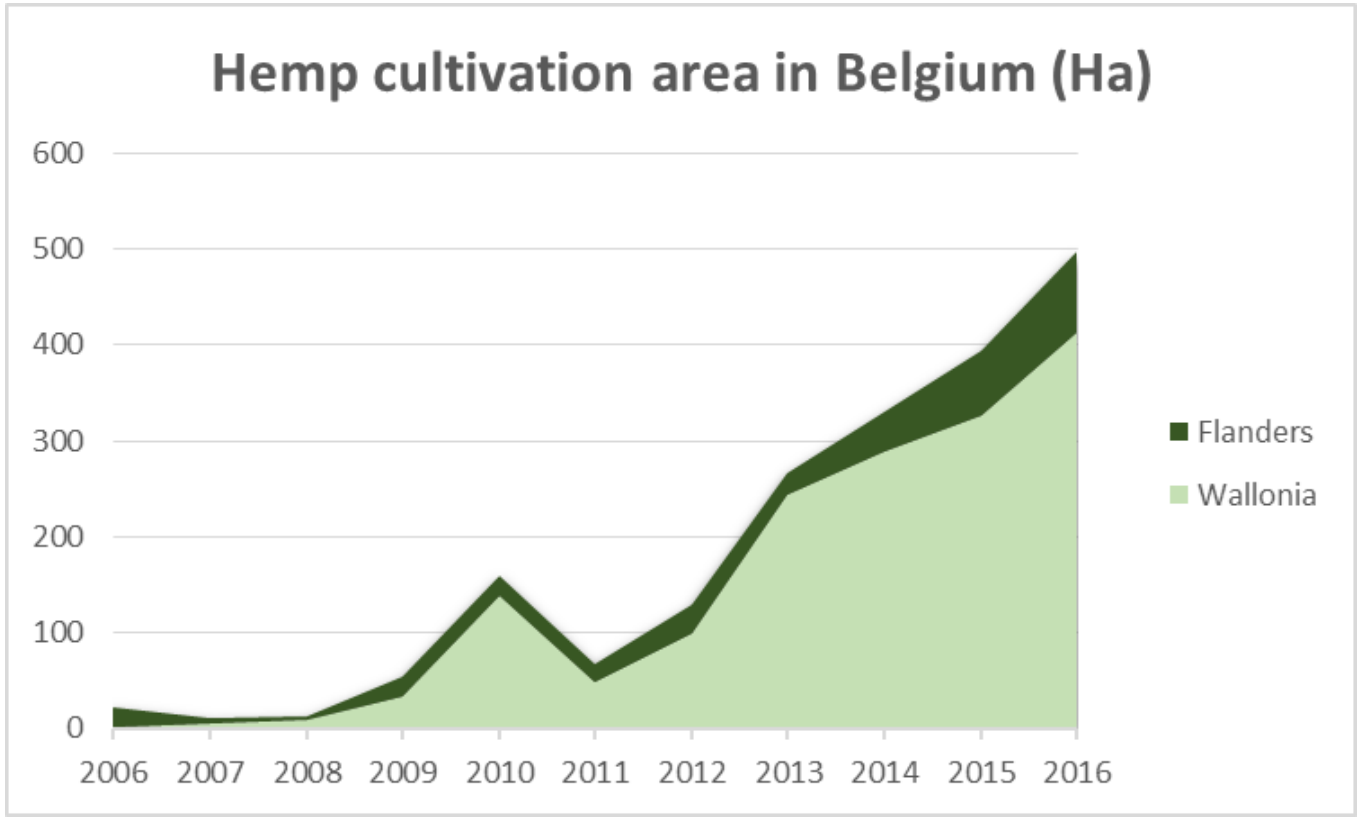
Own grown hemp

Optimization of hemp fibre quality for textile applications through an integrated chain approach

Veronique Troch and Myréne Vanderhoeven

Hemp in Belgium



- Farmers are interested in extending the cultivated area
- Spinning, weaving and clothing companies are keen to use locally grown hemp

“Own grown hemp” project (2017-2019)

To support revival of the hemp industry in Flanders, especially for high quality textile applications

- Collaboration between two departments:
  Biosciences and Food Sciences Department
  Fashion, Textile and Wood Technology Department

- Research project funded by University College Ghent
- Supported by industrial partners

Problem statement and Methodology

How can the quality of hemp fibre be controlled at several levels of the value chain?

