## BIOMASS YIELDS OF KENAF IN SOUTH EUROPE

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Kenaf

## Hibiscus cannabinus L. (Malvaceae)

- Kenaf is a short-day annual herbaceous crop cultivated mainly for its fibrous stem.
- It has been cultivated long, as early as 4000 BC in western Africa.
- Its area of cultivation is estimated to about 200,000 ha (FAO) and the main producers are Thailand, China, India and Mexico.
- Recent research has demonstrated numerous potential uses for each of the two stem materials (bark or core), which often must been separated.



## Reasons for considering kenaf as a high productivity multi-purpose nonfood crop for Europe:

- It can provide raw material for both industrial and energy applications.
- The high biomass potential (up to 26 t/ha) and the low inputs of the crop.
- It offers alternative land use and can be used in a crop rotation.
- It is an annual non-food crop with quite similar cultivation and harvest to other conventional field crops.
- It has high farmers perception as an annual crop.



## Uses of the crop

- Core uses (paper pulp, oil/chemical absorbents, insulation panels, horticultural mixes, bedding materials for animals, etc.). Apart from the industrial uses the core material can be used for thermochemical process (combustion, gasification and pyrolysis).
- Bark uses (paper pulp production)
- The whole plant has high protein and good digestibility and may be pelletized).



## State-of-the-art of the crop in Europe

- The sustainable yielding potential of the crop as well as the limitations that certain cultivation techniques (irrigation, fertilization, sowing date and planting density) place of the crop growth have not been defined.
- In the framework of the two previous EU projects the using for kenaf and pulp have been tested by several industries. Hardly any publication has been published to report the results and the exploitation plans of these projects.



# Methods and Materials

- ✓ In the view of BIOKENAF project a total number of 13 kenaf field trials were established in Europe (2003).
- ✓ The aim of the work in seven of these trials was to investigate the effect of the sowing date and planting density of the yields of two late-maturity kenaf varieties, while in the rest varieties the aim was to investigate the effect of different irrigation and fertilization rates on yields.



### Description of the trial "sowing dates-plant populations-varieties" in seven sites in southern Europe

Partner / Country	Site of the trial	Tested factors /	Sowing dates
		Experimental layout	
CRES - Greece	Aliartos (central Greece)	Two sowing dates	S <sub>1</sub> : 18/5/03, S <sub>2</sub> : 7/6/03
DACPA - Italy	Enna Geracello (Sicily)	Two plant populations	S <sub>1</sub> : 12/6/03, S <sub>2</sub> : 4/7/03
UTH-Greece	Palamas (central Greece)	(200,000 and 400,000 pl/ha)	S <sub>1</sub> : 20/5/03, S <sub>2</sub> : 13/6/03
INIA-Spain	Alcala de Henares (Madrid)	Two varieties	S <sub>1</sub> : 28/5/03, S <sub>2</sub> : 11/6/03
	Guadajira (Badahoz)	(Tainung 2 and Everglades 41)	S <sub>1</sub> : 22/5/03, S <sub>2</sub> : 4/6/03
UniNOVA - Portugal	Monte de Caparica (Lisbon)	The experimental levent	S <sub>1</sub> : 26/6/03, S <sub>2</sub> : 11/7/03
UNIBO - Italy	Gardriano (Bologna)	was a $2^3$ factorial in three blocks	S <sub>1</sub> : 19/5/03, S <sub>2</sub> : 19/6/03

### Description of the trial "irrigation-fertilization" in six sites in southern Europe

Partner / Country	Site of the trial	Sowing time	Tested factors	Experimental
				layout
CRES - Greece	Aliartos (central Greece)			
		31/5/03	Four irrigation rates	
DACPA - Italy	Enna Geracello (Sicily)		(0, 25, 50 and 100 of PET)	
		24/6/03	Three nitrogen fertilization	
INIA – Spain	Alcala de Henares (Madrid)		rates (0, 75 and 150 kg N/ha)	
	Guadajira (Badahoz)			A split-split block
UniNOVA-Portugal	Monte de Caparica (Lisbon)			design in three
		4/7/03		blocks
UTH - Greece	Palamas (central Greece)		Three irrigation rates	
		20/5/03	(0, 50 and 100 of PET)	
			Four nitrogen fertilization rates	
			(0, 50, 100 and 150 kg N/ha)	
UNIBO - Italy	Gardriano (Bologna)			
		26/5/03	Four nitrogen fertilization	A split block
			rates (0, 50, 100 and 150 kg	design in three
			N/ha)	blocks

## Measurements

- Plant height every two weeks (on five marked plants per plot)
- Stem diameter every four weeks (on five marked plants per plot)
- Leaf area meter (LAI) measurements every three weeks
- Harvests (2 m row) every three weeks from end of July to December

Estimation of fresh and dry matter yields of total plant and per plant fraction (leaves, bark and core)



### Results from the trial "sowing dates-plant populations-varieties"

#### Plant height (cm)

	Experimental sites					
	Aliartos	Palamas	Alcala	Guadajira	Monte	Gardriano
			de Henares		de Caparica	
Sowing times						
Early sowing	308	382	243	309	126	150
Late sowing	283	342	248	345	103	98
Pl. populations						
200,000 pl/ha	305	362	243	359	119	131
400,000 pl/ha	286	362	249	340	110	117
Varieties						
Tainung 2	295	357	248	370	118	120
Everglades 41	295	367	243	336	111	127

