

BIOKENAF

QLK5-CT-2002-01729



INSTITUTO NACIONAL DE INVESTIGACIÓN Y
TECNOLOGÍA AGRARIA Y ALIMENTARIA (INIA)

DPTO. MEDIO AMBIENTE

ALCALA DE HENARES, MADRID, SPAIN



INIA

Dpto. Medio Ambiente
Alcalá de Henares (Madrid)

Task 2.3: Effect of irrigation and
nitrogen fertilization on biomass yields

SIDT

Junta de Extremadura
Finca "La Orden",
Guadajira, Badajoz

Task 2.2: Effect of different
sowing dates and plant population
on biomass yields

Task 2.2: Effect of different sowing dates and plant population on biomass yields

Field experiments in Alcalá de Henares, Madrid, Spain

Sowing dates

- sowing dates:
 - S1: 28/05
 - S2: 11/06
- Tainung 2
- 200000 plants/ha

Plant population

- plant density:
 - D1: 200000 plants/ha
 - D2: 400000 plants/ha
- Tainung 2
- sowing date: 28/05

Varieties

- kenaf variety:
 - Tainung 2
 - Everglades 41
 - Salvador
- 200000 plants/ha
- sowing date: 11/06

Field experiments in Guadajira, Badajoz, Spain

Sowing dates & Varieties

- sowing dates:
 - S1: 22/05
 - S2: 04/06
- Kenaf variety:
 - Tainung 2
 - Everglades 41
- 200000 plants/ha

Plant population & Varieties

- Plant density
 - D1: 200000 plants/ha
 - D2: 400000 plants/ha
- Kenaf variety:
 - Tainung 2
 - Salvador
 - Everglades 41
- Sowing date: 04/06

Sowing dates & Plant population

- sowing dates:
 - S1: 12/05
 - S2: 04/06
- Plant density
 - D1: 200000 plants/ha
 - D2: 400000 plants/ha
- Salvador

Measurements

Growth data

- Plant height
- Stem diameter

Plant productivity data

- Fresh weight of leaf, bark and core
- Dry weight of leaf, bark and core

Other measurements

- Leaf area meter
- SPAD
- Canopy temperature
- Soil analysis
- Plant analysis (N, P, K)



Meteorological data

- Temperature
- Humidity
- Precipitation
- Evaporation
- Wind speed

Effect of sowing date on plant growth and biomass yields

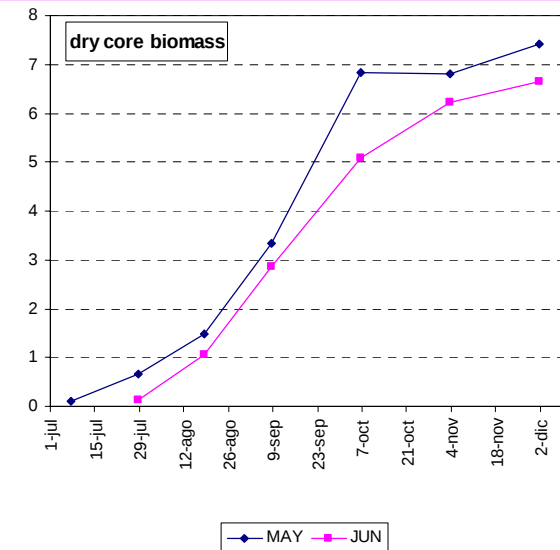
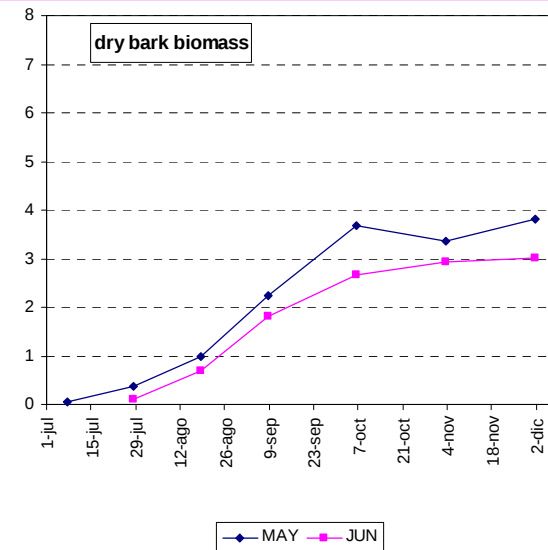
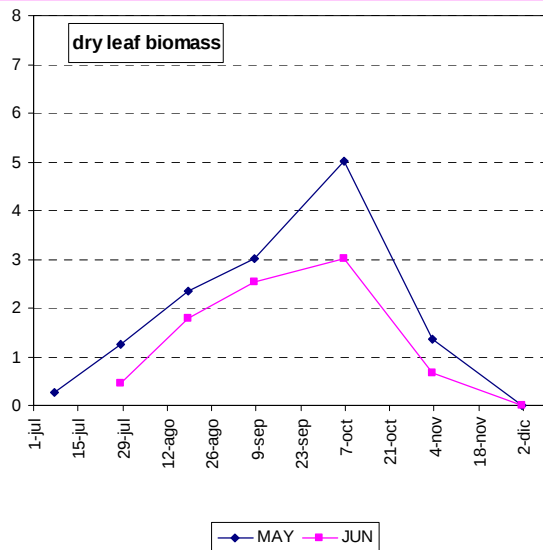
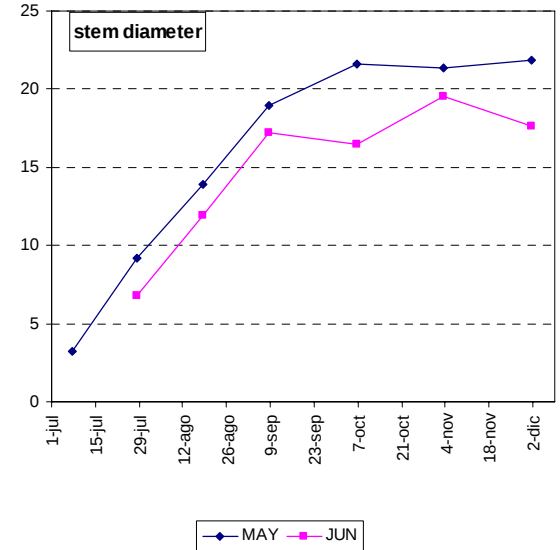
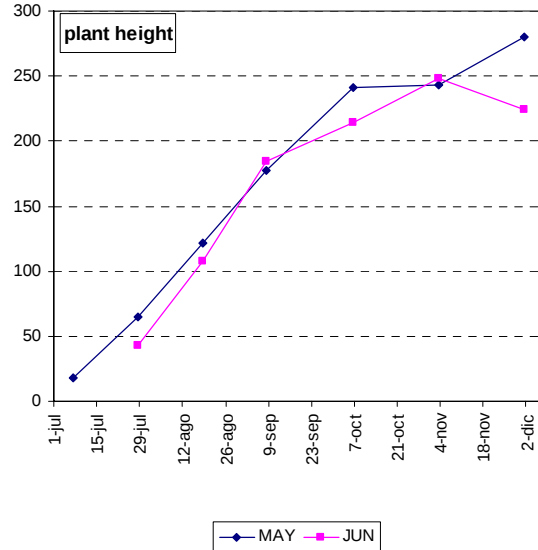
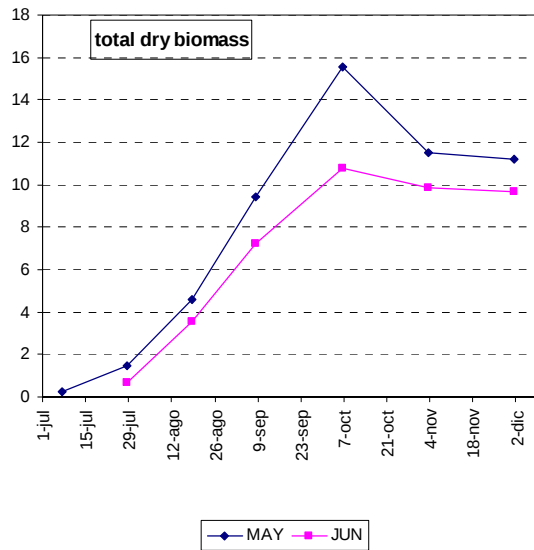
Field experiments in Alcalá de Henares, Madrid, Spain

- sowing dates:
 - S1: 28/05
 - S2: 11/06
- Tainung 2
- 200000 plants/ha

Effect of sowing time (S1, end of May; S2, beginning of June) on the dry stem biomass yield of kenaf (t/ha), plant height (cm), and stem diameter (mm) at the end of growth period in Alcalá de Henares, Madrid, Spain. N, number of plots; The letters in the columns indicate means showing a significant difference at the 5 % level (Duncan's multiple range test).

	N	Stem biomass (t/ha)	Plant height (cm)	Stem diameter (mm)
<u>Sowing date</u>				
S1	3	11.6 a	242.9 a	21.3 a
S2	3	9.2 b	248.0 a	19.5 a
OVERALL SCORES	6	10.4	245.5	20.4

