



UNIVERSITY OF BOLOGNA

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**Department of Agroenvironmental
Science and technologies**



G.Ri.C.I.
Research Group on Industrial Crops

BioKenaf Project

Contract No: QLK5-CT2002-01729

Third technical meeting

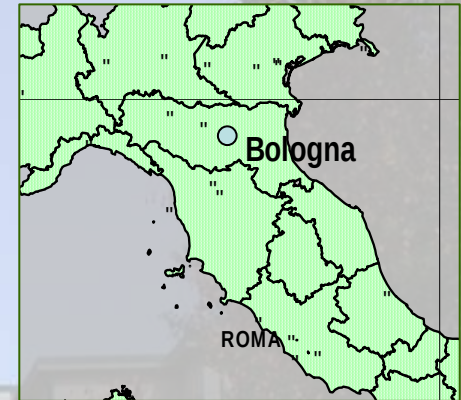
May 13, 2004

Rome

First year results (WP2 - Task 2.2 2.3)



• **Field trials were carried out in the period May - December 2003 at the Experimental Farm of Bologna University, Cadriano (Northern Italy).**



coordinates:

44° 33' N, 11° 21' E

altitude: 32 m a.s.l.

soil slope: 0%

farm soil typology:

Udic Ustochreps fine silty, mixed mesic

sand = 19%

silt = 53%

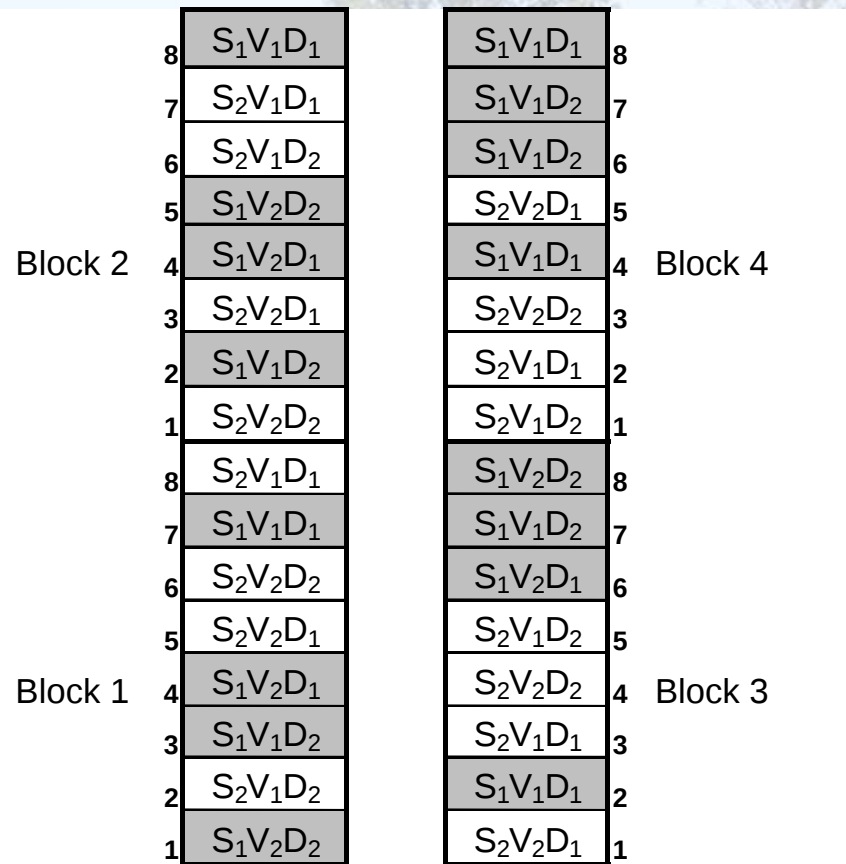
clay = 28%

pH = 7.14

organic matter = 1.9%

Experimental layout Task 2.2

Sowing time and Plant populations

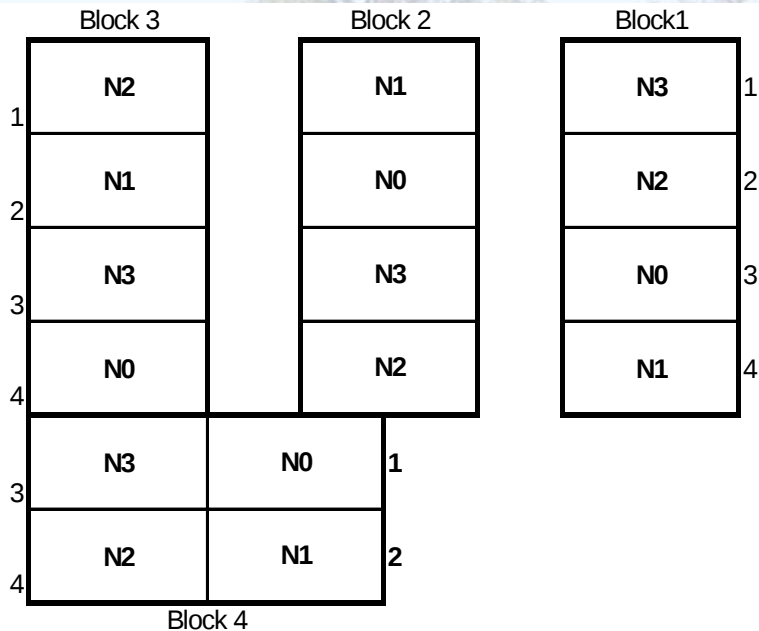


results of soil analyses

Task 2.2		units	method
pH (in H ₂ O)	= 7,47		M.III. 1 DM 13-9-99
CaCO ₃ TOT	= 1	%	(Dietrich-Fruehling)
CaCO ₃ ACT	= 1	%	(Drouineau)
Organic Carbon	= 10,1	g kg ⁻¹	(Walkley & Black)
Organic Matter	= 1,8	%	
total N	= 1,15	‰	(Dumas)
C.E.C.	= 19	meq/100 g	(M. 27 DM 11-05-92)
P ass.	= 78	g kg ⁻¹ P ₂ O ₅	(Olsen)
K exc.	= 245	g kg ⁻¹ K ₂ O	(M. 13,5 DM 13-9-99)
Ca exc.	= 4242	g kg ⁻¹ CaO	(M. 13,5 DM 13-9-99)
Mg exc.	= 560	g kg ⁻¹ MgO	(M. 13,5 DM 13-9-99)
Na exc.	= 75	g kg ⁻¹	(M. 13,5 DM 13-9-99)

Experimental layout Task 2.3

Nitrogen fertilisation rates



Complete randomized blocks

genotype: Dowling

density: 20 plant/m²

N0: no fertilization

N1: 50 kg N/ha

N2: 100 kg N/ha

N3: 150 kg N/ha



results of soil analyses

	Task 2.3	units	method
pH (in H ₂ O)	= 7,96		M.III. 1 DM 13-9-99
CaCO ₃ TOT	= 3,4	%	(Dietrich-Fruehling)
CaCO ₃ ACT	= 2,4	%	(Drouineau)
Organic Carbon	= 10	g kg ⁻¹	(Walkley & Black)
Organic Matter	= 1,7	%	
total N	= 1,13	‰	(Dumas)
C.E.C.	= 20	meq/100 g	(M. 27 DM 11-05-92)
P ass.	= 52	g kg ⁻¹ P ₂ O ₅	(Olsen)
K exc.	= 228	g kg ⁻¹ K ₂ O	(M. 13,5 DM 13-9-99)
Ca exc.	= 4608	g kg ⁻¹ CaO	(M. 13,5 DM 13-9-99)
Mg exc.	= 605	g kg ⁻¹ MgO	(M. 13,5 DM 13-9-99)
Na exc.	= 81	g kg ⁻¹	(M. 13,5 DM 13-9-99)