#### Stem diameter (mm)

	Experimental sites					
	Aliartos	Palamas	Alcala	Guadajira	Monte de	Gardriano
			de Henares		Caparica	
Sowing times						
Early sowing	18.2	24.8	21.3	12.4	10.8	13.3
Late sowing	20.0	20.7	19.5	13.9	10.0	11.3
Pl.						
populations						
200,000 pl/ha	21.0	23.4	21.3	14.4	10.3	13.9
400,000 pl/ha	17.2	22.1	17.9	13.7	10.5	10.6
Varieties						
Tainung 2	18.8	23.1	19.5	14.1	10.3	12.6
Everglades 41	19.4	22.4	18.6	15.1	10.5	11.9



### Results from the trial "sowing dates-plant populations-varieties"

#### Yields (t/ha)

	Experimental sites						
	Aliartos	Enna	Palamas	Alcala de	Guadajira	Monte de	Gardriano
		Geracello		Henares	-	Caparica	
Sowing times							
Early sowing	13.2	14.5	17.7	11.6	21.1	6.3	6.5
Late sowing	12.8	11.5	11.8	9.2	27.9	4.0	4.1
Pl. populations							
200,000 pl/ha	11.5	12.1	14.5	10.2	21.0	4.5	5.1
400,000 pl/ha	14.5	13.9	15.1	11.9	25.9	5.8	5.5
Varieties							
Tainung 2	14.0	13.4	14.3	9.2	26.5	5.1	5.3
Everglades 41	12.0	12.5	15.3	11.1	22.4	5.2	5.2



### Mean yields (t/ha) (overall sites) from the trial "sowing dates-plant populations-varieties"





### Results from the trial "irrigation-fertilization"

#### Plant height (cm)

	Experimental sites						
	Aliartos	Enna Geracello	Alcala de Henares	Monte de Caparica	Gardriano		
Irrigation rates							
0% of PET	259	289	107	56	-		
25% of PET	324	292	159	69	-		
50% of PET	331	271	173	104	-		
100% of PET	337	279	233	87	-		
Nitrogen rates							
0 kg N/ha	299	307	177	81	159		
50 kg N/ha	-	-	-	-	150		
75 kg N/ha	305	267	171	73	147		
150 kg N/ha	334	274	157	84	142		

#### Stem diameter (mm)

	Experimental sites						
	Aliartos	Enna Geracello	Palamas	Alcala de	Monte de Caparica	Gardriano	
				Henares			
Irrigation							
rates							
0% of PET	18.3	19.1	19.7	16.9	6.3	-	
25% of PET	19.2	19.8	-	18.0	7.0	-	
50% of PET	20.1	20.3	22.0	15.7	9.0	-	
100% of PET	20.7	23.7	26.1	11.6	8.7	-	
Nitrogen rates							
0 kg N/ha	19.0	20.9	22.2	16.4	7.8	16.7	
50 kg N/ha	-	-	22.5	-	-	16.7	
75 kg N/ha	19.2	20.3	22.2	17.8	7.5	14.6	
150 kg N/ha	20.5	21.1	23.6	21.6	8.0	13.0	



### Results from the trial "irrigation-fertilization"

#### Dry matter yields (t/ha)

	Experimental sites						
	Aliartos	Enna Geracello	Palamas	Alcala de Henares	Monte de Caparica	Gardriano	
Irrigation							
rates							
0% of PET	8.4	7.5	13.2	2.8	1.6	-	
25% of PET	13.4	8.2	-	5.4	2.1	-	
50% of PET	14.0	7.9	19.0	6.9	3.2	-	
100% of PET	14.2	9.1	21.6	10.9	3.9	-	
Nitrogen rates							
0 kg N/ha	10.7	8.6	18.6	2.8	2.7	6.9	
50 kg N/ha	-	-	18.1		-	6.5	
75 kg N/ha	12.6	8.4	18.9	5.9	2.6	5.9	
150 kg N/ha	14.2	7.7	16.2	6.2	2.8	6.5	



### Mean dry matter yields (t/ha) for the trial "irrigation-fertilization" (averaged overall sites)

Dry matter yields (t/ha)





# Conclusions

The main conclusions derived for the described kenaf trials are summarized below:

- Taking into consideration the specific climatic conditions of the Southern Europe it was found that higher yields can be produced when the sowing take place between the end April to the middle of May. In the cases that the sowing took place after the middle of June the achieved yields were considerably low (Monde de Caparica, Lisbon).
- The plants that grew up in plots with high density (400,000 pl/ha) although were shorter with smaller stem diameter were more productive (14 %) compared to the ones that grew up in the plot with the low density (200,000 pl/ha).



# Conclusions

- Concerning the two tested late-maturity varieties (Tainung 2, Everglades 41) it was found that their yielding capacity was almost the same with a slight superiority of Tainung 2 over Everglades 41, when grown in South Europe.
- It was found that by increasing the applied water in the kenaf fields their productivity was increased and in most cases the yields that were recorded for the applied irrigation rates were differ statistically (P<0.05).</p>
- On the contrary the dry yields did not or slight increased by the increase of the applied nitrogen fertilization.