Effect of sowing date on plant growth and biomass yields



Effect of sowing date and kenaf variety on plant growth and biomass yields

Field experiments in Guadajira, Badajoz, Spain

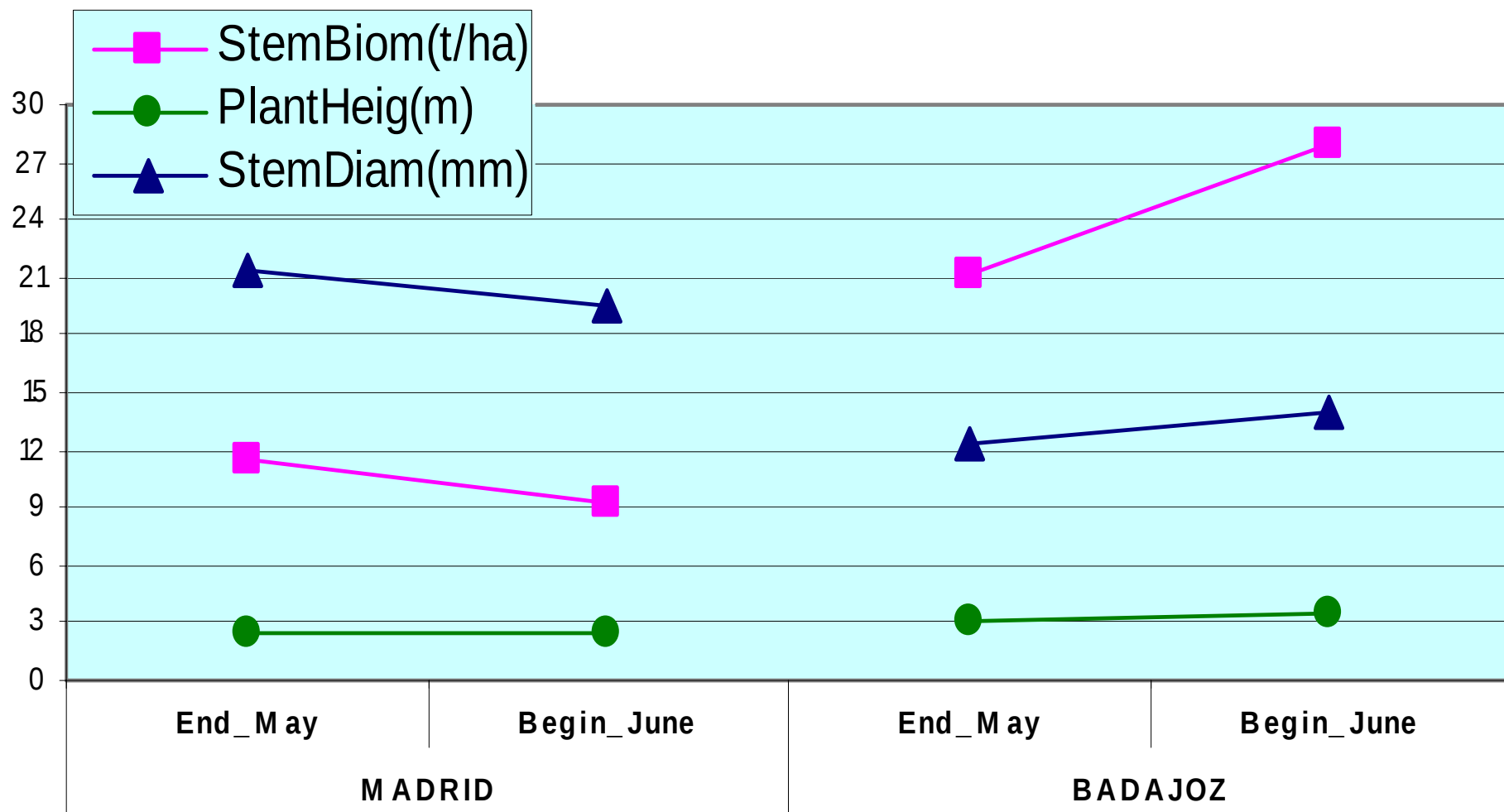
- sowing dates:
 - S1: 22/05
 - S2: 04/06
- Kenaf variety:
 - Tainung 2
 - Everglades 41
- 200000 plants/ha

Effect of sowing time (S1, end of May; S2, beginning of June) and kenaf variety (Tainung 2 and Everglades 41) on the dry stem biomass yield of kenaf (t/ha), plant height (cm), and stem diameter (mm) at the end of growth period in Guadajira, Badajoz, Spain. N, number of plots; The letters in the columns indicate means showing a significant difference at the 5 % level (Duncan's multiple range test).

	N	Stem biomass (t/ha)	Plant height (cm)	Stem diameter (mm)
<u>Kenaf variety</u>				
Tainung 2	6	25.4 a	336.7 a	13.4 a
Everglades 41	6	23.6 a	316.8 a	12.9 a
<u>Sowing date</u>				
S1	6	21.1 a	308.8 b	12.4 b
S2	6	27.9 a	344.7 a	13.9 a
OVERALL SCORES	12	24.3	326.8	13.2

Mean values effect of sowing date on plant growth and biomass yields between MADRID & BADAJOZ

Biomass_Heigh_Diameter RELATIONS & Localities_SowDate



Effect of plant population on plant growth and biomass yields

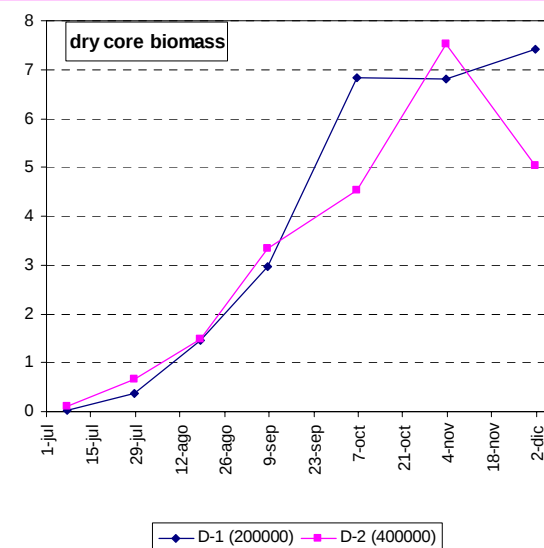
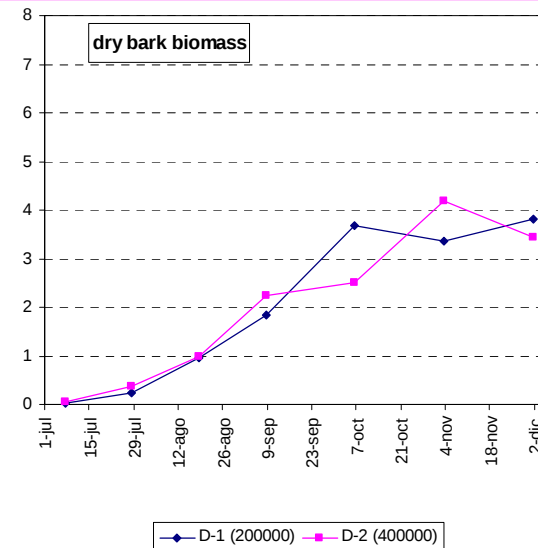
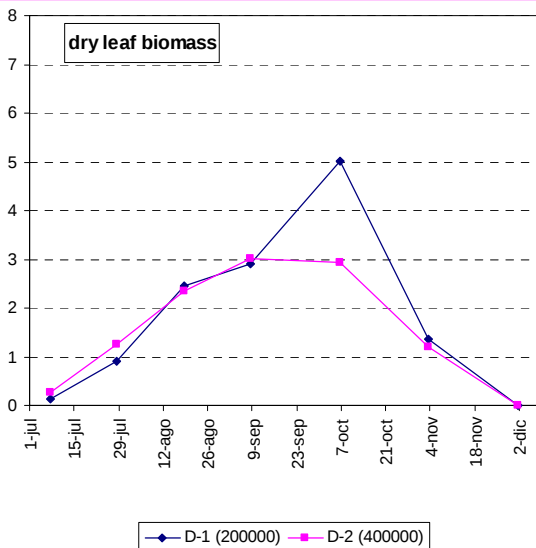
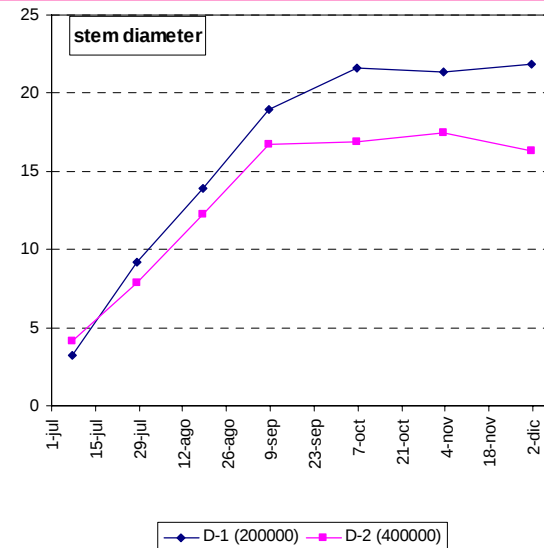
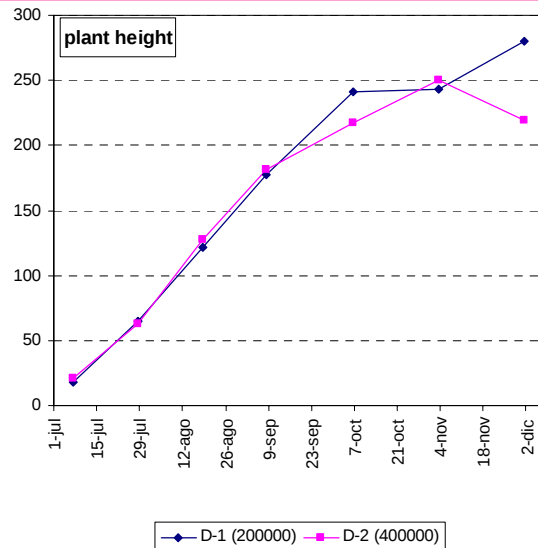
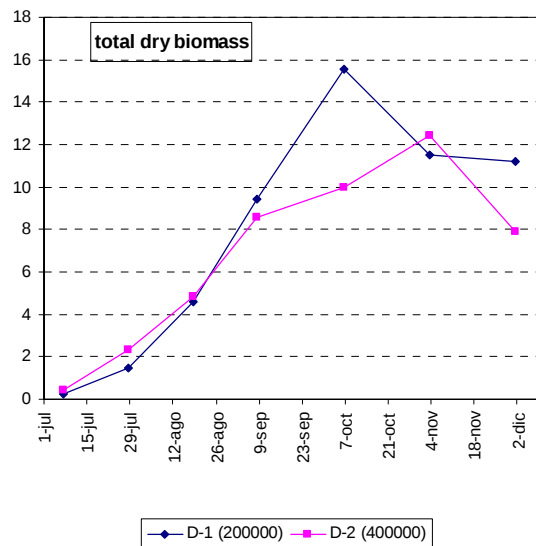
Field experiments in Alcalá de Henares, Madrid, Spain

- plant density:
 - D1: 200000 plants/ha
 - D2: 400000 plants/ha
- Tainung 2
- sowing date: 28/05

Effect of plant density (D1, 200000 plants/ha; D2, 400000 plants/ha) on the dry stem biomass yield of kenaf (t/ha), plant height (cm), and stem diameter (mm) at the end of growth period in Alcalá de Henares, Madrid, Spain. N, number of plots; The letters in the columns indicate means showing a significant difference at the 5 % level (Duncan's multiple range test).

	N	Stem biomass (t/ha)	Plant height (cm)	Stem diameter (mm)
<u>Plant density</u>				
D1	3	10.2 a	242.9 a	21.3 a
D2	3	11.9 a	248.5 a	17.9 a
OVERALL SCORES	6	11.1	245.7	19.6

Effect of plant population on plant growth and biomass yields



Effect of sowing date and plant population on plant growth and biomass yields

Field experiments in Guadajira, Badajoz, Spain

- sowing dates:
 - S1: 12/05
 - S2: 04/06
- Plant density
 - D1: 200000 plants/ha
 - D2: 400000 plants/ha
- Salvador

Effect of sowing time (S1, May; S2, beginning of June) and plant density (D1, 200000 plants/ha; D2, 400000 plants/ha) on the dry stem biomass yield of kenaf (t/ha), plant height (cm), and stem diameter (mm) at the end of growth period in Guadajira, Badajoz, Spain. N, number of plots; The letters in the columns indicate means showing a significant difference at the 5 % level (Duncan's multiple range test).

