment* (MAI) – circumference- has been measured in five field trials installed in the north of Belgium on different soil types (Fig 3) and ranges between 6,5 cm and 9,2 cm.

Fig 3. Soil properties of the 5 field sites mentioned below

Test field	Overboelare	Ruisbroek	Rotselaar	Kermt	Denderwindeke
Soil texture	no profile	no profile	no profile	no profile	no profile
Soil profile	weak gleying sandy loam soil	very strong gleying sandy loam soil	very strong gleying clay soil	strong gleying loam soil	strong gleying loam soil

Fig 4. MAI (Mean annual increment - circumference in cm) of the cultivar Oudenberg in 5 field trials aging from 11 to 18 years and compared to the INBO cultivars Muur and Vesten and cultivar Koster (planting distance - 8m x 8m)



Wood technology

Wood properties were obtained from the Laboratory for wood technology, University of Ghent, Belgium.

Physical properties	
Wood density (60%RV)	363 kg/m ³
Heartwood proportion (%)	40
Tension wood proportion (%)	7
Mechanical properties	
Modulus of elasticity (N/mm ²)	7788
Modulus of rupture (N/mm ²)	60

Industrial processes	
veneer A/B-grade (%)	82
C1-grade (%)	18
The wood is suitable for	
Veneer	good
Saw wood	very good

Disease resistance

The cultivar 'Oudenberg' has been tested and selected for its good resistance/tolerance to the leaf rust *Melampsora larici-populina*, leaf spot disease caused by *Marssonina brunnea* and bacterial canker caused by *Xanthomonas populi*. According to laboratory tests carried out at the laboratory* , the clone Oudenberg is field resistant to the woolly aphid, caused by *Phloemyzus passerinii*.

- Resistance to *Melampsora larici-populina* and *Marssonina brunnea* has been observed during several consecutive years at the INBO nursery in Geraardsbergen.
- Resistance to *Xanthomonas populi* has been tested by artificial infection on five 2-year-old trees

Fig 5. Resistance of the cultivar Oudenberg to the most important poplar diseases in Europe

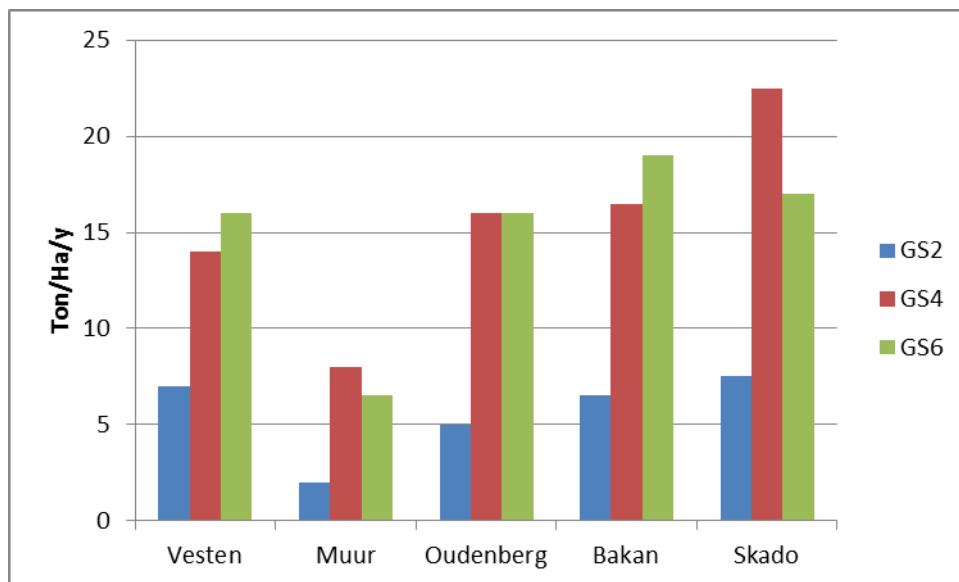
Cultivar	Leaf rust (<i>Melampsora larici-populina</i>)	Leaf spot disease (<i>Marssonina brunnea</i>)	Bacterial canker (<i>Xanthomonas populi</i>)	Woolly aphid (<i>Phloemyzus passerinii</i> (Sign.))
Vesten	tolerant	tolerant	tolerant	tolerant
Oudenberg	tolerant	tolerant	tolerant	tolerant
Muur	tolerant	tolerant	tolerant	tolerant