Field trials
- Varieties from different origin
- Sowing time and density
- Structural analysis at plant level

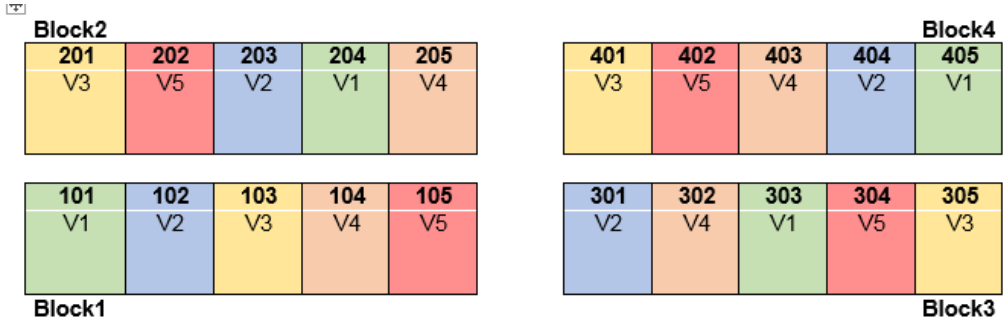
Retting methods
- Dew retting
- Enzymatic dew retting
- Enzymatic retting lab scale

Extraction and spinning
- Extraction of long fibres
- Spinning of short/long fibres
- Yarns quality analysis

Integration: quality monitoring and chain analysis

Field trial 2017

- University College Ghent experimental farm located in Bottelare (Flanders, Belgium)
- Five hemp cultivars from different origin and maturity
- Randomized complete block design with 4 replicates
- Single plot size 45 m^2
- Plant density estimated at 240 plants m^{-2}
- N fertilization 108 kg N ha^{-1} (37,5 ton ha^{-1} cattle slurry)
- Sowing at 5/05/2017
- Harvest at 50% flowering



►**Crop development**: emergence, flowering, plant height, plant density, stem diameter

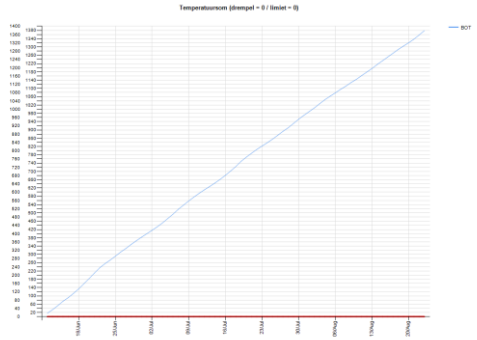
►**Harvest**: DM yield, bast content

Field trial 2017

Code	Cultivar	Origin	Sexual type	Maturity
V1	USO 31	Ukraine	monoecious	very early
V2	Dacia Secuieni	Romania	monoecious	late
V3	Bialobrzeskie	Poland	monoecious	medium
V4	Futura 75	France	monoecious	very late
V5	Carmagnola Selezionata (CS)	Italy	dioecious	late

Crop development

Emergence and flowering



Cultivar	Sowing to emergence (days)	Emergence to flowering (days)	T sum (°Cd)
USO 31	8	53	1020
Dacia Secuieni	8	89	1700
Bialobrzeskie	7	82	1560
Futura 75	7	90	1700
Carmagnola Selezionata (CS)	8	103	1940

Crop development

Plant density

Cultivar	Plant density at 30 DAE (Plants m^{-2})	Plant density at harvest (Plants m^{-2})
USO 31	122,22 b	133,33 a
Dacia Secuieni	153,33 b	161,11 a
Bialobrzeskie	214,44 a	192,22 a
Futura 75	207,78 a	156,67 a
Carmagnola Selezionata (CS)	223,33 a	187,78 a