Sowing, Emergence and Thinning out operations

19/05/2003 Sowing of Task 2.2_S1

24/05/2003 Emergence of Task 2.2_S1

5/06/2003 Thinning out of Task 2.2_S1

S1: firstsowingtime

19/06/2003 Sowing of Task 2.2_S2

S2: secondsowingtime

27/06/2003 Emergence of Task 2.2_S2

4/07/2003 Thinning out of Task 2.2_S2

Task 2.2

May

30

10

June

20

30

10

July

20

30

26/05/2003 Sowing of Task 2.3

29/05/2003 Emergence of Task 2.3

20/06/2003 Thinning out of Task 2.3

Task 2.3



Data collecting

Survey on five fixed plants

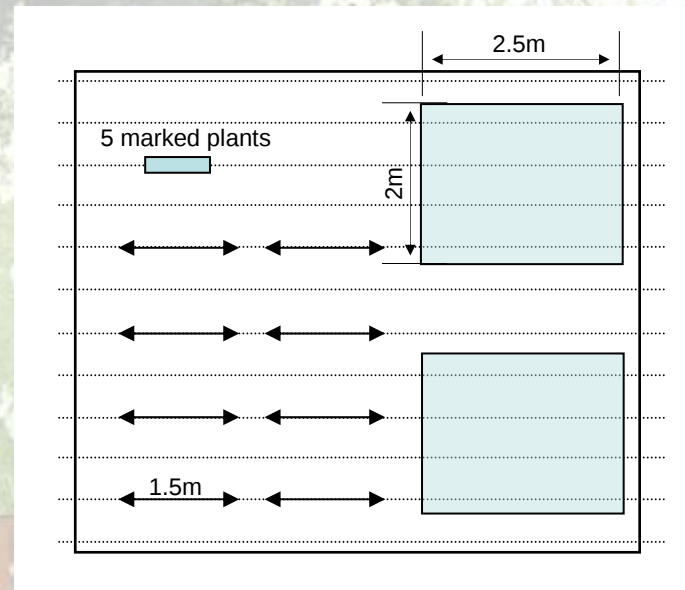
- height and base stem diameter

Repeated harvests (rows of 1,5 m)

- Fresh weight of harvested row
- Number of plants
- Height (cm) and Base Stem Diameter (mm)
- Fresh/dry weight of stems, leaves and petioles
- Number of leaves and leaf area (cm²)

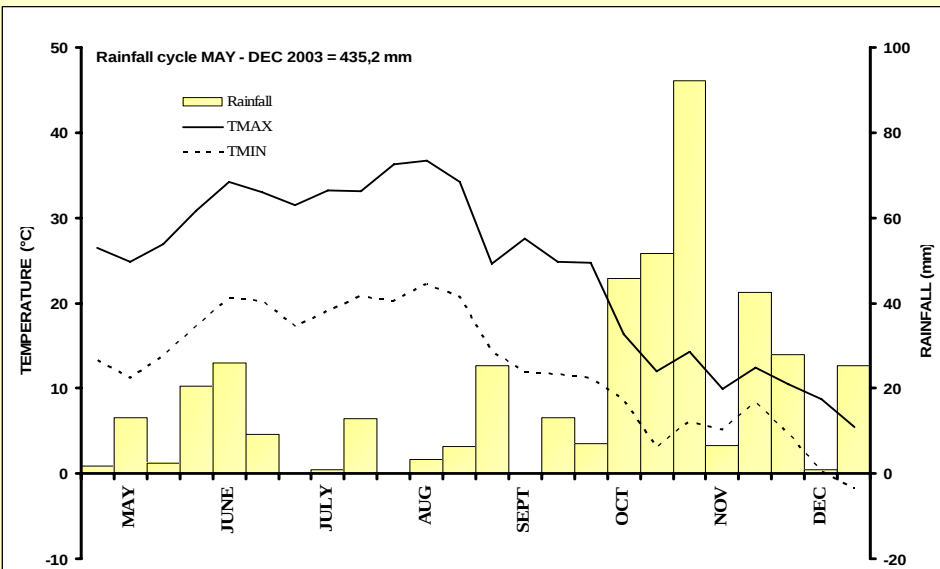
Final harvests (Harvest A and B)

- Biometric parameters
- Number of ramifications
- Number of nodes
- Decortication (fresh/dry weight of bark and core)
- N% in soil and stems



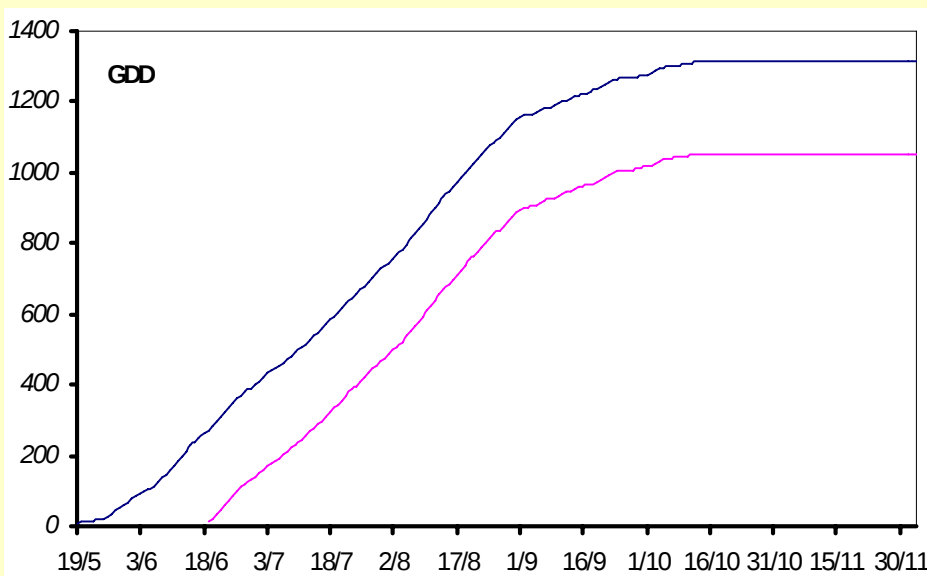
<i>harvest date</i>	26/6	10/7	25/7	31/7	7/8	21/8	28/8	12/9	18/9	3/10	10/10	5/11	5/11	4/12	4/12
S1	I	II		III		IV		V		VI		VII		VIII	
S2			I		II		III		IV		V		VI		VII
DOY	177	191	206	212	219	233	240	255	261	276	283	309	309	338	338
DAE	34	48	29	69	42	90	63	112	84	133	106	167	132	197	161
GDD	360	493	407	736	567	1026	850	1235	969	1288	1005	1288	1005	1288	1005

Climatic conditions



- precipitation was almost absent during the summer
- rainfalls from the first sowing (19th May 2003) to the final harvest (4th December 2003) were 380 mm
(last ten years: 634 mm)
- from the first sowing date to before the plant death (25th October) precipitation was 190 mm
(last ten years: 503 mm)