Biomass production under short rotation coppice

Realized dry weight (Ton /ha /y) for the cultivar Oudenberg under short rotation coppice has been measured in an experimental site located in Lochristi, Flanders (Belgium, 51°06'44" N, 3°51'02" E) , planting density of 8.000 cuttings/Ha.

The plantation has been harvest after 2, 4 and 6 years. Fig 6. shows realized dry weight for each second growing season (GS2, GS4 and GS6) of each 2-year-rotation. Just like Vesten, Oudenberg is producing 16 Ton /ha /y after the third harvest.

Fig 6. Realized dry weight under short rotation coppice of the INBO poplar cultivar Oudenberg compared to the INBO cultivars Muur, Vesten, Bakan and Skado



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Poplar Cultivar 'SKADO'

Passport

Interspecific hybrid	<i>Populus trichocarpa x Populus maximowiczii</i>		
Parents	Mother	P.trichocarpa 'S.724-116'	
	Father	P. maximowiczii 'S.122-3' (Japan)	
		S.724 = V.235 (Fritzi Pauley) x V.24 (Columbia River) S.122 = P. maximowiczii, Hokkaido, Japan	
Creation	1970, by controlled crossing at INBO, Geraardsbergen, Belgium		
Plant Variety Protection Certificate	EU 44786 from 17/10/2016		
Gender	Female		
INBO Breeding N°	75.023/23		

Phenotype

CULTIVAR	TRUNK FORM & COLOR	FORM OF TREE CROWN	BRANCHINESS
Bakan	Light flexible trunk smooth, pale bark	<i>elongated, egg-shaped crown (wider than Dender & Marke)</i>	<i>fairly thin branches</i>
Skado	Light flexible trunk smooth, pale bark	<i>elongated, egg-shaped crown (wider than Dender & Marke)</i>	<i>fairly thin branches</i>
Dender	Straight to light flexible trunk smooth, pale bark	<i>elongated, egg-shaped crown</i>	<i>Fairly thin branches heavy branch at a height of 6 to 8 m</i>
Marke	Straight to light flexible trunk smooth, pale bark	<i>elongated, egg-shaped crown</i>	<i>Fairly thin branches heavy branch at a height of 6 to 8 m</i>