	N	Stem biomass (t/ha)	Plant height (cm)	Stem diameter (mm)
<u>Sowing date</u>				
S1	6	24.0 a	336.5 a	14.3 a
S2	6	21.6 a	342.3 a	13.1 a
<u>Plant density</u>				
D1	6	21.4 a	348.0 a	13.3 a
D2	6	24.1 a	330.8 a	14.0 a
OVERALL SCORES	12	22.8	339.4	13.7

Effect of plant population and kenaf variety on plant growth and biomass yields

Field experiments in Guadajira, Badajoz, Spain

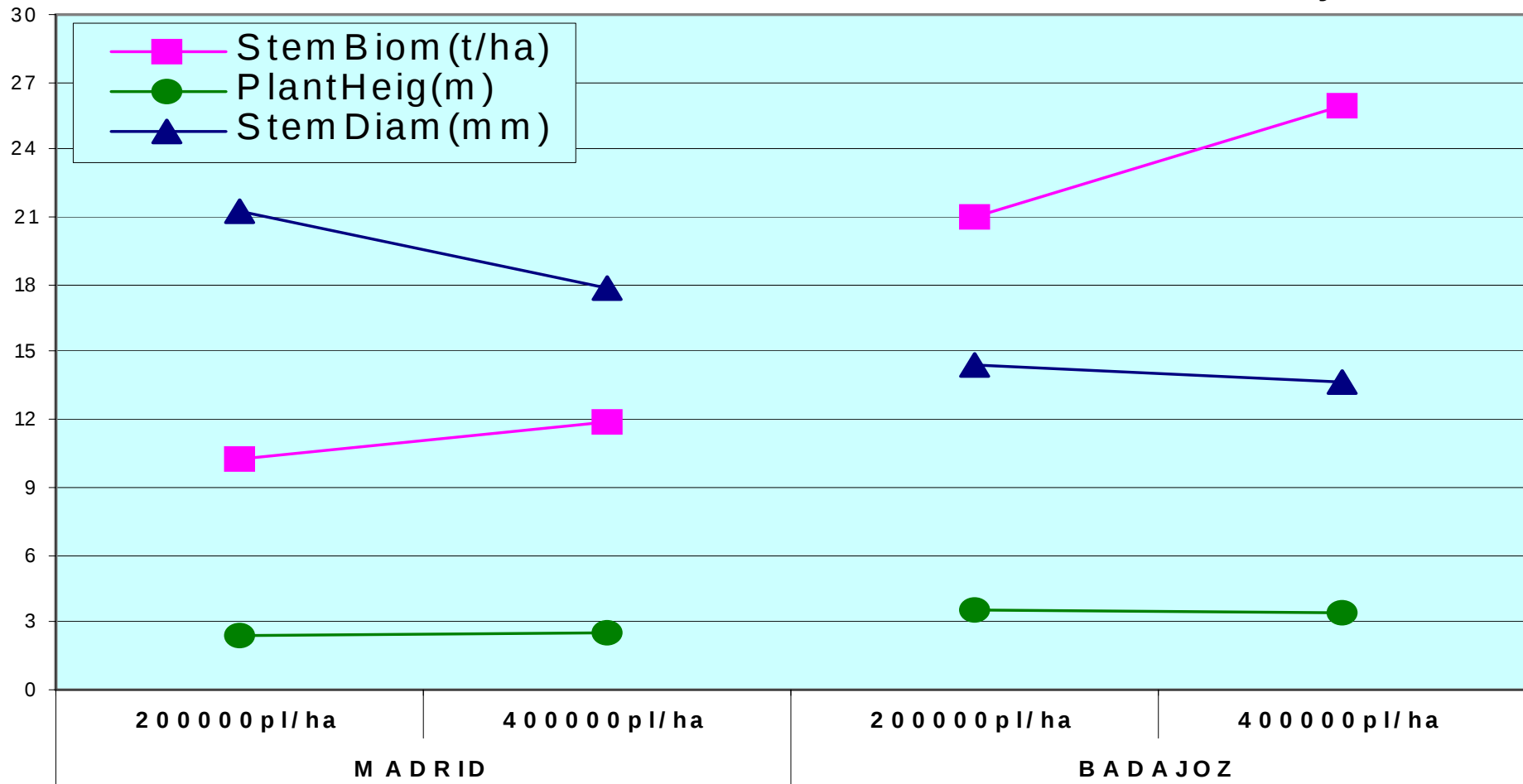
- Plant density
 - D1: 200000 plants/ha
 - D2: 400000 plants/ha
- Kenaf variety:
 - Tainung 2
 - Salvador
 - Everglades 41
- Sowing date: 04/06

Effect of plant density (D1, 200000 plants/ha; D2, 400000 plants/ha) and kenaf variety (Tainung 2; Salvador; Everglades 41) on the dry stem biomass yield of kenaf (t/ha), plant height (cm), and stem diameter (mm) at the end of growth period in Guadajira, Badajoz, Spain. N, number of plots; The letters in the columns indicate means showing a significant difference at the 5 % level (Duncan's multiple range test).

	N	Stem biomass (t/ha)	Plant height (cm)	Stem diameter (mm)
<u>Kenaf variety</u>				
Tainung 2	6	26.5 a	370.0 a	14.1 a
Salvador	6	21.6 a	342.3 b	13.1 a
Everglades 41	6	22.4 a	335.7 b	15.1 a
<u>Plant density</u>				
D1	9	21.0 a	359.1 a	14.4 a
D2	9	25.9 a	339.6 a	13.7 a
OVERALL SCORES	18	23.5	349.4	14.1

Mean values effect of plant density on plant growth and biomass yields between MADRID & BADAJOZ

Biomass_Height_Diameter RELATIONS & Localities_Density



Effect of kenaf varieties on plant growth and biomass yields

Field experiments in Alcalá de Henares, Madrid, Spain

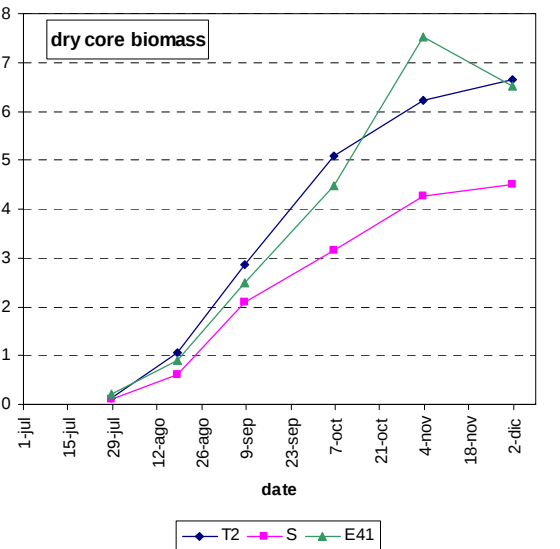
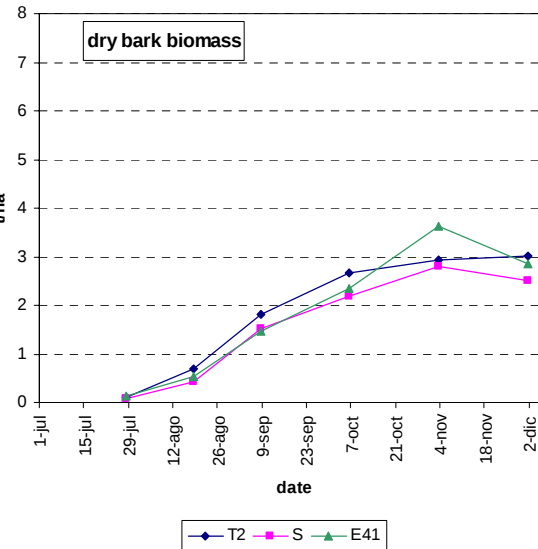
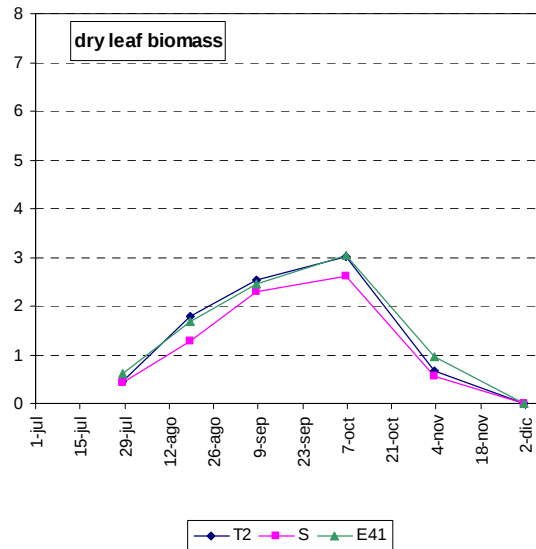
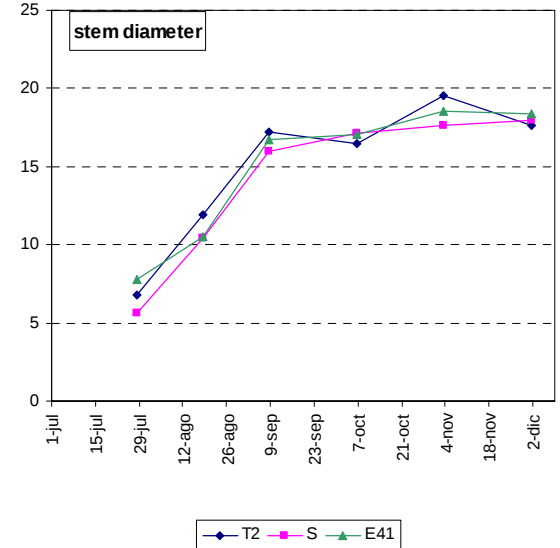
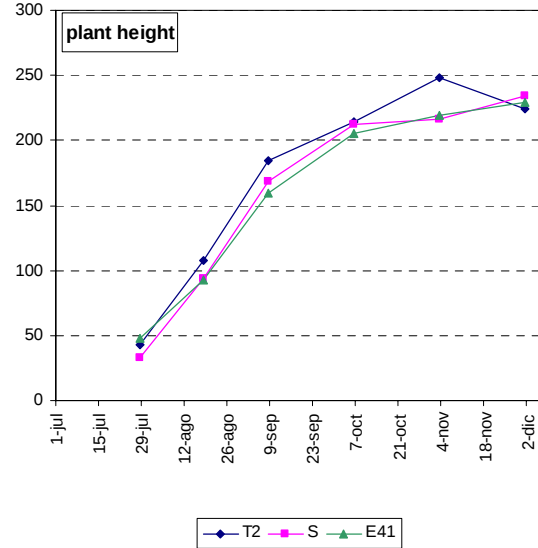
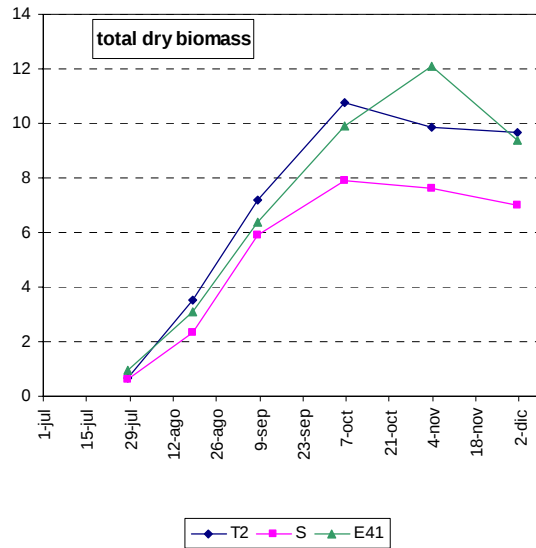
-Kenaf variety:

- Tainung 2
- Everglades 41
- Salvador
- 200000 plants/ha
- Sowing date: 11/06

Effect of kenaf variety (Tainung 2, Salvador, Everglades 41) on the dry stem biomass yield of kenaf(t/ha), plant height (cm), and stem diameter (mm) at the end of growth period in Alcalá de Henares, Madrid, Spain. N, number of plots; The letters in the columns indicate means showing a significant difference at the 5 % level (Duncan's multiple range test).