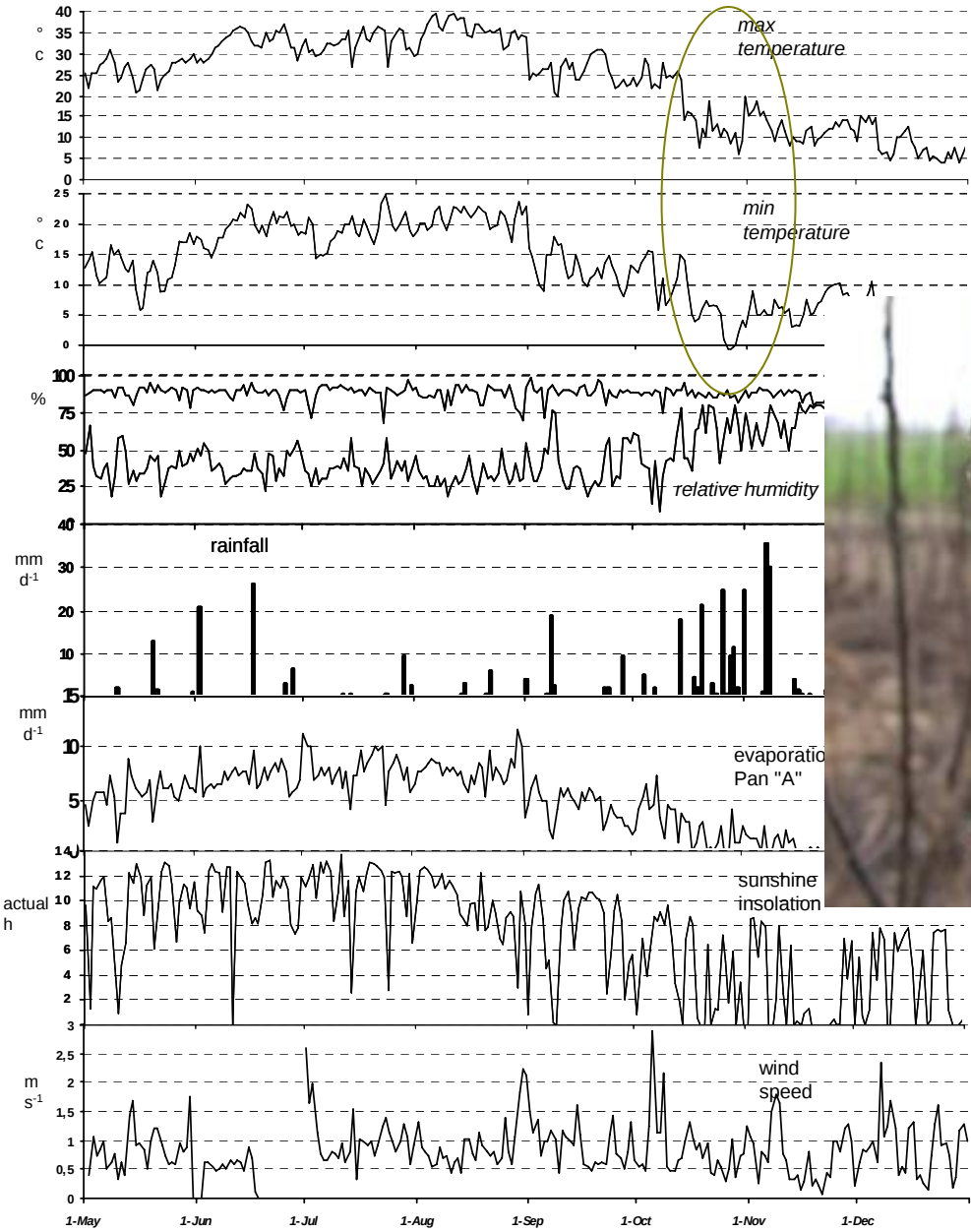
Rainfall, Min and Max temperature during the experimental period



- Air temperature followed the typical trend of the local conditions
- Unusual high max temperatures from June to August between 35°C to 40°C

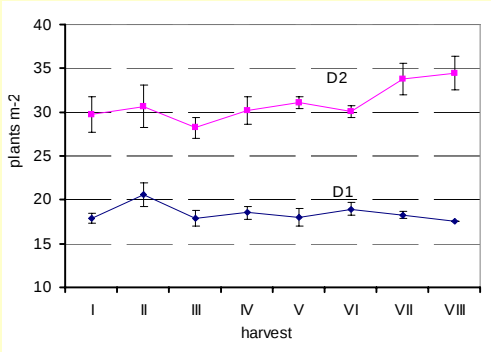
Accumulation of GDD from sowing (S1: 19/5; S2: 19/6) to the final harvest (4/12)

Daily meteorological collected parameter from May 2003 to December 2003



Results Task 2.2

Height and Base stem diameter

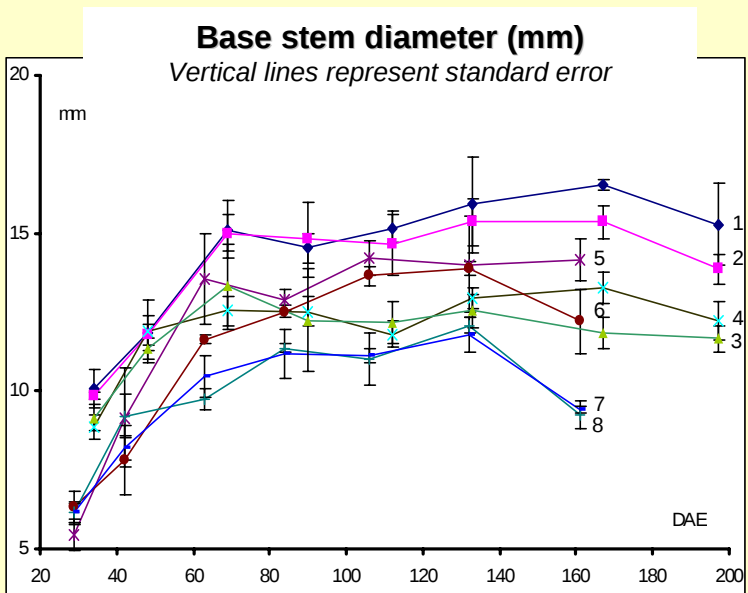
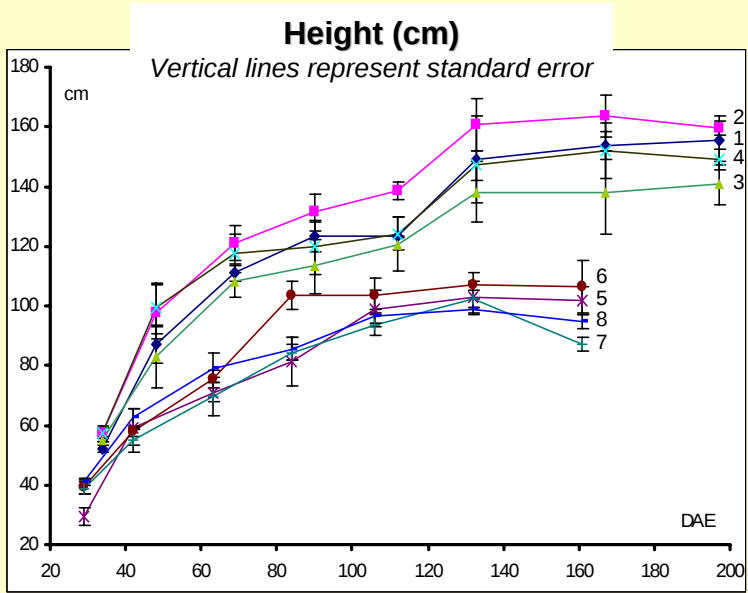


Real density:

D1: 18.5 ± 1.7 plants m⁻²

D2: 31 ± 3.4 plants m⁻²

n°	Sow ing	Genotype	Density (plants m ⁻²)
1	S1	Everglades41	20
2	S1	Tainung2	20
3	S1	Everglades41	40
4	S1	Tainung2	40
5	S2	Everglades41	20
6	S2	Tainung2	20
7	S2	Everglades41	40
8	S2	Tainung2	40