Important: Requires early monitoring and shape correction



Skado – tree form and branchiness



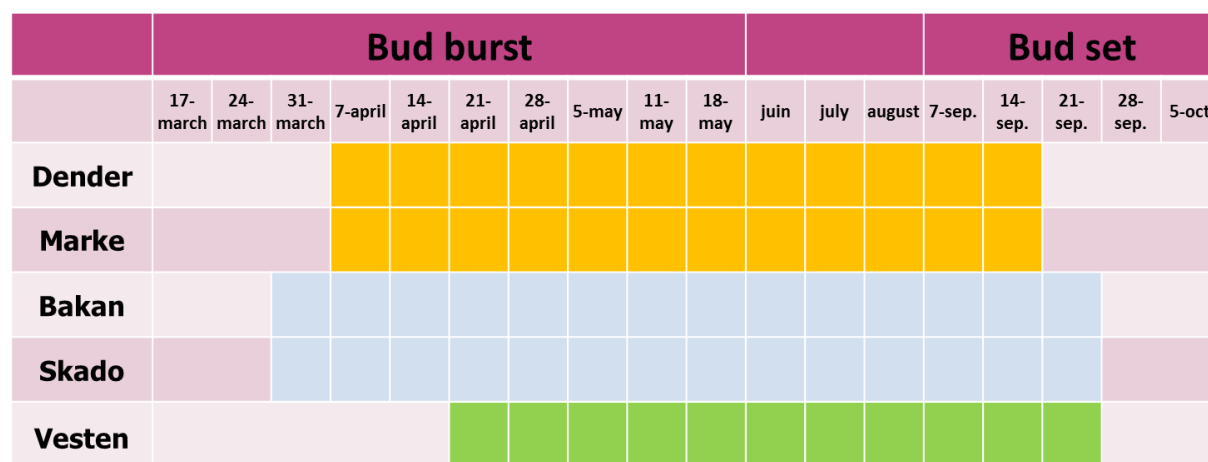
Skado – trunk form and color

Phenology

At the INBO nursery in Geraardsbergen (50° 48' N, 3° 57' E) , the cultivar 'Skado' reaches bud burst in the last week of May and the timing of bud set in autumn is the third week of September. (Fig. 1).

Bud burst is one week earlier than Dender and Marke and bud set is one week later.

Fig 1. Phenology of the cultivar Skado compared to the INBO cultivars Dender, Marke, Bakan and Vesten and observed in the INBO nursery at Geraardsbergen (2015)



Growth characteristics

Fig 2. Height and diameter of two-year-old trees of the cultivar Skado in the INBO nursery at Geraardsbergen, compared to the INBO cultivars Dender, Marke and Bakan.

Cultivar	# trees	Height(cm)	Category 1 (D25-30mm) (%)	Category 2 (D30-40mm) (%)	Category 3 (D40-50mm) (%)
Dender	27	424	0	37	63
Marke	21	406	0	29	71
Bakan	32	523	16	72	13
Skado	37	556	40	57	3

The trees of Skado are longer but on average less thick than those of the cultivars Dender and Marke.

Mean Annual Increment (MAI) - circonference

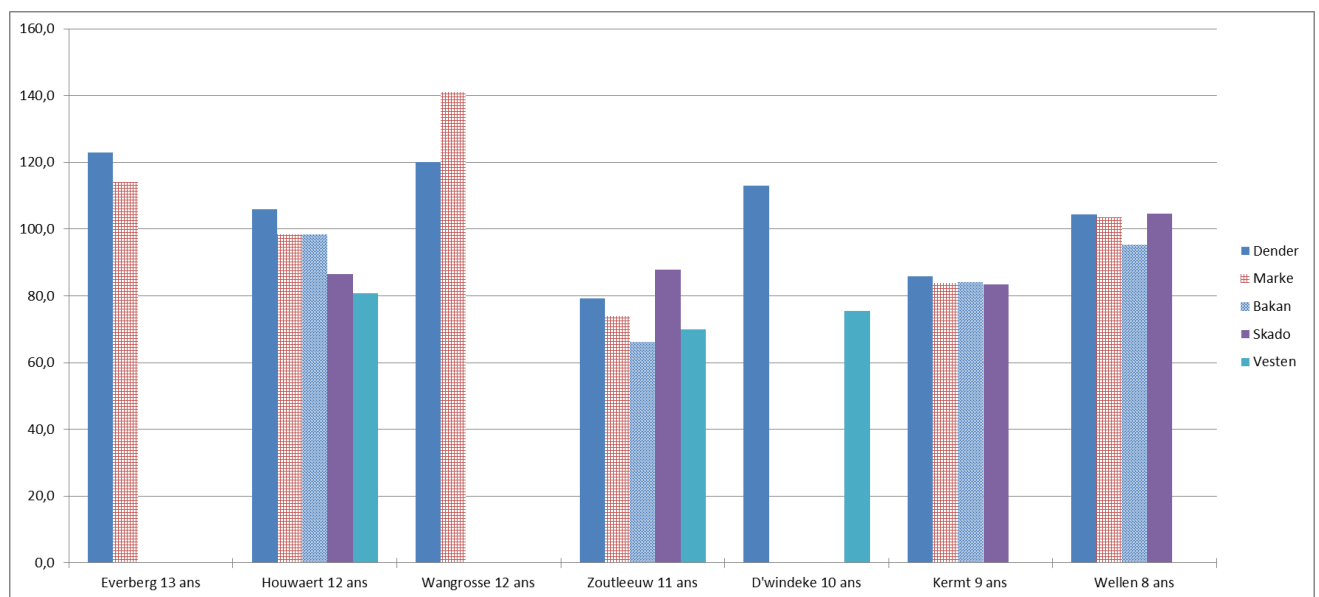
MAI has been measured in 7 field trials aging from 8 to 13 years and installed in the north of Belgium on different soil types – planting distance 8m x 8m