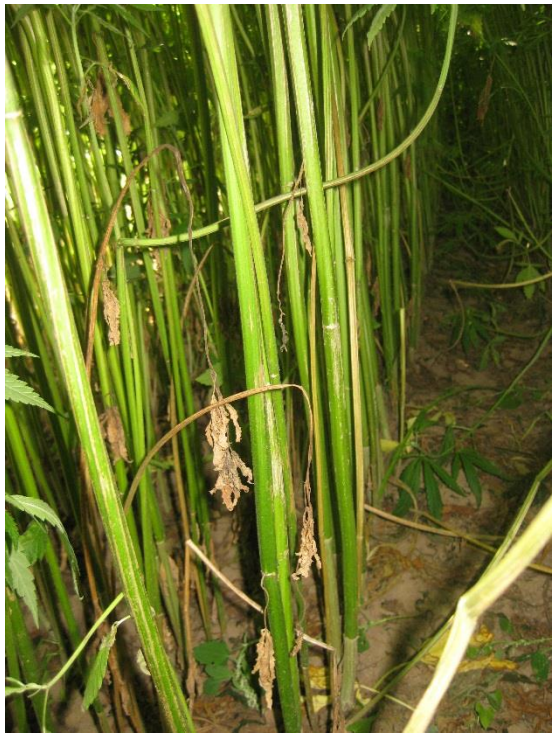
Crop development

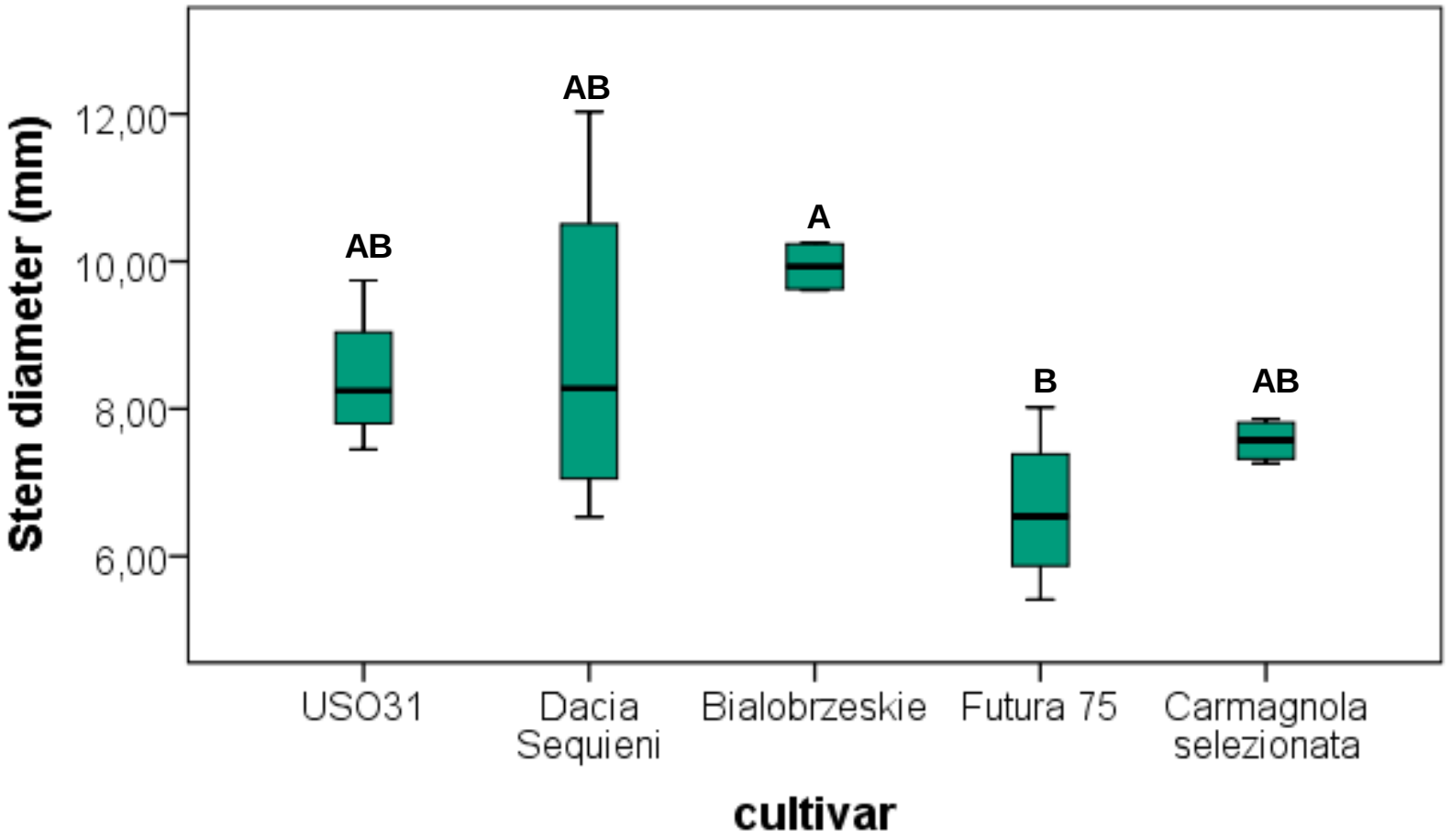
Plant height

Cultivar	Harvest date	plant height (cm)			
		at 30 DAE	at 60 DAE	at 90 DAE	at harvest
USO 31	4/07/2017	80,7	-	-	154,5 c
Dacia Secuieni	9/08/2017	79,2	154,7	-	238,9 b
Bialobrzeskie	1/08/2017	83,0	148,7	-	236,9 b
Futura 75	9/08/2017	84,6	151,7	-	240,8 b
Carmagnola Selezionata (CS)	23/08/2017	78,8	135,8	233,4	278,9 a