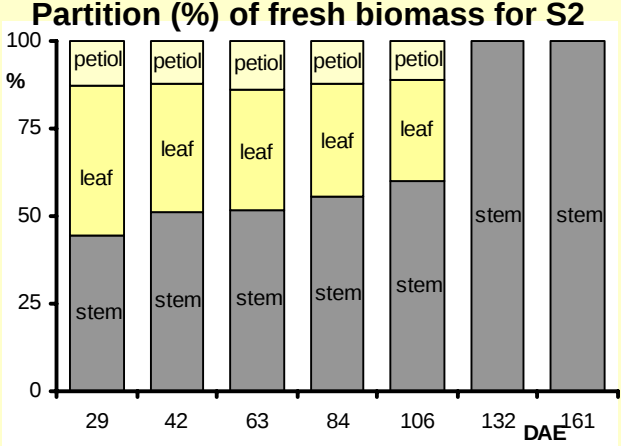
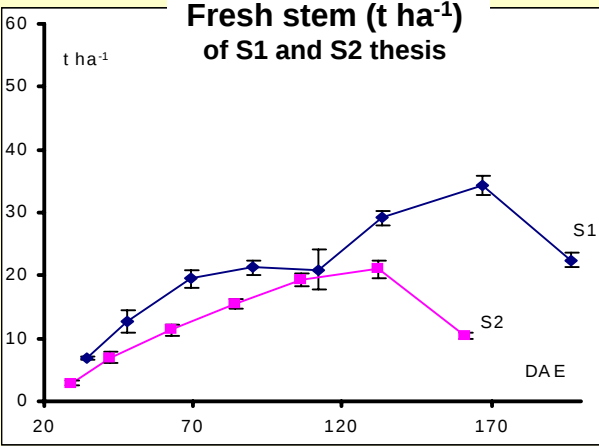
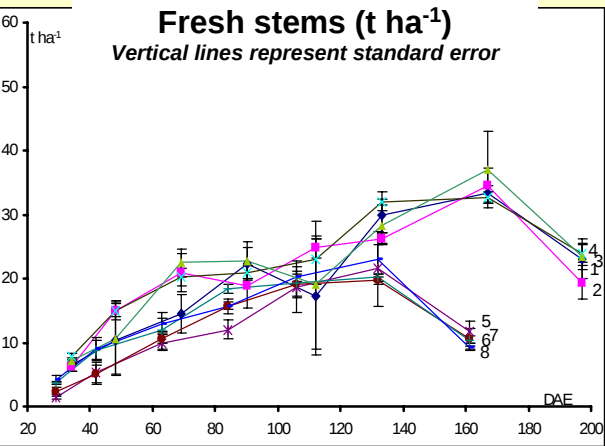
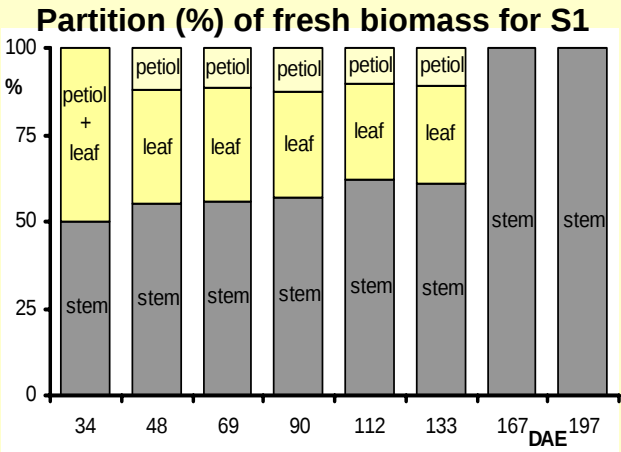
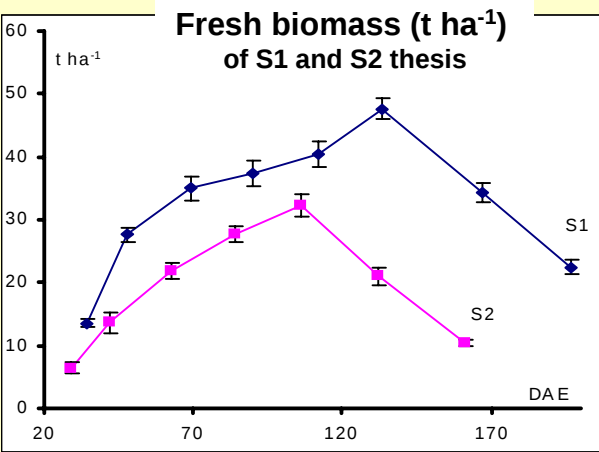
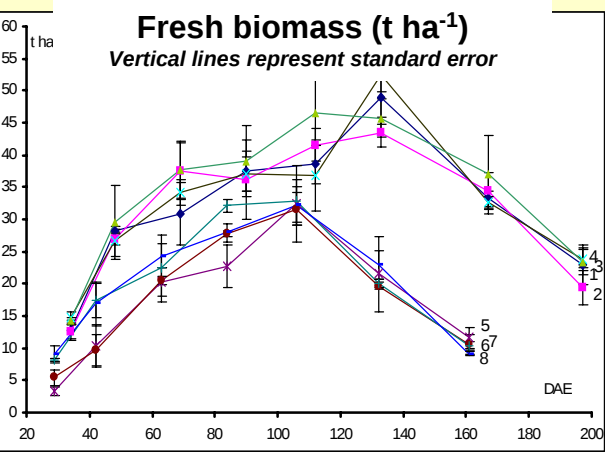


- Relevant differences were only between the two sowing times
- Max: 164 cm by thesis 2 (S1, D1, Tainung2) at 5th November
- Max height reached by S2 in about 100 DAE was reached by S1 only in 30 DAE

- Thesis 7 and 8 reached a low value significantly different from the other ones
- Increment until 70 DAE, following a stabilization
- D2 lower values of diameter than D1