Fig 3. Soil properties of the 7 field sites mentioned below

Fieltrial name	Everberg	Houwaert	Wangrosse	Zoutleeuw	Denderwindeke	Kermt	Wellen
Soil profile	No profile	B-horizont	No profile	B-horizont/ No profile	No profile	No profile	
Soil texture	very strong gleying clay soil	moderate gleying sandy loam soil	strong gleying loam soil	Weak/modera te gleying loam soil	strong gleying loam soil	strong gleying loam soil	peat

Fig 4. Mean annual increment (circumference in cm)



Wood technology

Wood properties were obtained from the Laboratory for wood technology, University of Ghent, Belgium.

Physical properties	
Wood density (60%RV)	400
Heartwood proportion (%)	24
Tension wood proportion (%)	15
Mechanical properties	
Modulus of elasticity (N/mm ²)	9800
Modulus of rupture (N/mm ²)	60
Industrial processes	
veneer A/B-grade (%)	25
C1-grade (%)	75
The wood is suitable for	
Veneer **	Due to the low share of heartwood and tensionwood, this clone is very suitable for the production of veneer. Where also comes the high degree of whiteness, also with the C1 veneer. The larger proportion of C1 veneer is due to the presence of many small brushes that can easily be avoided by good pruning.
Saw wood	This clone has a very favorable strength-density ratio, which also makes it possible to produce quality saw wood. However, attention must be paid to the somewhat lower modulus of elasticity for possible construction purposes.

Disease resistance

The cultivar 'Skado' has been tested and selected for its good resistance/tolerance to the leaf rust *Melampsora larici-populina*, leaf spot disease caused by *Marssonina brunnea*, bacterial canker caused by *Xanthomonas populi* and woolly aphid, caused by *Phloemyzus passerinii*.

- Resistance to *Melampsora larici-populina* and *Marssonina brunnea* has been observed during several consecutive years at the INBO nursery in Geraardsbergen.
- Resistance to *Xanthomonas populi* has been tested by artificial infection on five 2-year-old trees
- Resistance to *Phloemyzus passerinii* has been tested by artificial infection at the CREA Centro di ricerca Foreste e Legno ,Casale Monferrato, Italy

Fig 5. Resistance of the cultivar Skado to the most important poplar diseases in Europe

Cultivar	Leaf rust (<i>Melampsora larici-populina</i>)	Leaf spot disease (<i>Marssonina brunnea</i>)	Bacterial canker (<i>Xanthomonas populi</i>)	Woolly aphid (<i>Phloemyzus passerinii</i> (Sign.))
Vesten	tolerant	tolerant	tolerant	tolerant
Bakan	tolerant	tolerant	tolerant	tolerant
Skado	tolerant	tolerant	tolerant	tolerant
Dender	Very tolerant	tolerant	tolerant	tolerant
Marke	Very tolerant	tolerant	tolerant	tolerant

Biomass production under short rotation coppice

Realized dry weight (ton/ ha/ y) for the cultivar Skado under short rotation coppice in two experimental sites