Crop development

Stem diameter



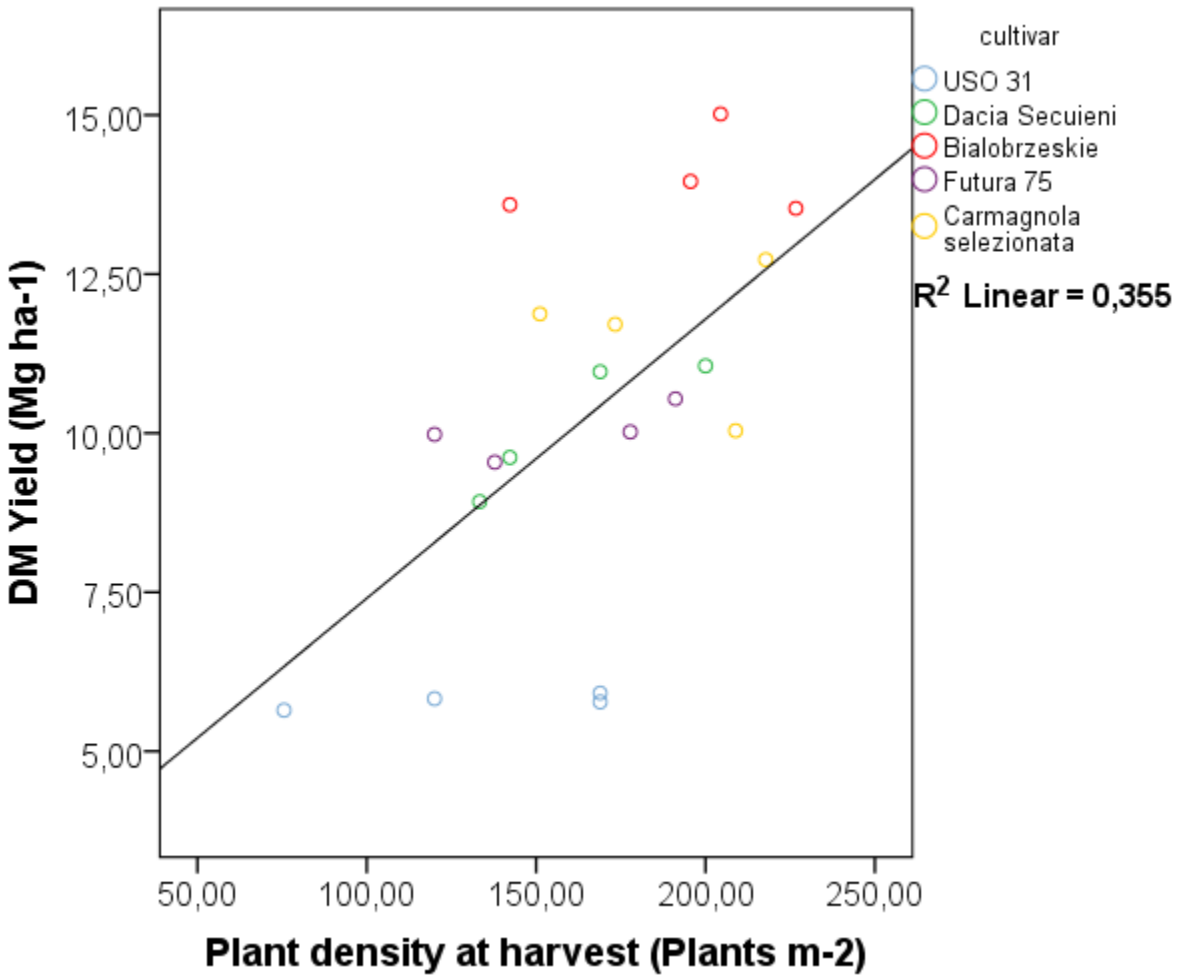


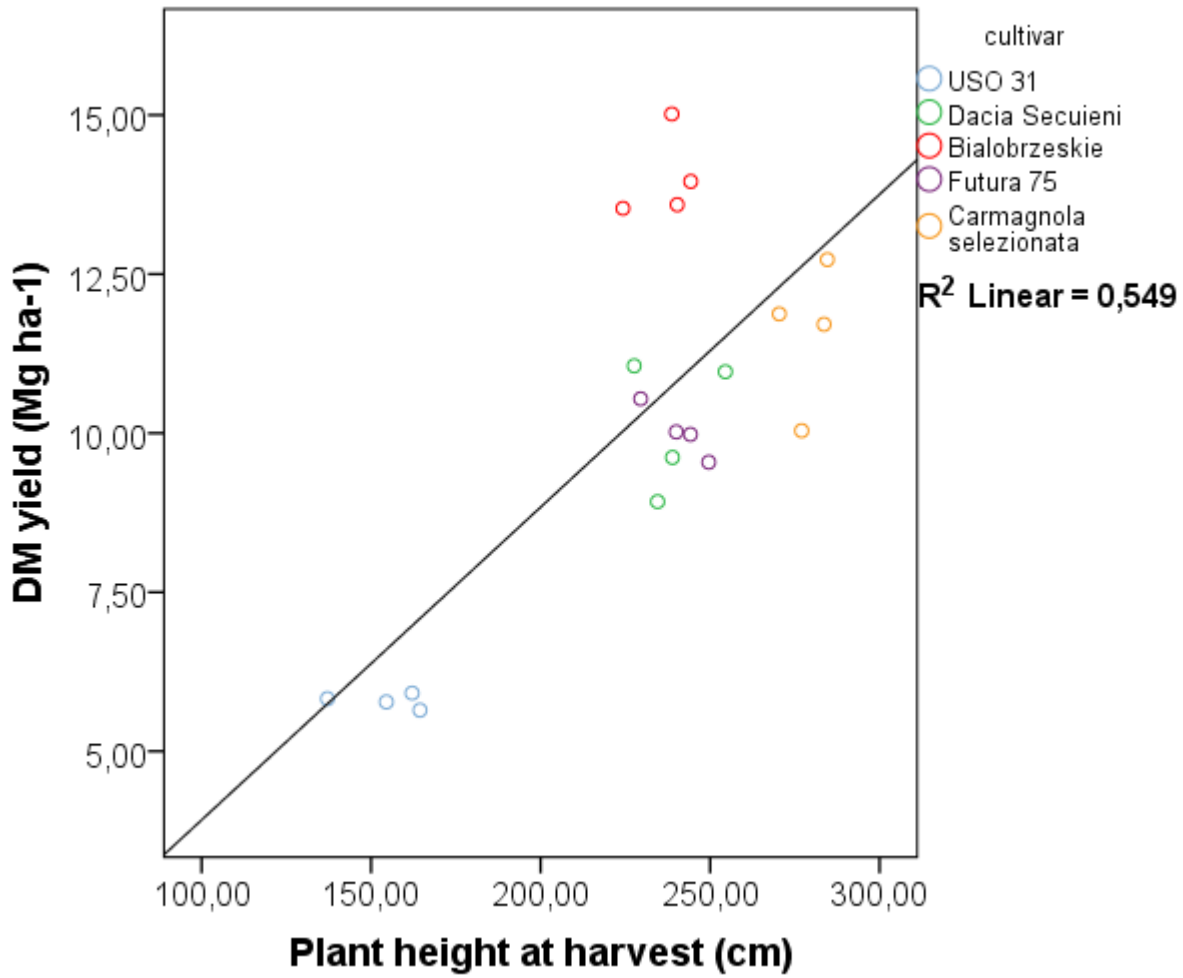
Harvest

DM yield (Mg ha^{-1}), bast content (%) and bast yield (Mg ha^{-1})

Cultivar	DM yield (Mg ha^{-1})	Bast content (%)	Bast yield (Mg ha^{-1})
USO 31	5,79 c	38 %	2,20 c
Dacia Secuieni	10,14 b	33%	3,31 b
Bialobrzeskie	14,02 a	34 %	4,77 a
Futura 75	10,02 b	29 %	2,88 b
Carmagnola Selezionata (CS)	11,59 b	25 %	2,90 b