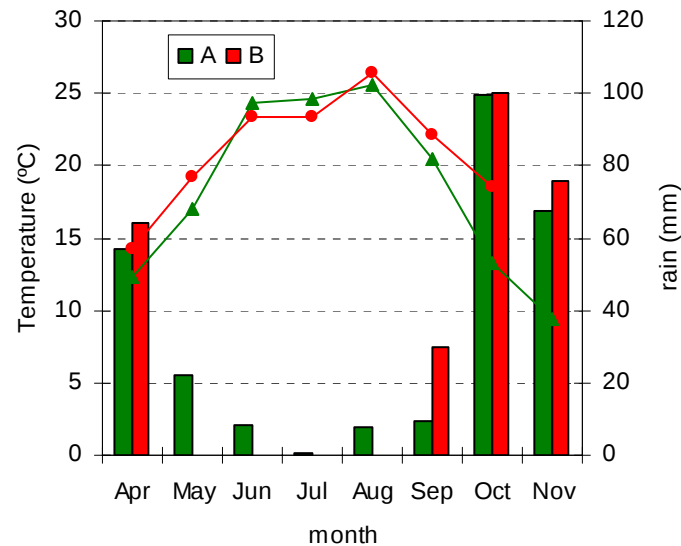
	N	Stem biomass (t/ha)	Plant height (cm)	Stem diameter (mm)
<u>Kenaf variety</u>				
Tainung 2	3	9.2 ab	248.0 a	19.5 a
Salvador	3	7.1 b	216.1 a	17.7 a
Everglades 41	3	11.1 a	219.4 a	18.6 a
OVERALL SCORES	9	9.1	227.8	18.6

Effect of kenaf varieties on plant growth and biomass yields



Effect of experimental locality on plant growth and biomass yields

- Experimental locality:
 - Alcalá de Henares, Madrid, Spain
 - Guadajira, Badajoz, Spain
- Kenaf variety:
 - Tainung 2
 - Everglades 41
 - Salvador
- 200000 plants/ha
- Sowing date: june



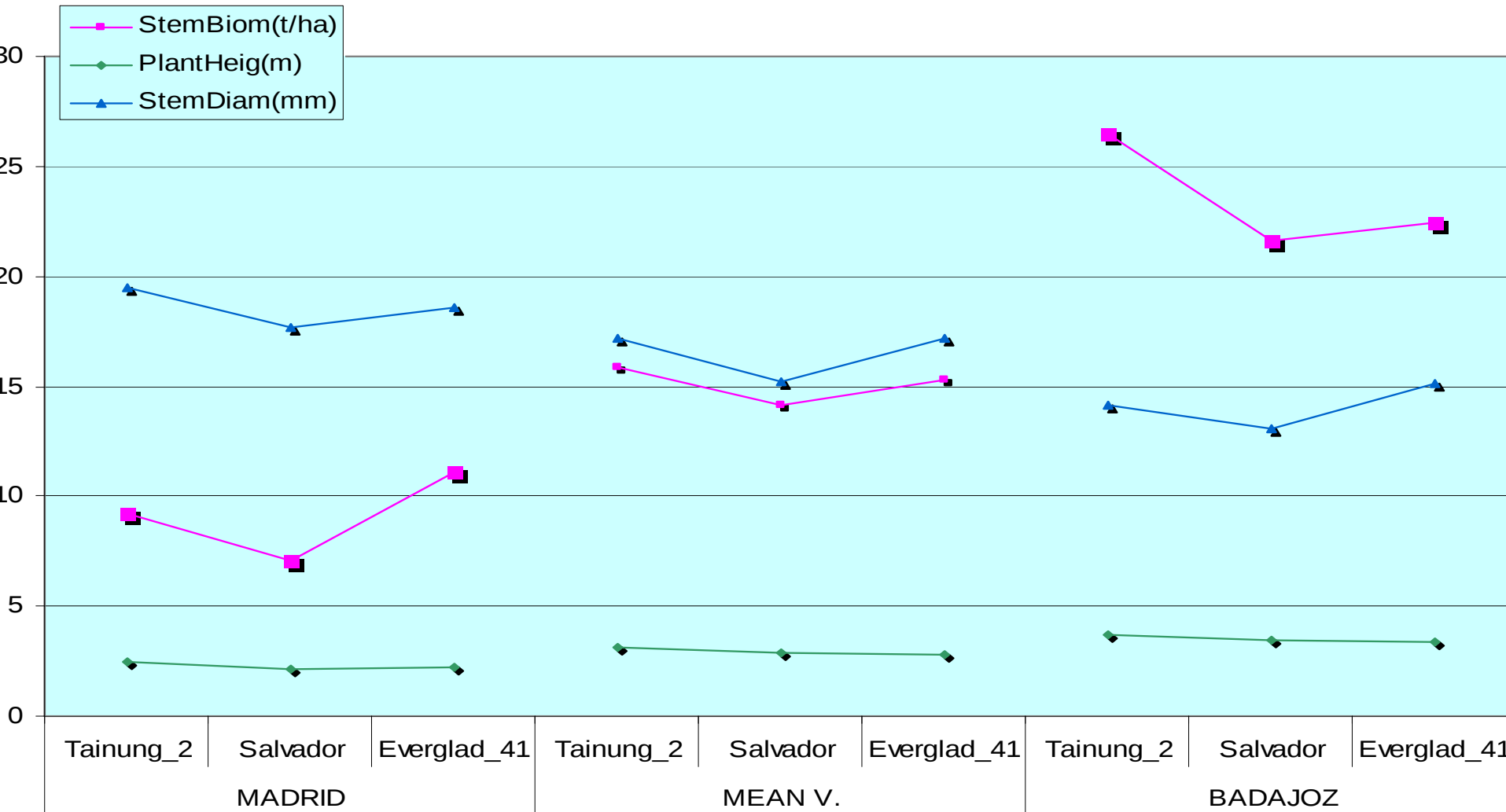
Effect of experimental locality on plant growth and biomass yields

Effect of kenaf variety (Taninung 2, Salvador, Everglades 41) and experimental locality (A: Alcalá de Henares, Madrid, Spain; B: Guadajira, Badajoz, Spain) on the dry stem biomass yield of kenaf (t/ha), plant height (cm), and stem diameter (mm) at the end of growth period, and analyses of variance. N, number of plots; DF, degrees of freedom; The letters in the columns indicate means showing a significant difference at the 5 % level (Duncan's multiple range test).

	N	Stem biomass (t/ha)	Plant height (cm)	Stem diameter (mm)
<u>Locality</u>				
A	9	9.1 b	227.8 b	18.6 a
B	9	21.0 a	359.1 a	14.4 b
<u>Kenaf variety</u>				
Tainung 2	6	15.9 a	315.0 a	17.2 a
Salvador	6	14.1 a	285.7 ab	15.2 a
Everglades 41	6	15.3 a	279.7 b	17.2 a
OVERALL SCORES	18	15.1	293.5	16.5
Source of variation	DF	Stem biomass	Plant height	Stem diameter
		----- P -----		
Locality (L)	1	0.0001	0.0001	0.0001
Variety (V)	2	ns	ns	ns
L x V	2	ns	ns	ns

Mean values effect of Varieties on plant growth and biomass yields between MADRID & BADAJOZ

Stem Characters&Height_RELATION with Localities&Varieties.



Mean values effect of Varieties on plant growth and biomass yields between MADRID & BADAJOZ

CONCLUSIONS:

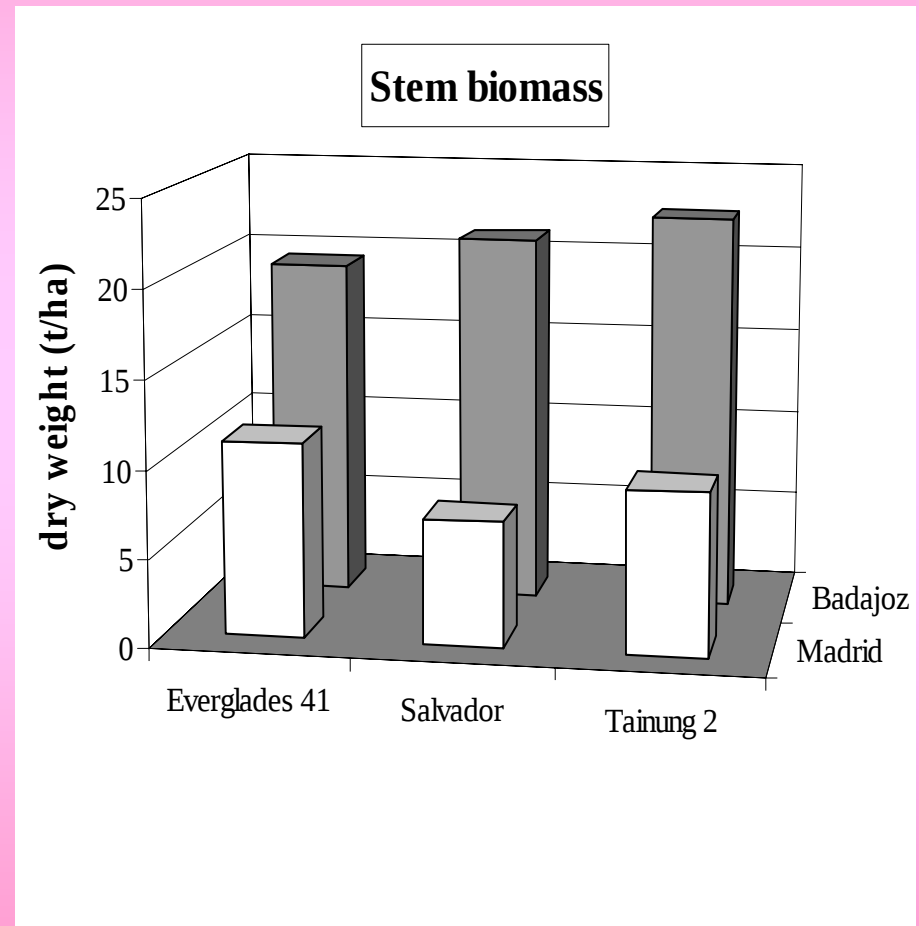
Effect of locality

The results show that the biomass production of kenaf was significantly greater in **Badajoz** than in **Madrid**.

Differences between the two localities

Kenaf has been shown to need relatively high temperatures during its growth cycle: .

Differences: between the two localities can be mainly due to Madrid low temperatures compared with Badajoz temperatures at the beginning and at the end of the cycle.



LOCALITY CONCLUSIONS:

Mean values effect of Varieties on plant growth and biomass yields between MADRID & BADAJOZ

CONCLUSIONS & DISCUSSION:

Effect of locality

The results show that the biomass production of kenaf was significantly greater in **Badajoz** than in **Madrid**.