Experimental site 1

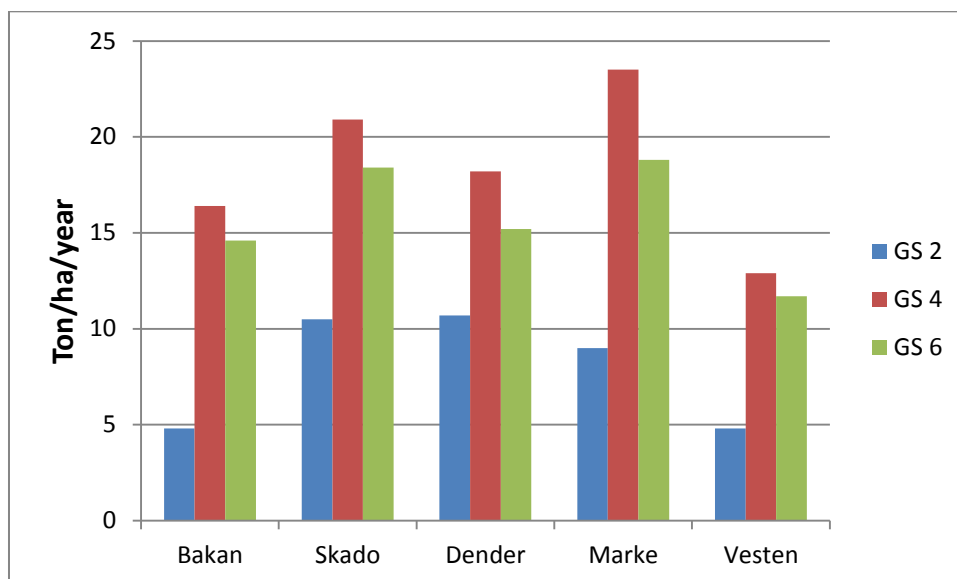
Location: Grimminge (Belgium, Lat. 50.7878759; Long. 3.938241)

Planting density: 10.000 cuttings/Ha.

Soil texture : *moderate gleying loam soil; soil profile: B-horizont*

The plantation has been harvest after 2, 4 and 6 years.

Fig.6 Realized dry weight after 2, 4 and 6 years. Skado is producing 20,9 ton/ha/y after the second harvest and 18,4 ton / ha/ y after the third harvest.



Ir. Linda Meiresonne, 2018 (INBO)

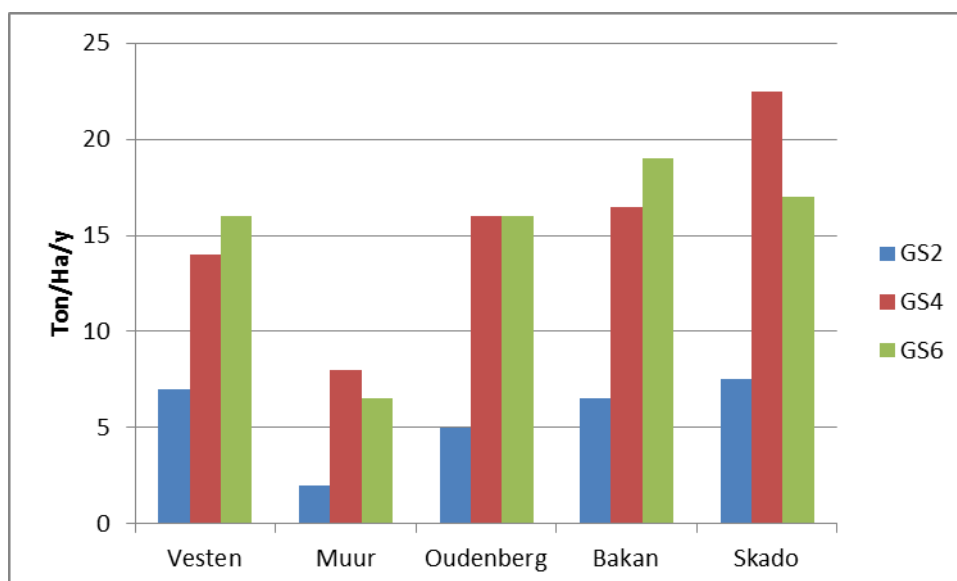
Experimental site 2

Location: Lochristi, Flanders (Belgium, Lat. 51.11194444; Long. 3.85055556)

Planting density : 8.000 cuttings/Ha.