Correlations





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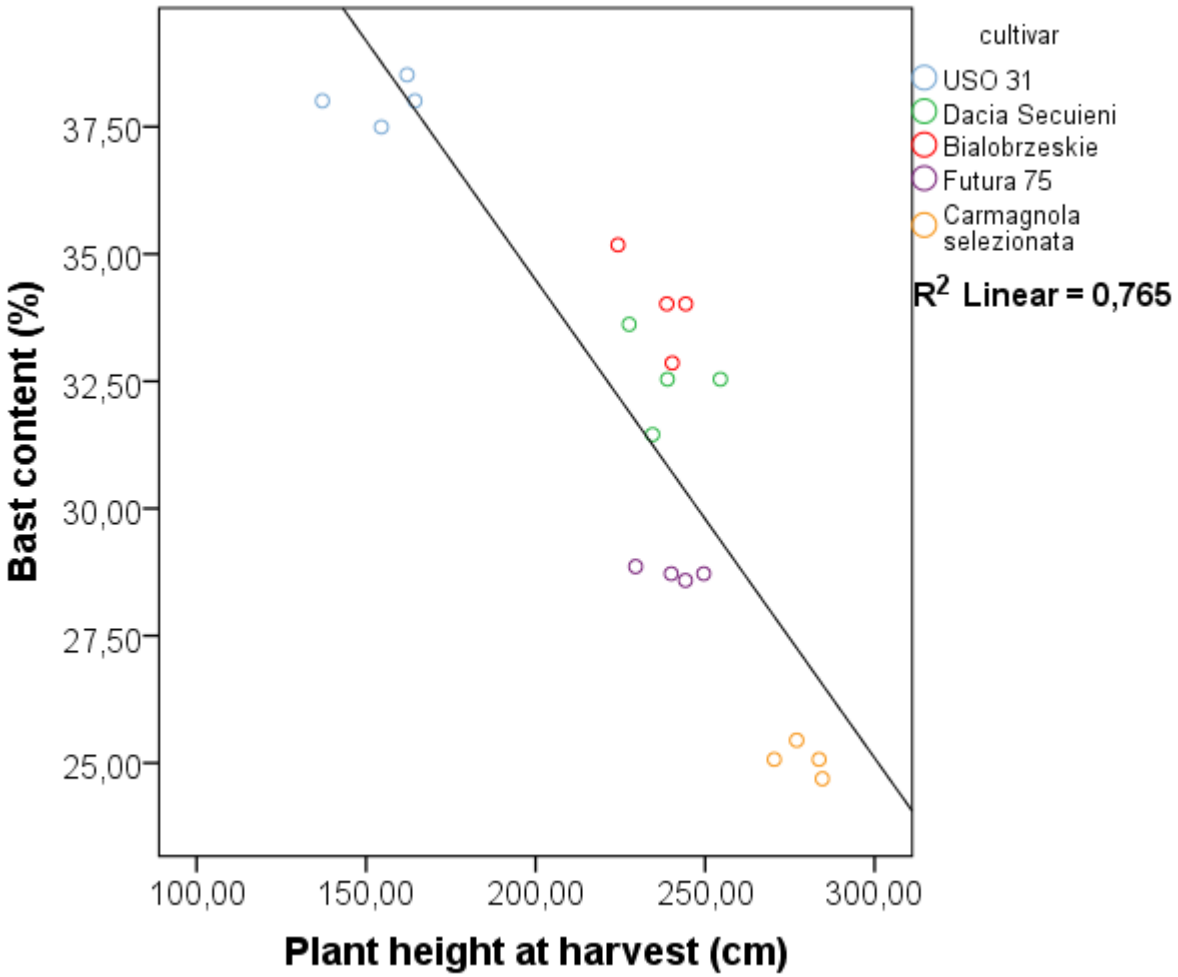
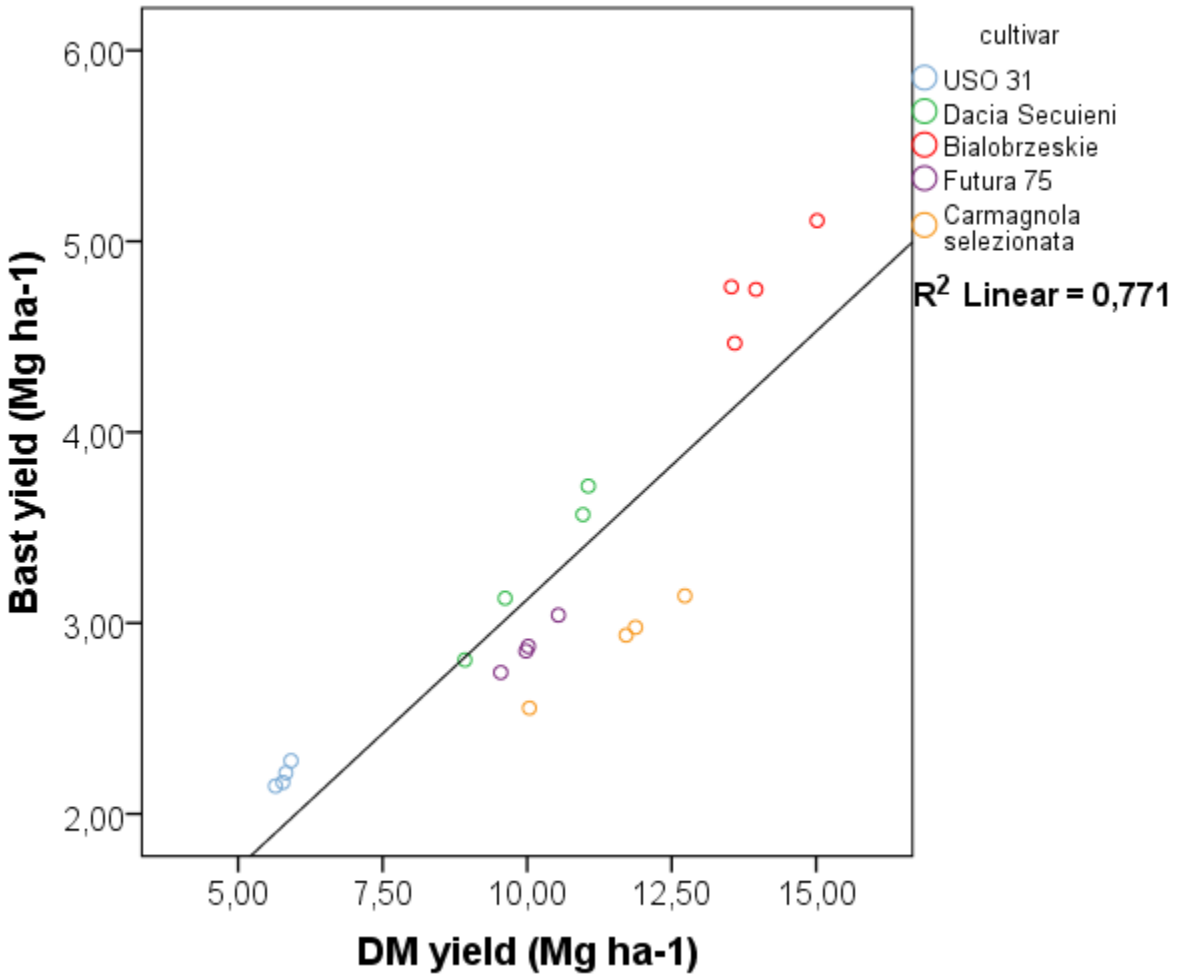