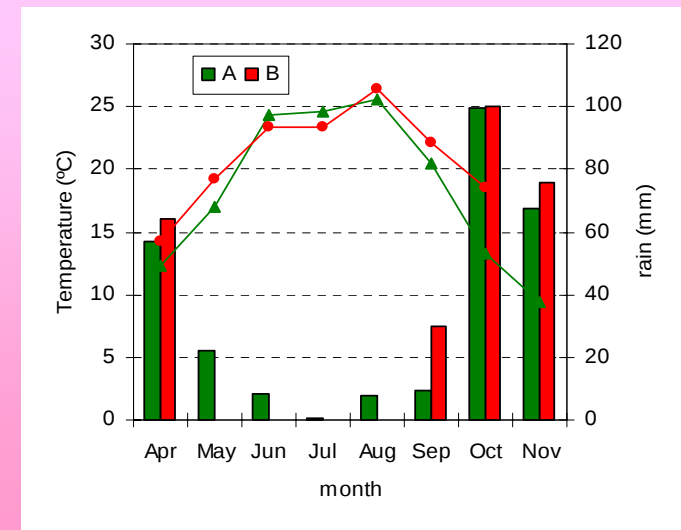
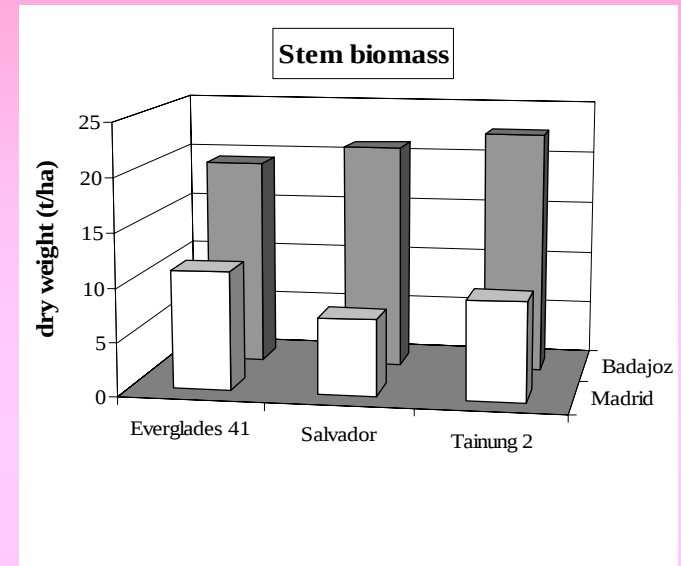
Differences between the two localities

Kenaf has been shown to need relatively high temperatures during its growth cycle:

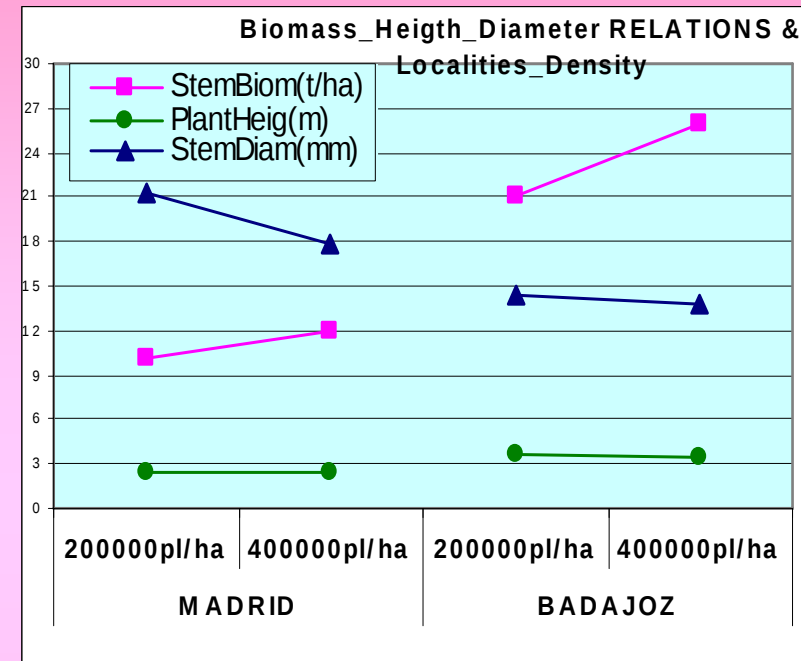
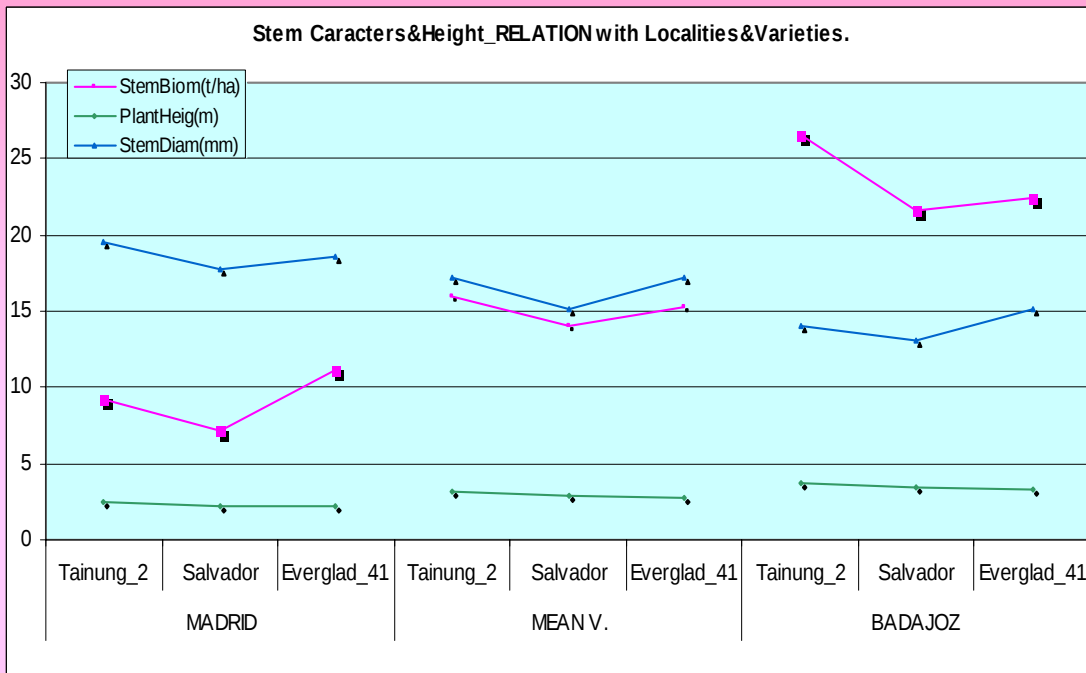
Kenaf.

Differences between the two localities Madrid & Badajoz, are due:

Differences: between the two localities can be mainly due to Madrid low temperatures compared with Badajoz temperatures at the beginning and at the end of the cycle.



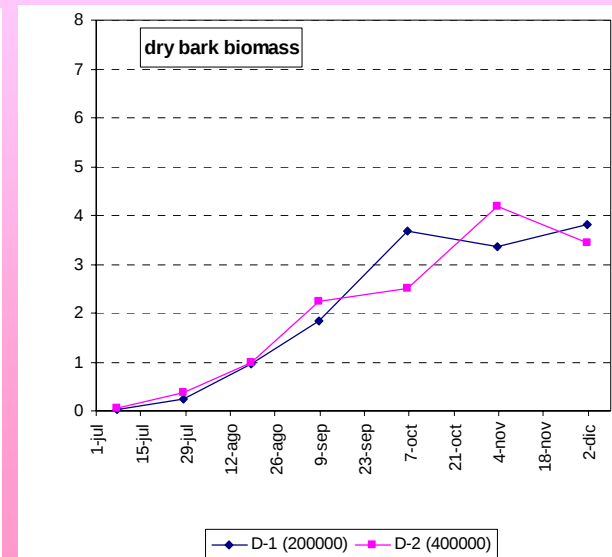
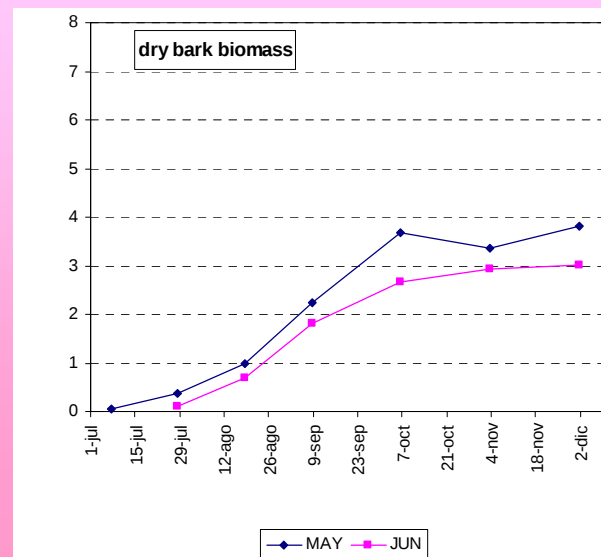
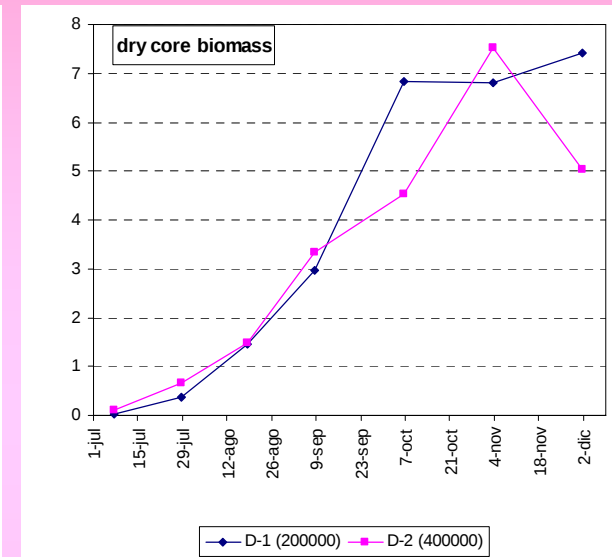
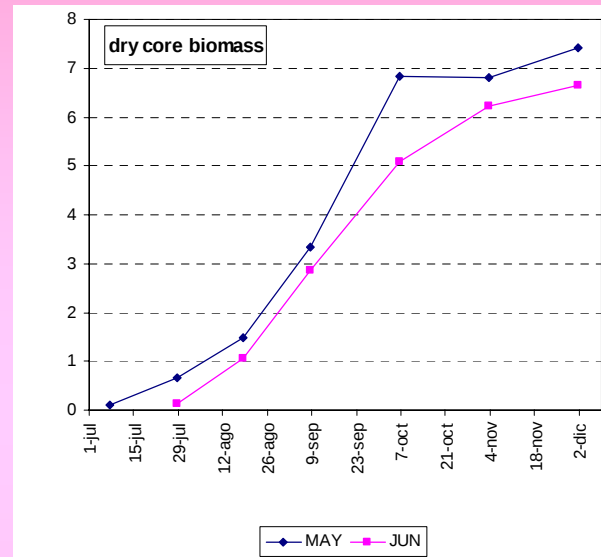
DISCUSSION: Relations between plant density & varieties