The plantation has been harvest after 2, 4 and 6 years.

Fig 6. Realized dry weight for each second growing season (GS2, GS4 and GS7) of each 2-year-rotation. Skado is producing 22,5 Ton/ha/year after the second harvest and 16,5 Ton /ha /y after the third harvest.



Poplar Cultivar 'VESTEN'

Passport

Interspecific hybrid	<i>Populus.deltoides</i> x <i>Populus nigra</i>
Parents	<i>Populus deltoides</i> = <i>Populus deltoides</i> V.5 (Iowa) x <i>Populus deltoides</i> V.12 (Illinois) <i>Populus nigra</i> = <i>Populus nigra</i> S.157-4 = <i>Populus nigra</i> Casale 4 (Italy) x <i>Populus nigra</i> 'Italica'
Creation	1978, by controlled crossing at INBO (Research Institute for Nature and Forest), Geraardsbergen, Belgium
Plant Variety Protection Certificate	EU 9265 – From 15/04/2002
Gender	Female
Cultivar number	78.018/204

Phenotype

Straightness of the stem	straight
Tree form	fastigiate
Forking	rarely
# branches	medium
Thickness of the branches	small

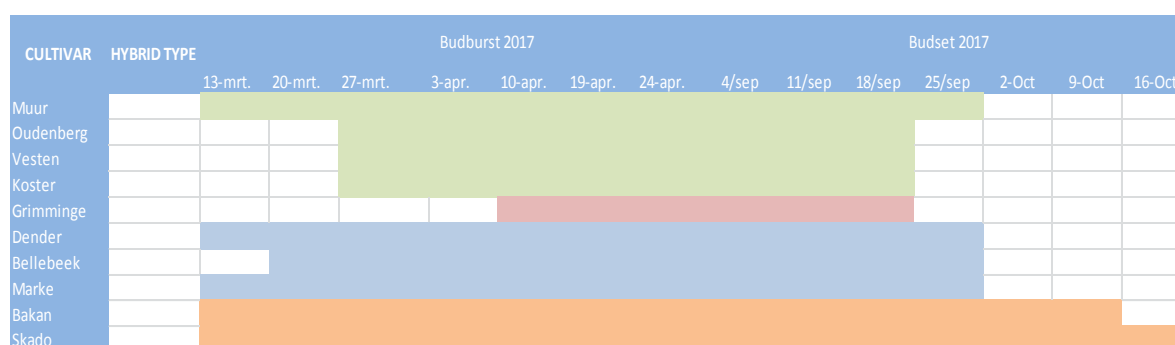


Cultivar Vesten, 15 y

Phenology

At the INBO nursery in Geraardsbergen (50° 48' N, 3° 57' E) in 2017, the cultivar 'Vesten' starts to flush in the last week of April and the timing of bud set in autumn is the third week of September (Fig 1). Timing of bud burst and bud set is the same as for the cultivars Koster and Oudenberg.

Fig 1. Phenology of the cultivar Vesten compared to other INBO cultivars and Koster observed in the INBO nursery at Geraardsbergen (Belgium, 2017)



Growth characteristics

Fig 2. Height and DBH (diameter at breast height) of **two-year-old trees** of the cultivar Vesten in the INBO nursery at Geraardsbergen (2015) compared to the *P. euramericana* cultivars Muur and Oudenberg