Results Task 2.2

Fresh biomass yield and partition on plant organs



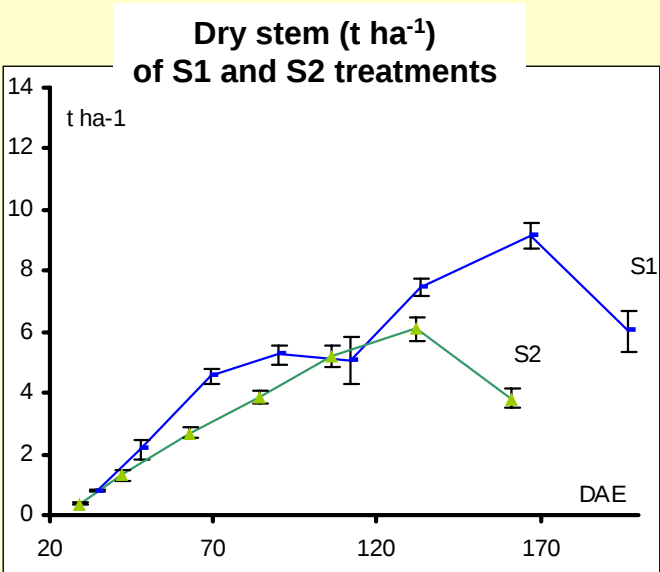
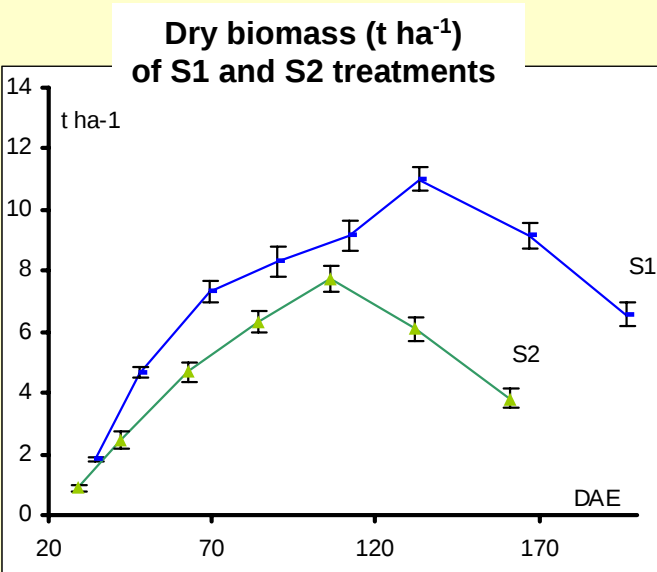
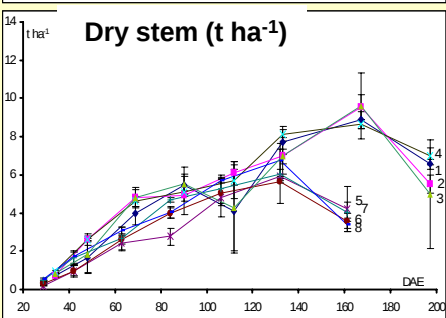
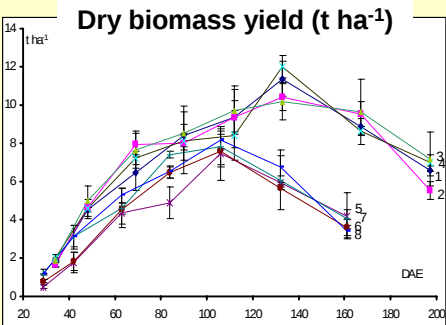
- At the final harvests fresh yields production decreased because plants were already died and without leaves
- Differences due to variety and density were within the range of the standard error

- Only sowing time seemed to affect yields
- Max value: $32,9 \text{ t ha}^{-1}$ (S2)
 $52,5 \text{ t ha}^{-1}$ (S1)
- Max reached by S2 in 110 DAE was reached by S1 only in 50 DAE

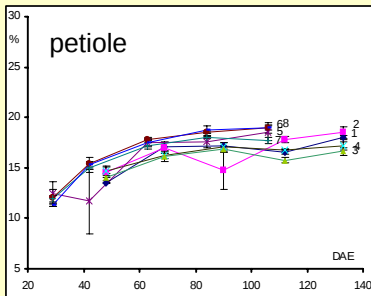
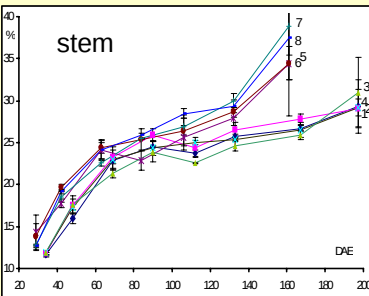
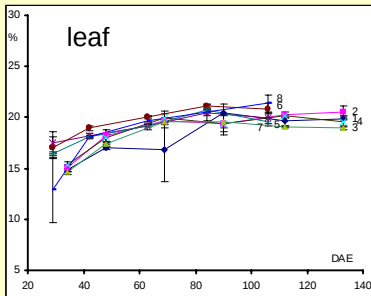
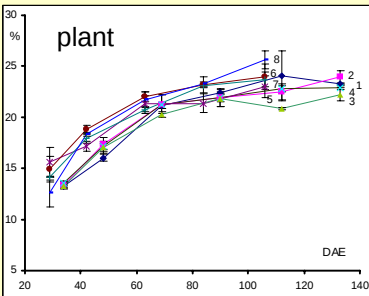
- At the final harvests only stems were present on field
- Petioles represent a considerable part of the total production
- % of stem respect to the plant increased with time in both the sowing times, whereas leaves % decreased

Results Task 2.2

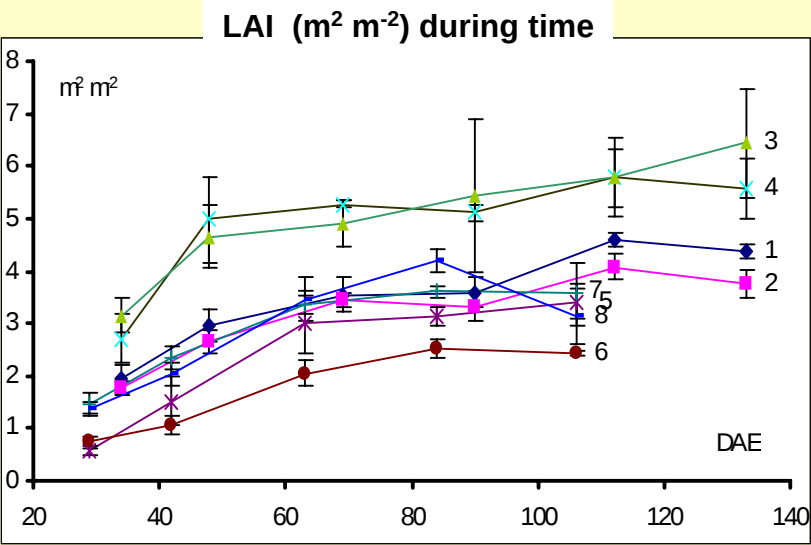
Dry biomass yield and matter content in plant organs



Dry content (%) during time.

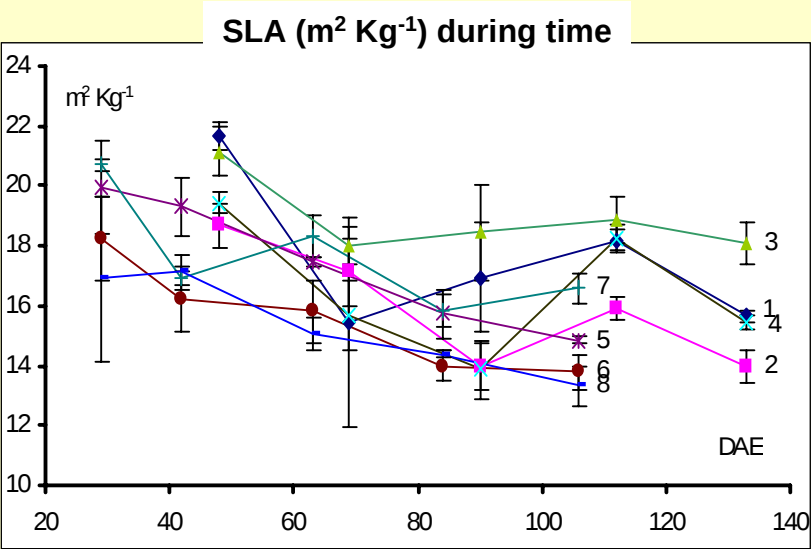


- Differences due to variety and density were within the range of the standard error
- All factor combinations with S1 produced about the double than those with S2
- Max value: around 10 t ha⁻¹ for thesis with S1 at 140 DAE
- Dry content in stem increased more significantly respect to the other plant organs.
- Treatment 7 (S2, D2, Everglades41) at the final harvest seemed to have stoked the highest percentage of dry biomass in stems



n°	Sowing	Genotype	Density (plants m ⁻²)
1	S1	Everglades41	20
2	S1	Tainung2	20
3	S1	Everglades41	40
4	S1	Tainung2	40
5	S2	Everglades41	20
6	S2	Tainung2	20
7	S2	Everglades41	40
8	S2	Tainung2	40