CONCLUSIONS & DISCUSSION: Competition for space and nutrients looks to be the trend who governs the relations between stem characters & height with varieties & plant density. Bigger plants occupying too much room by / m² of soil with are equivalent to n°plants/m². Badajoz varieties is equiv. to 400.000/ha. Stem diam. it has a negative trend in both. Height, inside each group shows also negative trend, and positive throughout the groups. Stem biomass for Badajoz going from **21 to 26** t/ha from 200000 to 400000 pl/ha.

sowing DATE & plant DENSITY CONCLUSIONS :

Dry BARK & CORE values are not effect by sowing DATE and plant DENSITY



Task 2.3: Effect of irrigation and nitrogen fertilization on biomass yields

Field experiments in Alcalá de Henares, Madrid, Spain

- 4 irrigation levels X 3 nitrogen fertilization X 3 replicates

I-0: 0% of PET

I-25: 25% of PET

I-50: 50% of PET

I-100: 100% of PET

N-0: 0 kg N/ha

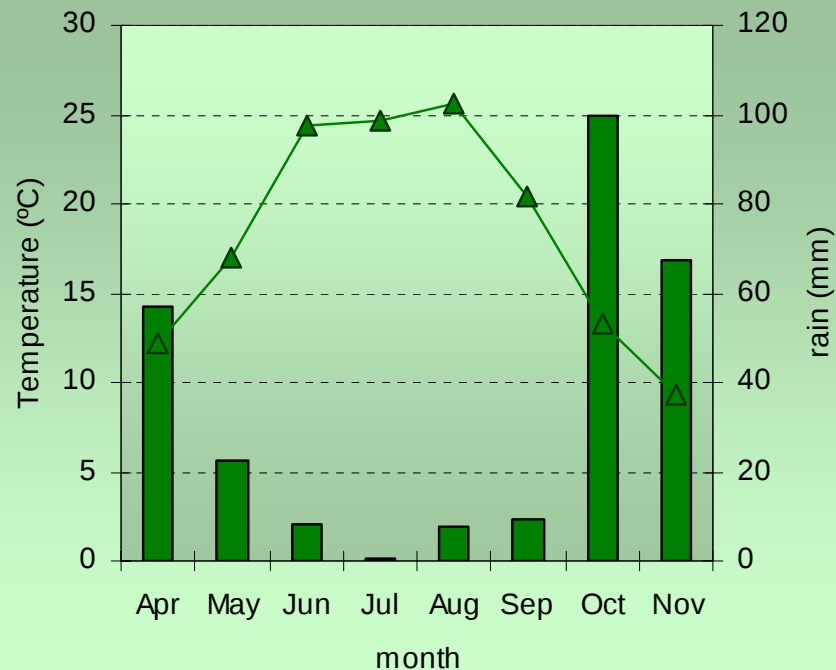
N-75: 75 kg N/ha

N-100: 100 kg N/ha

- kenaf variety: Tainung 2
- sowing date: 28/05/2003
- plant density: 200000 plants/ha

Field experiments in Alcalá de Henares, Madrid, Spain

Climatic conditions during experimental essays



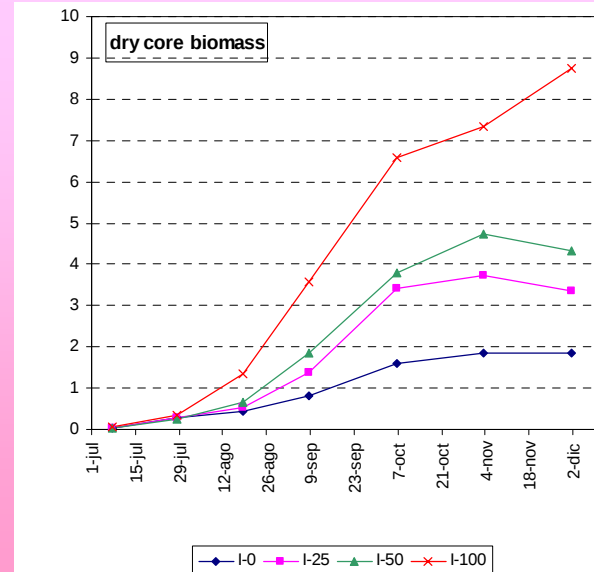
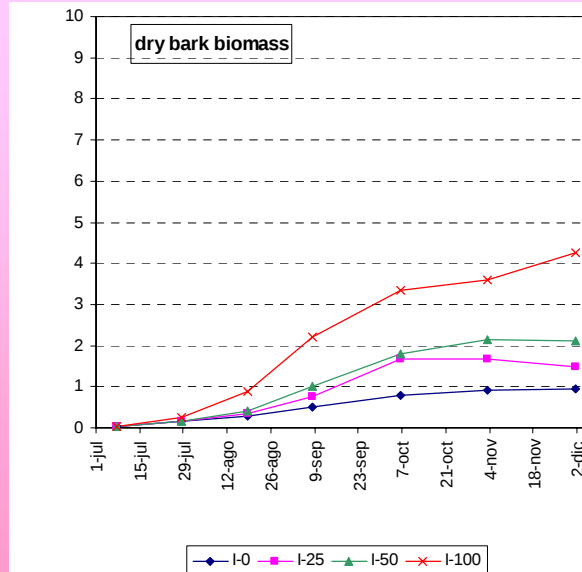
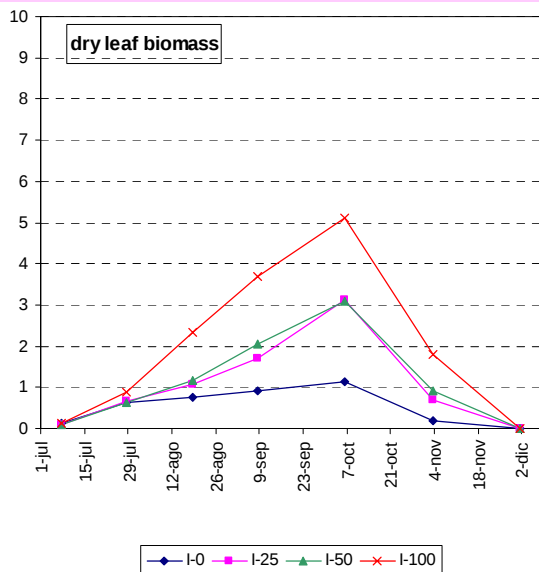
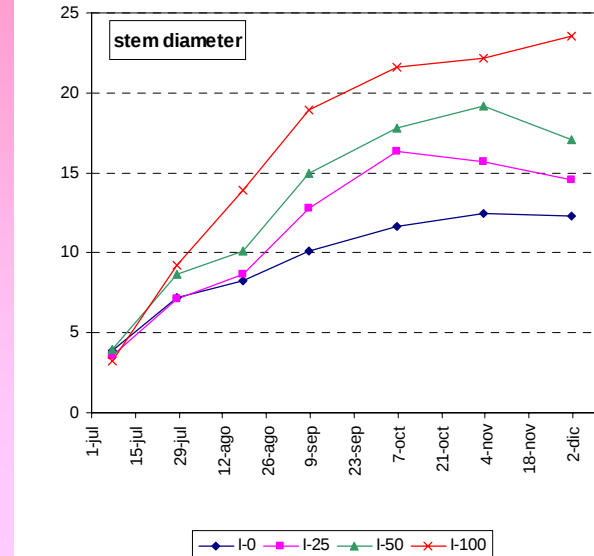
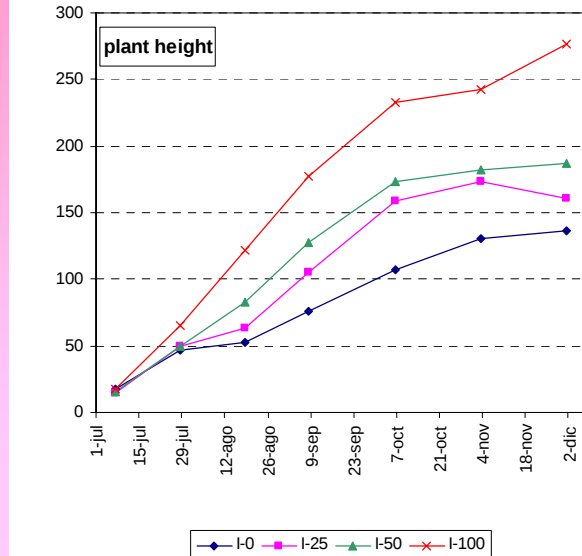
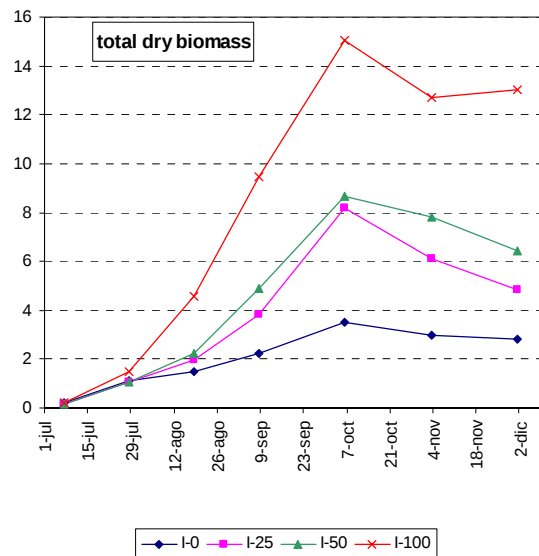
water supplied in each irrigation treatment