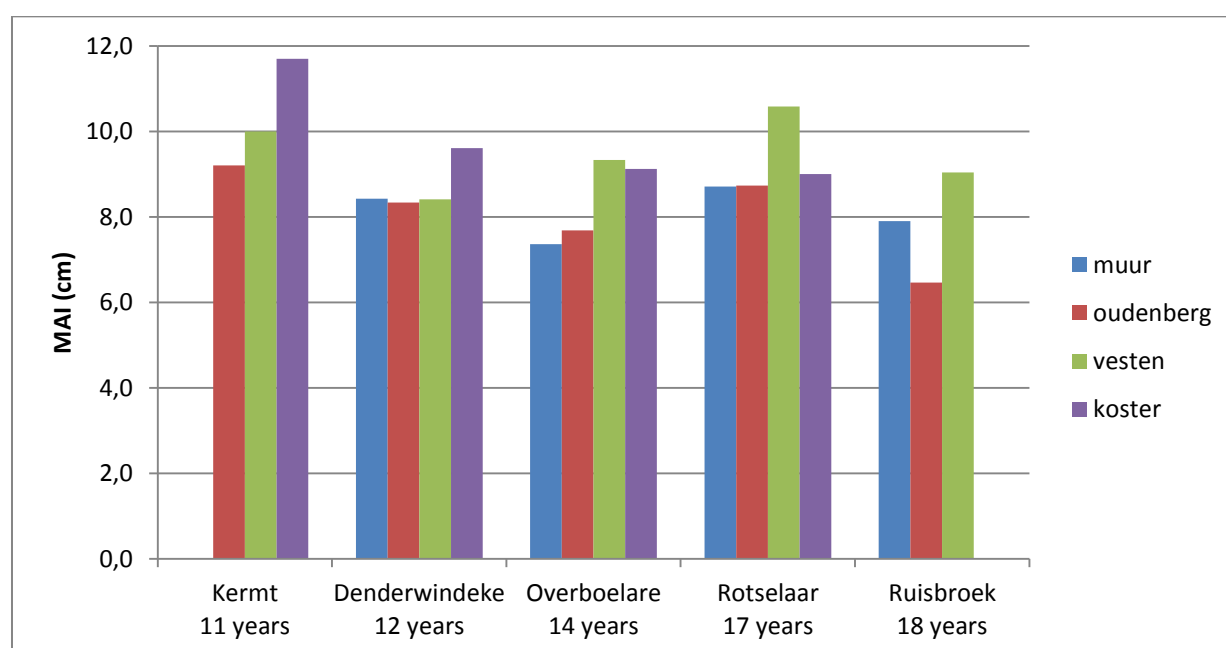
Cultivar	#trees	Height (cm)	% trees cat1 (Ø <25 mm)	% trees cat2 (Ø 25-30 mm)	% trees cat3 (Ø 30-40 mm)	% trees cat4 (Ø 40-50 mm)
Muur	50	381	44	48	8	0
Vesten	63	466	0	11	80	9
Oudenberg	62	423	0	16	80	4

The *Mean Annual Increment* (MAI) – circumference- has been measured in five field trials installed in the north of Belgium on different soil types (Fig 3) and ranges between 8,2 cm and 10,5 cm. The clone Vesten belongs to the fastest growing *P. euramericana* cultivars in Europe.

Fig 3. Soil properties of the 5 field sites mentioned below

Test field	Overboelare	Ruisbroek	Rotselaar	Kermt	Denderwindeke
Soil texture	no profile	no profile	no profile	no profile	no profile
Soil profile	weak gleying sandy loam soil	very strong gleying sandy loam soil	very strong gleying clay soil	strong gleying loam soil	strong gleying loam soil

Fig 4. MAI (Mean annual increment - circumference in cm) of the cultivar Vesten in 5 field trials aging from 11 to 18 years and compared to the INBO cultivars Muur and Oudenberg and cultivar Koster (planting distance - 8m x 8m)



Wood properties were obtained from the Laboratory for wood technology, University of Ghent, Belgium.

Physical properties	
Wood density (60%RV)	451 kg/m ³
Heartwood proportion (%)	42
Tension wood proportion (%)	22
Mechanical properties	
Modulus of elasticity (N/mm ²)	9935
Modulus of rupture (N/mm ²)	72
Industrial processes	
veneer A/B-grade (%)	82
C1-grade (%)	18
The wood is suitable for	
Veneer	excellent (even for CE multiplex)
Saw wood	very good/excellent

Disease resistance

The cultivar 'Vesten' has been tested and selected for its good resistance/tolerance to the leaf rust *Melampsora larici-populina*, leaf spot disease caused by *Marssonina brunnea* and bacterial canker caused by *Xanthomonas populi*. According to laboratory tests carried out at the laboratory* , the clone Vesten is field resistant to the woolly aphid, caused by *Phloemyzus passerinii*.