Conclusion field trial

- Emergence 7-8 days after sowing

- Difference in duration of vegetative phase between cultivars (53-103 days)
  → difference in plant height at harvest between cultivars

- Difference between cultivars for plant density
  → Self-thinning for cultivars with higher density at 30 DAE

- High variation in stem diameter within plots
  → higher sowing densities might be necessary?

- Higher plant density and higher plant height results in higher DM yield
- Higher bast content at lower plant height
- Higher DM yield results in higher bast yield

Retting proces in function of optimal fibre extraction

Field retting

Enzymatic field retting

Enzymatic retting on lab-scale reactors

►% long fibre, % short fibre, structural analysis, fibre quality

Tested enzymes

Supplier	Enzyme	Type	Temp range	pH range	Suggested dosage
Novozymes	Bioprep 3000 L	Pure Pectate lyase	20 – 65°C	6 - 10	0.03-0.2%
	Scourzyme L	Pure Pectate lyase (diluted)	20 – 65°C	6 - 10	0.25-1.5%
	Pulpzyme HC 2500	Pure endo-xylanase	30-70°C	4-11	0.05-0.15%
	NS 59049	Pure Pectinlyase	20 – 65°C	3.5 - 5.5	0.1-0.3%
	Viscozyme L	Glucanase	20 - 55°C	4.0 - 6.0	0.1-0.3%
Dupont	PrimaGreen EcoSour	Pectate lyase	30-70°C	6.5 - 7.5	0.03-0.2%
InoTEX	TEXAZYM SER-7conc.	Mix	45– 60°C	7 – 9	
CHT	Beisol pro	Mix	55°C	8 - 9	1.0 - 4.0 %
	DENIMCOL LAC-LRE	Laccase	60-70°C	4 - 6	0.5-2.0 %

Enzymatic retting

Series 1

Experiment	Enzyme(s)	proces-temp.	pH	Straw
1	0.2% Bioprep L 3000 0.15% Pulpzyme HC 2500	60°C	pH 8	Hempflax NL Belchanvre
2	0.3% NS 59049 0.15% Pulpzyme HC 2500	60°C	pH 5	Hempflax NL Belchanvre
3	0.3% Viscozyme L	50°C	pH 5	Hempflax NL Belchanvre
4	0.2% Bioprep L 3000	55°C	pH 7	Hempflax NL Belchanvre Finola
5	0.3% NS 59049	55°C	pH 4,5	Hempflax NL Belchanvre
6	1,5% Scourzyme L	55°C	pH 7	Finola Belchanvre
7	0.15% Pulpzyme HC 2500	70°C	pH 8	Finola Belchanvre
8	0.2% PrimaGreen EcoSour	50°C	pH 7	Finola Belchanvre