- Treatment 3 (S1, Everglades41) and 4 (S1, Tainung2) showed the highest values of LAI (both D2)
- Also sowing time influenced LAI



- SLA trend showed differences between the two tested sowing times and the two tested densities
- Differences due to variety were in the range of the variation of the standard error

Results Task 2.2

Final harvests

Soil moisture: 19.30 – 20.74 %

Plants lost leaves before the harvests, all yields are referred to stem

	harvest date	GDD		scutching date
		S1	S2	
harvest A	05/11/2003	1288	1005	06/11/2003
harvest B	04/12/2003	1288	1005	11/12/2003

• Fresh and dry yields of stems, bark and core

HARVEST					Stem (t ha ⁻¹)		Bark (t ha ⁻¹)		Core (t ha ⁻¹)		Dry Matter (%)			
					fresh	dry	fresh	dry	fresh	dry	stem	bark	core	
1	S1	D1	Everglades41	A	32,0	8,5	9,4	2,6	12,6	4,1	29,6	33,3	52,2	
				B	22,1	6,3	7,3	2,2	10,1	3,6	25,8	34,1	54,9	
2	S1	D1	Tainung2	A	35,7	9,9	7,2	2,3	11,2	4,3	30,0	32,1	62,0	
				B	21,4	6,2	8,4	2,5	8,5	3,0	26,7	37,8	44,7	
3	S1	D2	Everglades41	A	35,6	9,3	10,1	3,2	13,7	4,4	26,2	43,2	52,4	
				B	21,2	6,7	6,6	2,2	8,1	3,2	31,8	32,1	44,0	
4	S1	D2	Tainung2	A	31,8	8,5	10,3	2,9	13,5	4,6	27,7	36,4	57,7	
				B	22,4	6,6	7,6	2,8	11,7	4,4	28,0	40,4	64,0	
					mean A	33,8	9,0	9,2	2,8	12,7	4,4	28,3	36,3	56,1
					mean B	21,8	6,4	7,5	2,4	9,6	3,5	28,1	36,1	51,9
5	S2	D1	Everglades41	A	23,5	6,5	6,0	1,9	7,6	3,0	32,5	37,9	57,6	
				B	10,9	3,8	6,0	1,7	9,2	3,5	30,2	28,1	66,7	
6	S2	D1	Tainung2	A	18,6	5,3	4,9	1,8	5,1	2,2	31,7	40,8	50,7	
				B	11,3	3,9	8,2	2,4	9,7	3,4	31,2	40,5	53,1	
7	S2	D2	Everglades41	A	21,5	6,5	7,6	2,2	8,8	3,3	31,6	39,4	55,7	
				B	11,8	4,5	5,4	2,0	6,0	2,3	37,2	39,5	46,2	
8	S2	D2	Tainung2	A	20,5	6,0	4,3	1,8	6,0	2,5	36,4	38,5	48,6	
				B	11,3	4,2	7,1	2,0	9,5	3,3	29,9	36,1	59,2	
					mean A	21,1	6,1	5,7	1,9	6,9	2,7	33,1	39,1	53,2
					mean B	11,3	4,1	6,7	2,0	8,6	3,1	32,1	36,0	56,3

• Real density, ramifications and n° of nodes

					HARVEST	plants (n° m ⁻²)	height (cm)	stem diameter (mm)	ramificated plants (%)	ramifications per plant (n°)	nodes (n°)
1	S1	D1	Everglades41	A		18,3	153,6	16,5	35,5	3,3	46,8
				B		17,7	155,4	15,3	32,9	3,1	36,0
2	S1	D1	Tainung2	A		20,1	163,9	15,4	32,6	2,2	42,3
				B		18,1	159,6	13,9	71,9	2,8	28,9
5	S2	D1	Everglades41	A		19,0	102,7	14,0	55,4	2,3	27,6
				B		18,3	102,0	14,2	47,1	2,2	37,7
6	S2	D1	Tainung2	A		19,8	106,8	13,9	41,4	1,8	29,9
				B		18,8	106,2	12,2	28,1	1,9	25,5
					mean	18,8	131,3	14,4	43,1	2,5	34,3
3	S1	D2	Everglades41	A		30,6	137,8	11,8	25,3	1,2	37,5
				B		32,6	136,7	11,6	24,7	1,5	26,8
4	S1	D2	Tainung2	A		29,7	152,0	13,3	21,0	2,5	33,5
				B		31,6	148,9	12,2	32,4	1,3	31,6
7	S2	D2	Everglades41	A		36,4	102,2	12,1	24,3	2,2	20,9
				B		35,9	87,0	9,3	20,8	1,9	24,6
8	S2	D2	Tainung2	A		31,0	98,6	11,8	31,4	1,6	24,1
				B		30,1	94,8	9,4	42,7	1,8	33,7
					mean	32,2	119,8	11,4	27,8	1,7	29,1

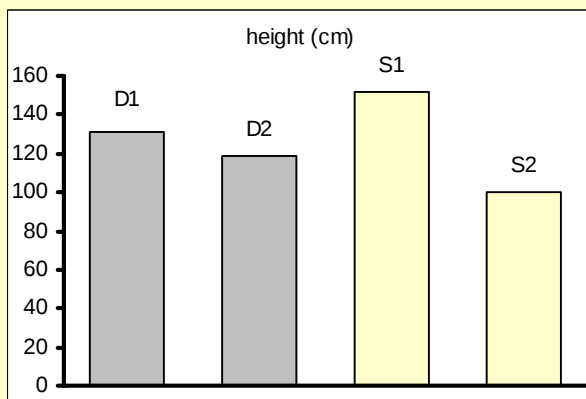
Analysis of variance (ANOVA) for all treatments and their interaction:

4 factors complete randomized block design

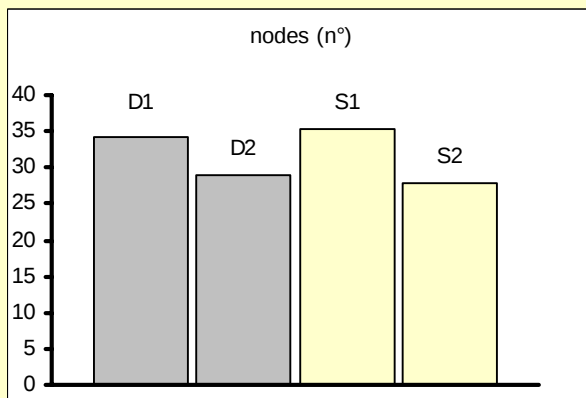
- Variety
 - Density
 - Sowing time
 - Harvest
- (2 levels)

Trends of some interesting parameters related to the factor that significantly affect their value

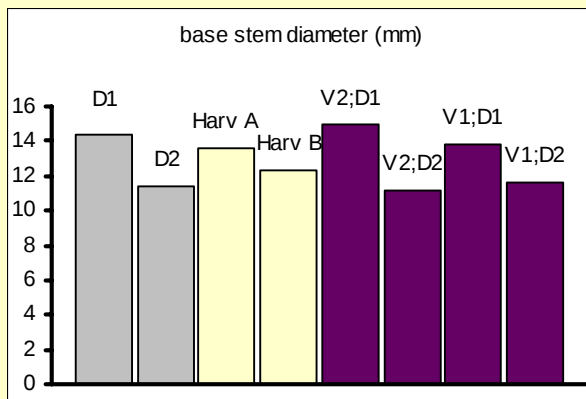
V1: Tainung2
V2: Everglades41
S1: first sowing (19th May)
S2: second sowing (19th June)
D1: 20 plants m⁻²
D2: 40 plants m⁻²