- Resistance to *Melampsora larici-populina* and *Marssonina brunnea* has been observed during several consecutive years at the INBO nursery in Geraardsbergen.
- Resistance to *Xanthomonas populi* has been tested by artificial infection on five 2-year-old trees

Fig 5. Resistance of the cultivar Vesten to the most important poplar diseases in Europe

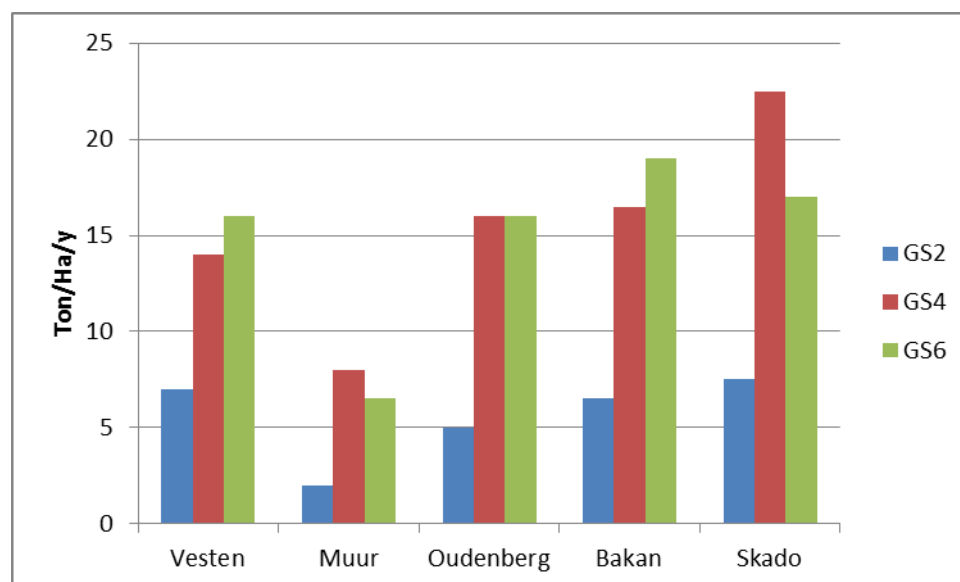
Cultivar	Leaf rust (<i>Melampsora larici-populina</i>)	Leaf spot disease (<i>Marssonina brunnea</i>)	Bacterial canker (<i>Xanthomonas populi</i>)	Woolly aphid (<i>Phloemyzus passerinii</i> (Sign.))
Vesten	tolerant	tolerant	tolerant	tolerant
Bakan	tolerant	tolerant	tolerant	tolerant
Skado	tolerant	tolerant	tolerant	tolerant
Dender	Very tolerant	tolerant	tolerant	tolerant
Marke	Very tolerant	tolerant	tolerant	tolerant

Biomass production under short rotation coppice

Realized dry weight (Ton /ha /y) for the cultivar Vesten under short rotation coppice has been measured in an experimental site located in Lochristi, Flanders (Belgium, 51°06'44" N, 3°51'02" E) , planting density of 8.000 cuttings/Ha.

The plantation has been harvest after 2, 4 and 6 years. Fig 6. shows realized dry weight for each second growing season (GS2, GS4 and GS6) of each 2-year-rotation. Vesten is producing 16 Ton /ha /y after the third harvest.

Fig 6. Realized dry weight under short rotation coppice of the INBO poplar cultivar Vesten compared to the INBO cultivars Muur, Oudenberg, Bakan and Skado



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Cultivar “Vesten”, 19 years old, Lommel (Belgium)