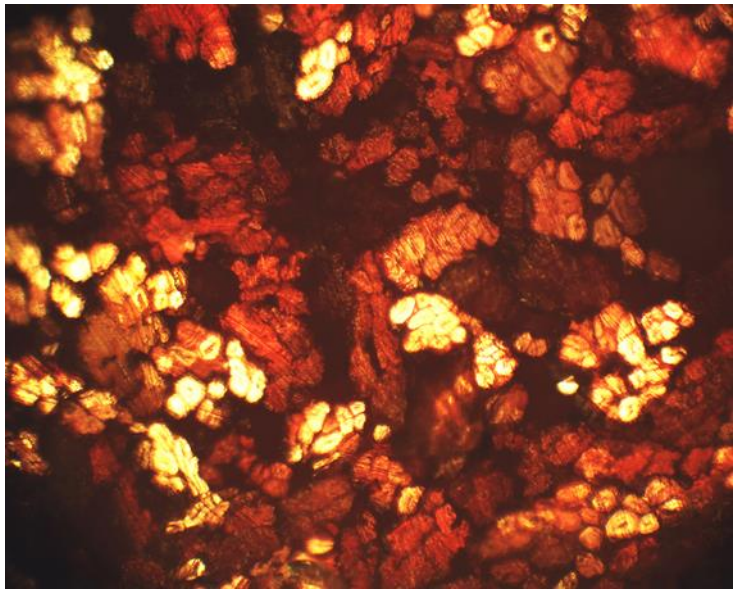
Enzymatic retting

Series 2

Experiment	Enzyme(s)	proces-temp.	pH	Straw
1	0.3% NS 59049 0.15% Pulpzyme HC 2500 0.5% Denimcol LAC LRE	60 °C	pH 5	Finola
2	0.2% Bioprep 3000 L 0.15% Pulpzyme HC 2500 0.5% Denimcol LAC LRE	60 °C	pH 6	Finola
3	2% Beisol PRO	60 °C	pH 8.5	Finola
4	0.2% Texazym SER 7	60 °C	pH 8	Finola

Enzyme selection

- Based on results of:
  - Visual assesment of fibres
  - Ruthenium red test
  - Phloroglucinol colouring test



- Enzymatic retting ⟷ chemical retting

Enzyme selection

- Bioprep L 3000 (Novozymes)
- Primagreen Ecoscour (Dupont)
- Beisol Pro (CHT)

Testing on own grown hemp

- Test on pilot installation (+/- 1kg)
- Green stems

- After **4** hours enzyme treatment: **no satisfying result**

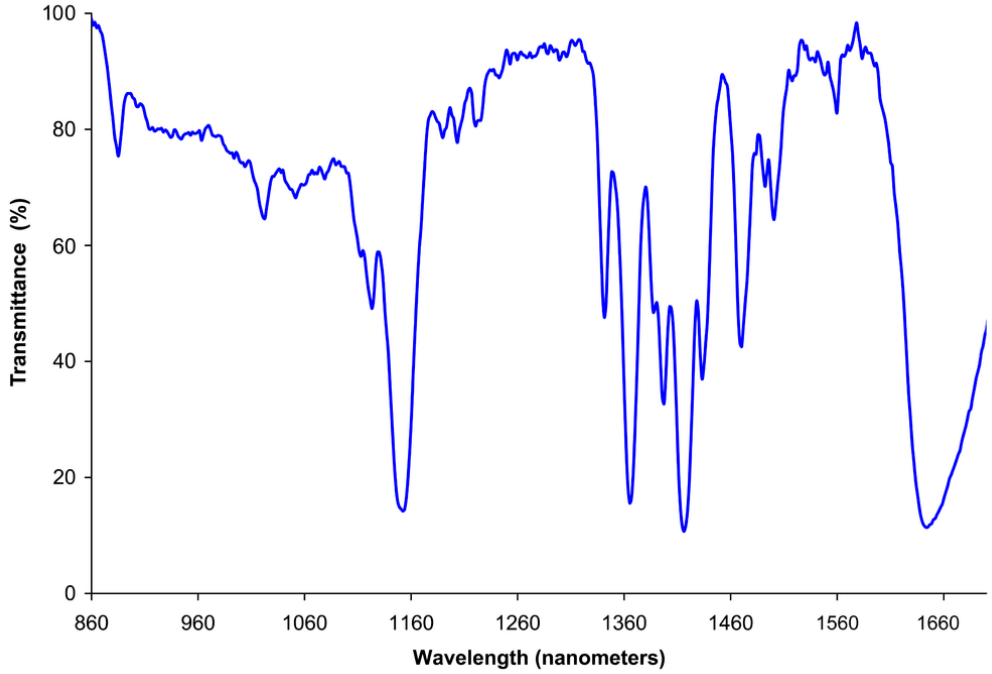
- No longer profitable ➡ test were stopped

Further research

- New tests after green decortication
  - Unretted dried stems are broken using old flax processing equipment
  - Bast fibres are treated with the enzymes

Further research

- After enzyme treatment:
  - Testing on fibre quality:
    - Fibre length
    - Fibre fineness
    - Fibre strength
    - Fibre elasticity
  - Testing on fibre composition
    - NIR spectroscopy



Further research

- Microwave treatment of hemp

Project team

Biosciences and Food Sciences Department

Veronique Troch
Joos Latré
Jos Nollet
Wouter Van der Borght

Veronique.troch@hogent.be

Fashion, Textile and Wood Technology Department

Myréne Vanderhoeven
Sofie Vermeire
Alexandra De Raeve
Simona Vasile
Dries Vansteenkiste

Myrene.vanderhoeven@hogent.be