Height: important effect of density and sowing time

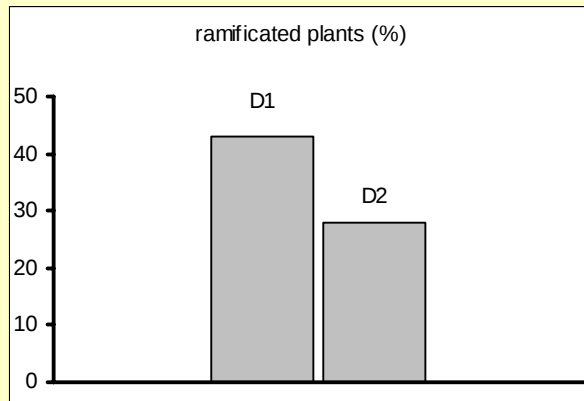


N° of nodes: important effect of density and sowing time



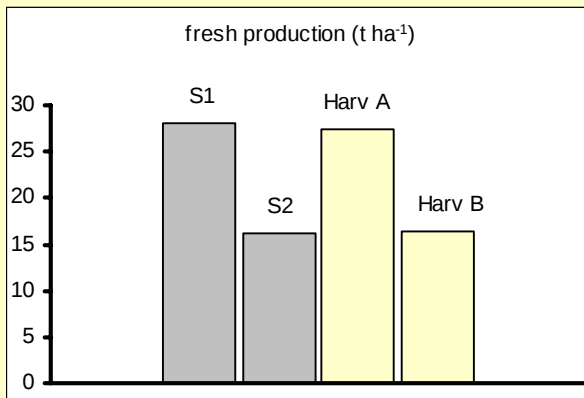
Base stem diameter: important effect of density and harvest time and interaction between variety and density

Trends of some interesting parameters related to the factor that significantly affect their value

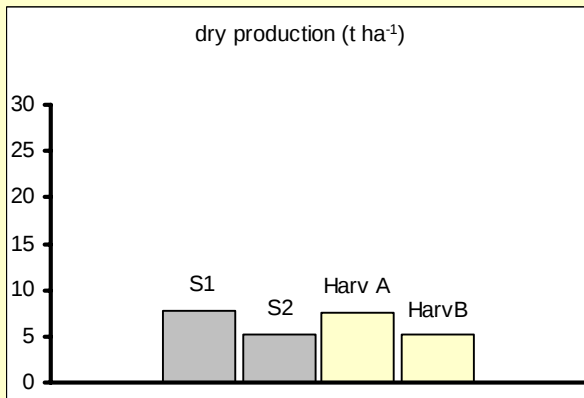


% of ramificated plants: important effect of density

ramifications per plants: less important



• Fresh production and dry production was influenced significantly by sowing time



• decreasing of yields between the harvest A and B mainly because of the death of the plants for the lowest temperatures

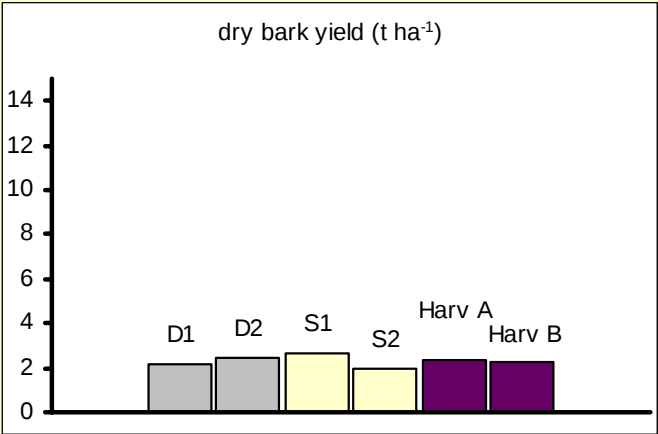
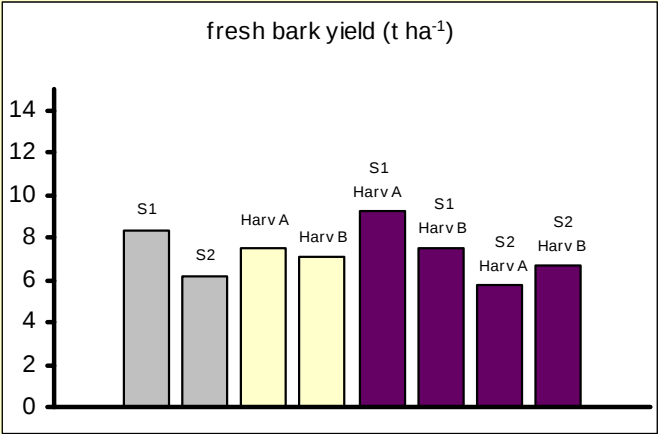
Mechanical decortications



bark



core



Same patch can be observed for fresh and dry production of bark and core.

Dry bark production was also dependent by density

Results Task 2.3

Final harvests

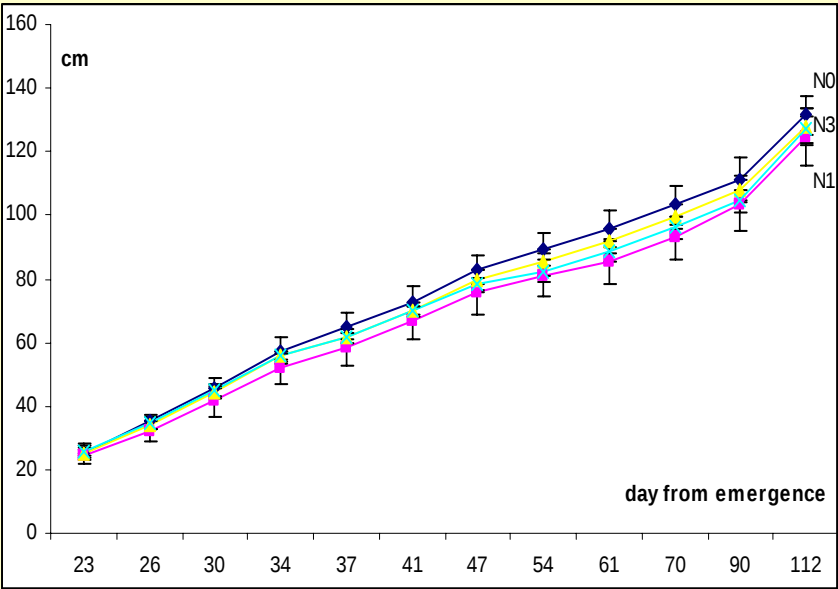
- Low emergence
- No repeated harvests of rows
- 2 final harvests

Harvests were carried out on marked areas at plants emergence

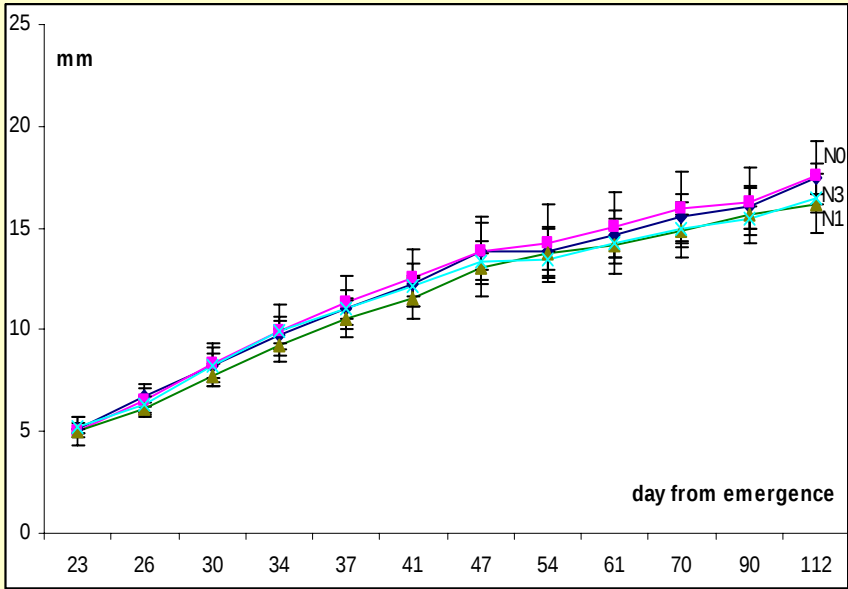
	<i>N level</i>	<i>harvest A</i>	<i>harvest B</i>	<i>mean</i>
1	<i>N0</i>	14,9	16,0	15,5
2	<i>N1</i>	15,8	14,5	15,2
3	<i>N2</i>	17,6	19,3	18,5
4	<i>N3</i>	17,1	19,3	18,2
	<i>mean</i>	16,4	17,3	16,8 ± 1,9

	harvest date	acc. thermal time	souting date
harvest A	13/11/2008	1300,25	13/11/2008
harvest B	04/12/2008	1300,25	11/12/2008