irrigation (l/m ²)	
I-0	0
I-25	147
I-50	294
I-100	589

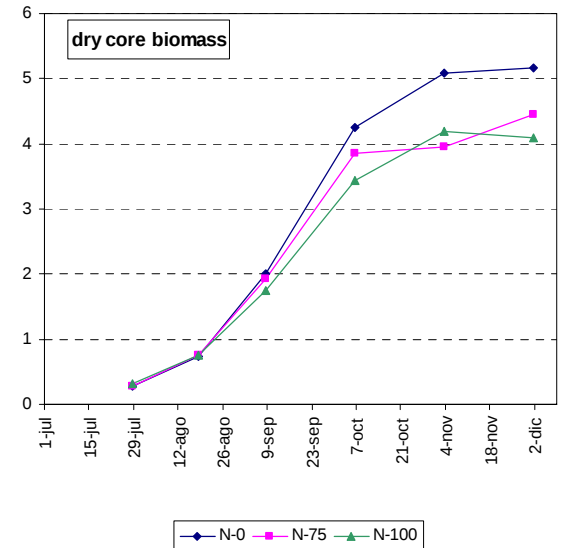
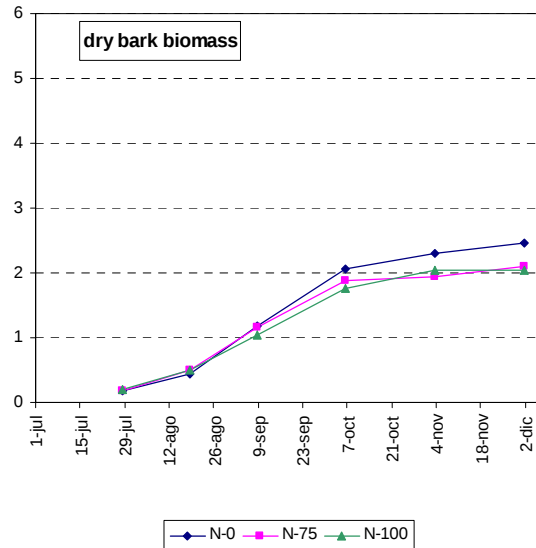
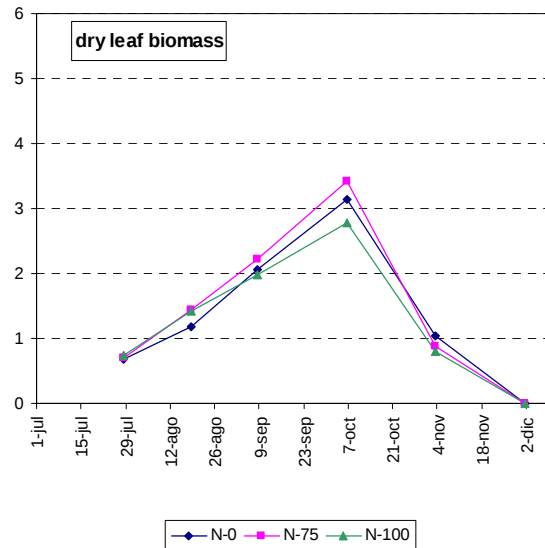
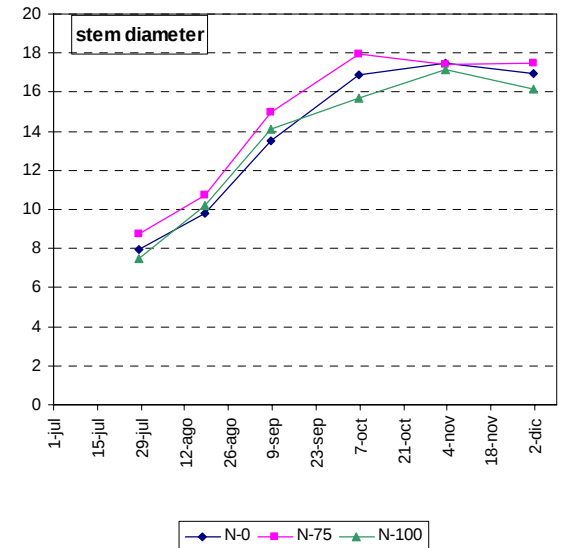
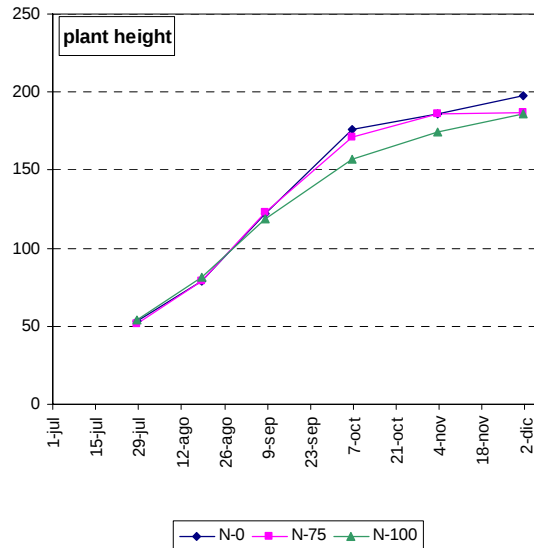
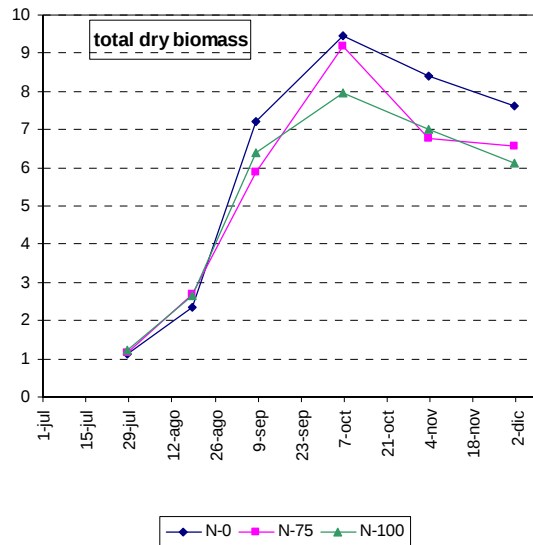
Effect of nitrogen fertilization (N_0 , 0 kg N/ha; N_{75} , 75 kg N/ha; N_{100} , 100 kg N/ha) and Irrigation (I_0 , without irrigation; I_{25} , 25 % PET; I_{50} , 50 % PET; I_{100} , 100% PET) on the dry stem biomass yield of kenaf(t/ha), plant height (cm), and stem diameter (mm) at the end of growth period in **Alcalá de Henares**, Madrid, Spain, and analyses of variance for the Fertilization and Irrigation variables. N, number of plots; DF, degrees of freedom; The letters in the columns indicate means showing a significant difference at the 5 % level (Duncan's multiple range test).

	N	Stem biomass (t/ha)	Plant height (cm)	Stem diameter (mm)
<u>Nitrogen Fertilization</u>				
N_0	12	7.4 a	176.5 a	16.9 a
N_{75}	12	5.9 a	170.8 a	18.0 a
N_{100}	12	6.2 a	156.9 a	15.7 a
<u>Irrigation</u>				
I_0	9	2.8 c	107.1 c	11.6 c
I_{25}	9	5.4 b	158.8 b	16.4 b
I_{50}	9	6.9 b	173.3 b	17.8 b
I_{100}	9	10.9 a	233.0 a	21.6 a
OVERALL SCORES	36	6.5	168.1	16.9
Source of variation	DF	Stem biomass	Plant height	Stem diameter
		----- <i>P</i> -----		
Nitrogen Fertilization (F)	2	ns	ns	ns
Irrigation (I)	3	0.0001	0.0001	0.0001
F x I	6	ns	ns	ns

Effect of irrigation on plant growth and biomass yields



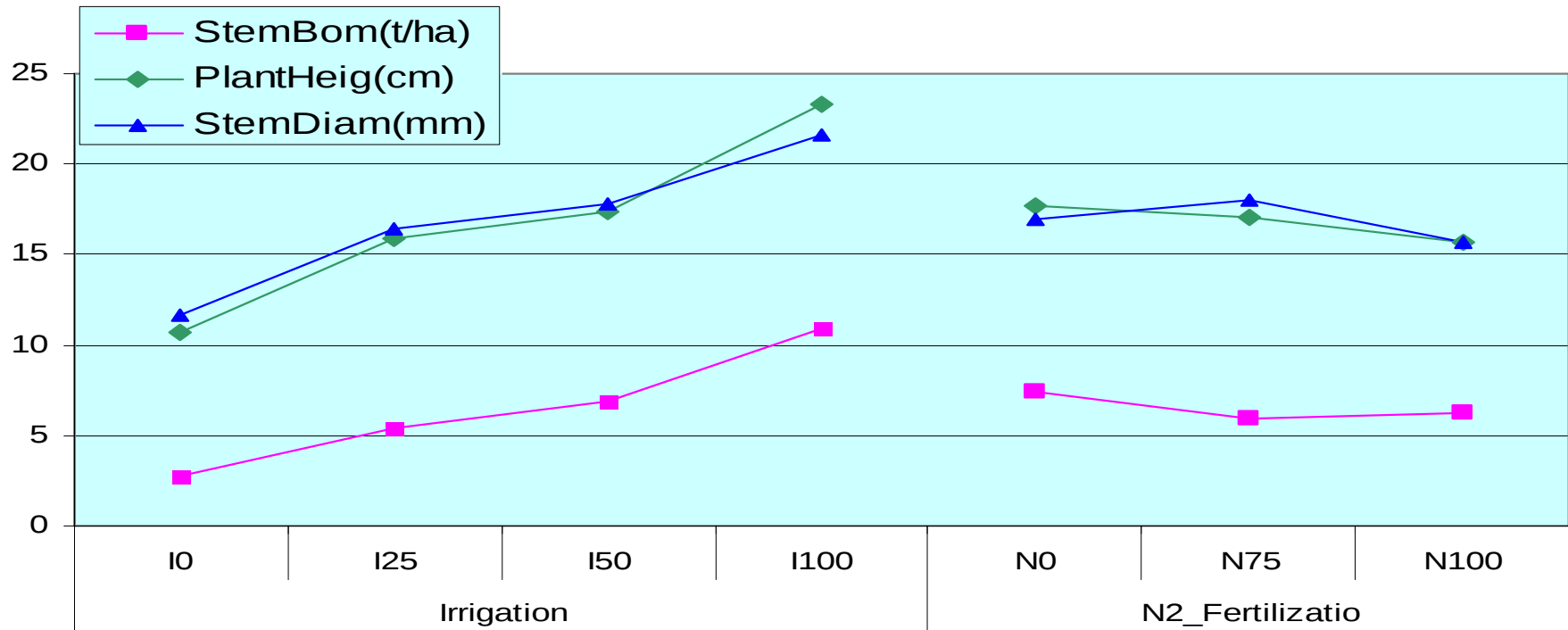
Effect of nitrogen fertilization on plant growth and biomass yields



CONCLUSIONS:

Effect of N_2 fertilization and irrigation on plant growth and biomass yields
MADRID

Madrid StemCharacters_RELATED with Irrigat&N2fertilz



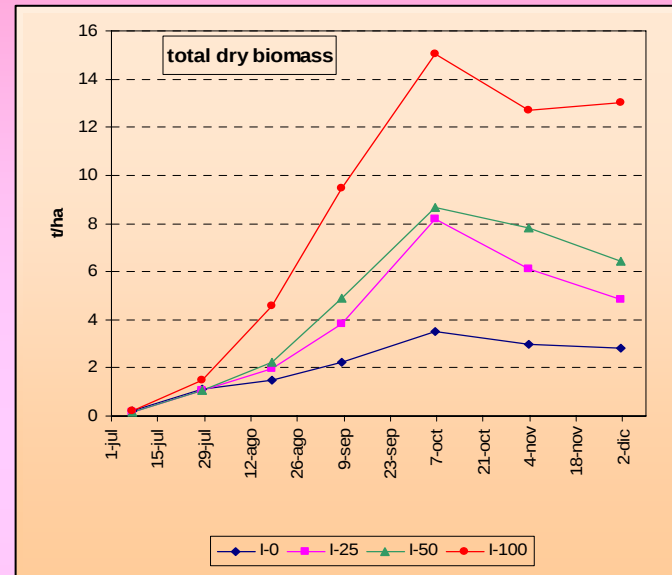
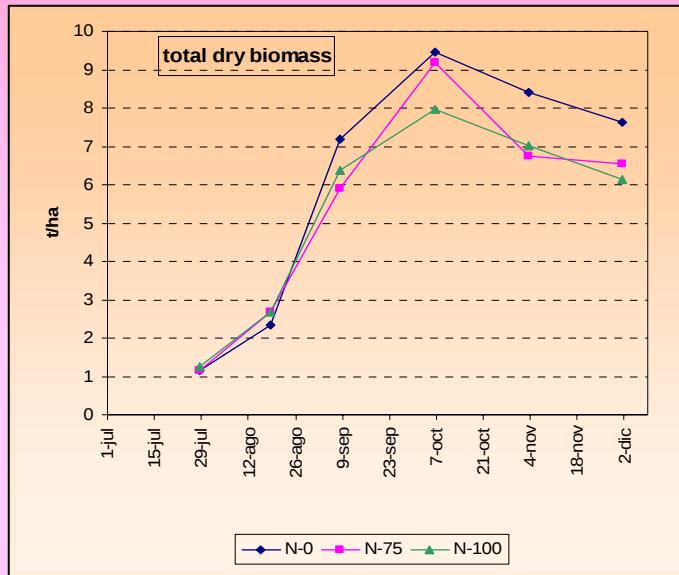
CONCLUTIONS:

The I_{100} was the best treatment. The difference between I_{50} and I_{25} biomass production were not significant. The effect of I_0 on reduction of biomass production was significant with the others irrigation treatments.

The fertilization did not affect to the biomass yield production of kenaf.

CONCLUSIONS:

Effect of N_2 fertilization and irrigation on total dry biomass MADRID



Effect of nitrogen fertilization (N_0 , 0 kg N/ha; N_{75} , 75 kg N/ha; N_{100} , 100 kg N/ha) and irrigation (I_0 , without irrigation; I_{25} , 25 % PET; I_{50} , 50 % PET; I_{100} , 100% PET) on the kenaf biomass yield (t/ha) in Alcalá de Henares (Madrid, Spain).

CONCLUSIONS:

The I_{100} was the best treatment and I_0 the worst. The difference between I_{50} and I_{25} biomass production were not significant. The pattern of biomass production of bark and core were similar. The fertilization did not affect to the biomass yield production of kenaf.

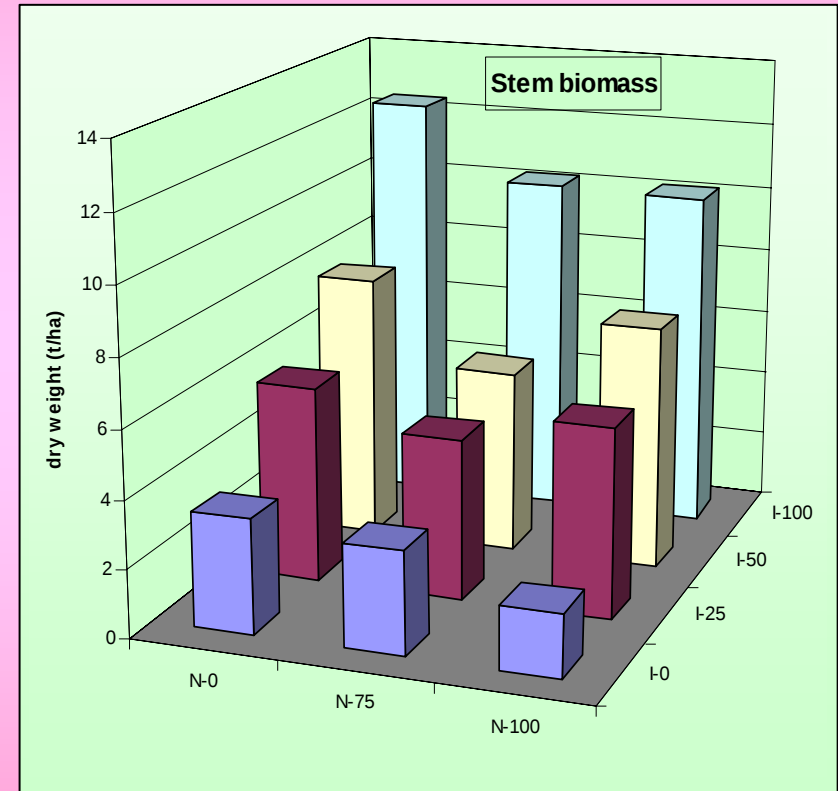
CONCLUSION:

Effect of N_2 fertilization and irrigation on Stem biomass yield in MADRID

CONCLUSIONS:

At the end of the experimental period, I_{50} treatment reduced dry stem production by 37 %, I_{25} by 50 % and I_0 by 75 % when compared with I_{100} treatment. *The highest stem biomass production: 12.4 t/ha* (bark: 3.9 t/ha; core: 8.5 t/ha) *was obtained in plots treated with N_0 (0 kg N/ha) and I_{100} (100% PET)*

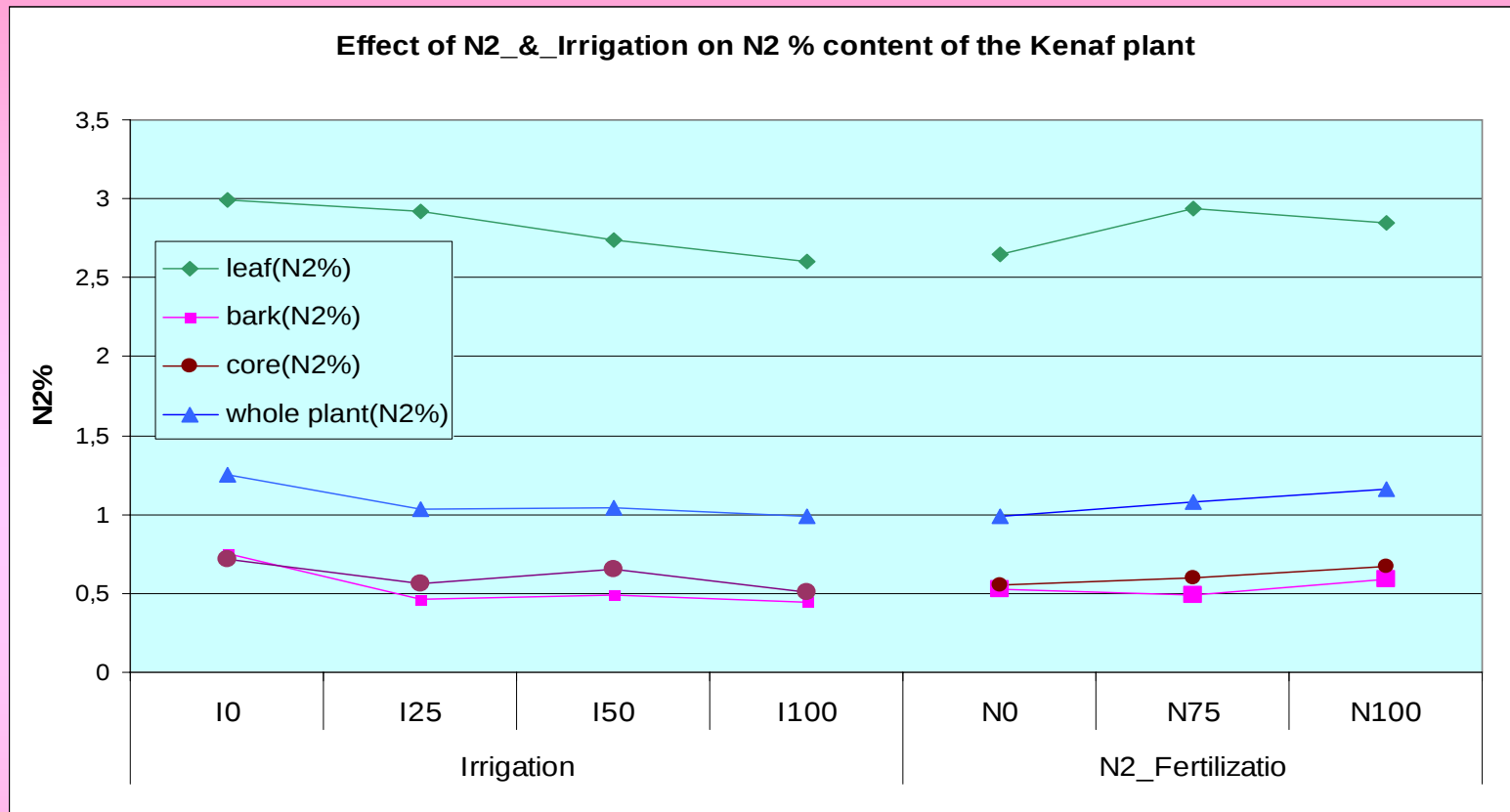
Effect of nitrogen fertilization (N_0 , 0 kg N/ha; N_{75} , 75 kg N/ha; N_{100} , 100 kg N/ha) and irrigation (I_0 , without irrigation; I_{25} , 25 % PET; I_{50} , 50 % PET; I_{100} , 100% PET) on the dry stem biomass yield of kenaf(t/ha) at the end of growth period in Alcalá de Henares, Madrid, Spain



Effect of nitrogen fertilization (N_0 , 0 kg N/ha; N_{75} , 75 kg N/ha; N_{100} , 100 kg N/ha) and Irrigation (I_0 , without irrigation; I_{25} , 25 % PET; I_{50} , 50 % PET; I_{100} , 100% PET) on **% nitrogen content in plant components (leaf, bark and core)** at the end of growth period in Alcalá de Henares, Madrid, Spain, and analyses of variance for the Fertilization and Irrigation variables. N, number of plots; DF, degrees of freedom; The letters in the columns indicate means showing a significant difference at the 5 % level (Duncan's multiple range test).

NITROGEN CONTENT (%)					
	N	leaf	bark	core	whole plant
<u>Nitrogen Fertilization</u>					
N_0	12	2.65 b	0.53 a	0.55 a	0.76 a
N_{75}	12	2.94 a	0.49 a	0.60 a	0.84 a
N_{100}	12	2.85 ab	0.59 a	0.67 a	0.89 a
<u>Irrigation</u>					
I_0	9	2.99 a	0.75 a	0.72 a	0.88 a
I_{25}	9	2.92 a	0.44 b	0.56 a	0.80 a
I_{50}	9	2.74 ab	0.49 b	0.65 a	0.83 a
I_{100}	9	2.60 b	0.46 b	0.51 a	0.80 a
OVERALL SCORES	36	2.81	0.54	0.61	0.83
		leaf	bark	core	whole plant
Source of variation	DF	P -----			
Nitrogen Fertilization (F)	2	0.0569	ns	ns	ns
Irrigation (I)	3	0.0381	0.0049	ns	ns
F x I	6	ns	ns	ns	ns

PLANT N₂% content. CONCLUSIONS:
 Effect of N₂ fertilization and irrigation on plant N₂%
 Concentración at the end of the growth period in MADRID



CONCLUSIONS: The N₂ fertilization increased significantly the N₂ content *in leaves, BUT* and similar content in the stem components for all fertilization treatments. Without irrigation (*I₀ treatment*) the N₂ content was higher than in the other irrigation treatments



02-09-03



02-09-03



14-10-03



14-10-03



Guadajira (Badajoz)



Alcalá de Henares (Madrid)