Heights of 10 marked plants



Base stem diameters of 10 marked plants



All the differences were within the range of variation of the standard error

Results Task 2.3

Final harvests

Soil moisture: 20 %

Plants lost leaves before the harvests, all yields are referred to stem

• Fresh and dry yields of stems, bark and core

HARVEST			Stem (t ha ⁻¹)		Bark (t ha ⁻¹)		Core (t ha ⁻¹)	
			fresh	dry	fresh	dry	fresh	dry
1	N0	A	27,4	6,8	10,7	3,0	15,0	4,5
		B	20,3	6,9	5,2	2,2	8,8	4,0
2	N1	A	24,7	7,2	9,5	2,5	12,2	3,8
		B	17,2	6,5	4,7	2,5	7,7	3,6
3	N2	A	26,1	7,3	10,1	2,8	13,8	4,2
		B	17,2	5,9	4,6	2,5	6,8	3,2
4	N3	A	24,2	6,9	9,2	2,4	12,8	3,8
		B	16,9	6,5	5,2	2,6	7,4	3,4

• Real density, ramifications and n° of nodes

HARVEST			plants (n° m ⁻²)	ramificated plants (%)	ramifications per plant (n°)	nodes (n°)
1	N0	A	12,8	44,1	3,1	54,8
		B	16,0	36,1	1,8	41,6
2	N1	A	12,6	49,5	3,4	64,2
		B	14,5	45,4	1,9	42,1
5	N2	A	17,2	28,3	2,4	48,2
		B	19,3	31,9	1,8	41,6
6	N3	A	16,6	36,6	2,0	50,6
		B	19,3	22,5	1,9	38,0
mean			16,0	36,8	2,3	47,6

• Height (cm), base stem diameter (mm) and dry content

HARVEST			height (cm)	base diameter (mm)	Dry Matter (%)		
					stem	bark	core
1	N0	A	171,3	18,4	27,6	27,7	30,2
		B	158,5	16,7	34,1	43,4	45,0
2	N1	A	171,3	20,6	26,9	26,4	31,3
		B	149,8	16,7	36,7	51,9	46,1
3	N2	A	156,3	16,2	28,1	28,2	30,7
		B	147,3	14,6	34,1	53,0	46,1
4	N3	A	154,7	15,6	28,9	25,7	30,0
		B	142,0	13,0	37,6	49,7	46,3

• Nitrogen content as % of N in soil and in stems

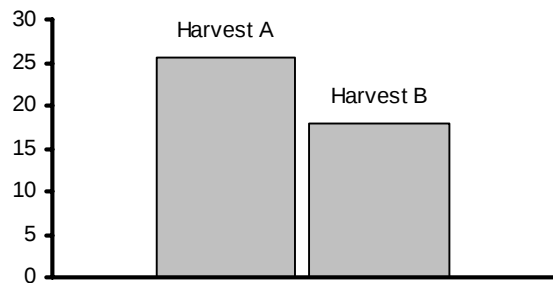
HARVEST			nitrogen content (%)	
			stems	soil
1	N0	A	0,83	0,13
		B	-	-
2	N1	A	1,01	0,13
		B	-	-
5	N2	A	1,12	0,14
		B	-	-
6	N3	A	1,17	0,14
		B	-	-

Analysis of variance (ANOVA)

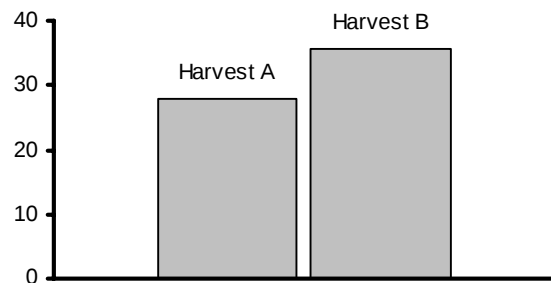
2 factors complete randomized block design:
Nitrogen level (N): 4 levels (0, 50, 100 and 150 Kg of N ha⁻¹)
Harvest (H): 2 levels (A and B).

Trends of some interesting parameters related to the factor that significantly affect their value

fresh production (t ha⁻¹)

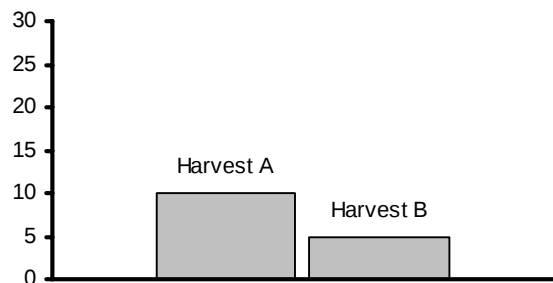


dry matter (%)



Only the harvest factor affected the dry material content, number of nodes, fresh production and dry content in bark and core.

fresh bark yield (t ha⁻¹)



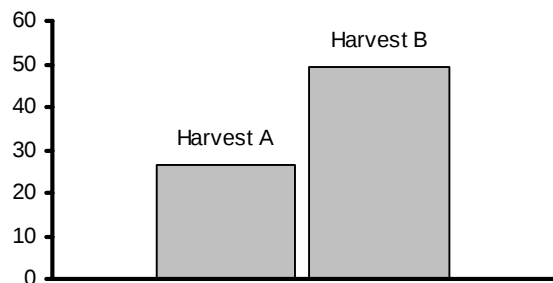
fresh core yield (t ha⁻¹)



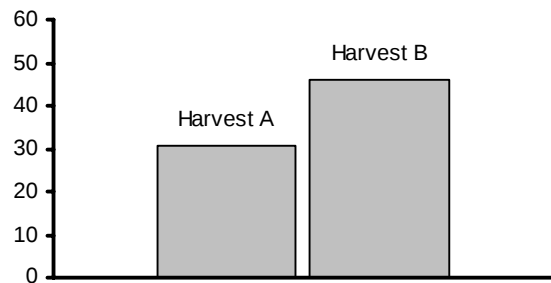
Differences between the harvest A and B because of the death of the plants for the lowest temperatures.

On the other hand dry yields was not significantly affected by harvest.

dry matter in bark (%)



dry matter in core (%)



Nitrogen content in soil and stem:

No effect of N level and Harvest

Conclusions and discussions

- No differences for the two tested varieties
- The effects of density was low
- Sowing and harvest time affected most of considered characteristics
-best results were obtained with the early sowing and early harvest-
- no influence of nitrogen levels on yields

Strongly effect of the meteorological conditions

Reducing differences

Yield levels very low, as for the other crops.