BIOKENAF

QLK5-CT-2002-01729

Biomass Production Chain and Growth Simulation Model for Kenaf

INSTITUTO NACIONAL DE INVESTIGACIÓN Y TECNOLOGÍA AGRARIA Y ALIMENTARIA (INIA)
DPTO. MEDIO AMBIENTE
ALCALA DE HENARES, MADRID, SPAIN

Catania, 5 July 2005

WP2. Adaptability and Productivity Trials

The **main aim** of this work package is determine the sustainable yielding potential of kenaf as an energy crop, at different locations in Southern Europe.

WP2 consists of four tasks:

- Task 2.1: Screening trial
- Task 2.2: Effect of sowing dates and plant populations on biomass yields
- Task 2.3: Effect of irrigation and nitrogen fertilisation on biomass yields
- Task 2.4: Kenaf field trials with size of 2ha

INIA
Dpto. Medio Ambiente
Alcalá de Henares (Madrid)

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

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

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

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

2003

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

2004

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-150: 150 kg N/ha

- kenaf variety: Tainung 2
- sowing date: 01/06/2004
- plant density: 200000 plants/ha

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

-Soil analysis

-Plant analysis (N, P, K)

Meteorological data

- Temperature
- Humidity
- Precipitation
- Evaporation
- Wind speed

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).

2003

	N	Stem biomass (t/ha)	Plant height (cm)	Stem diameter (mm)
Nitrogen Fertilization				
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
Irrigation				
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
		P		
Nitrogen Fertilization (F)	2	ns	ns	ns
Irrigation (I)	3	0.0001	0.0001	0.0001
F x I	6	ns	ns	ns

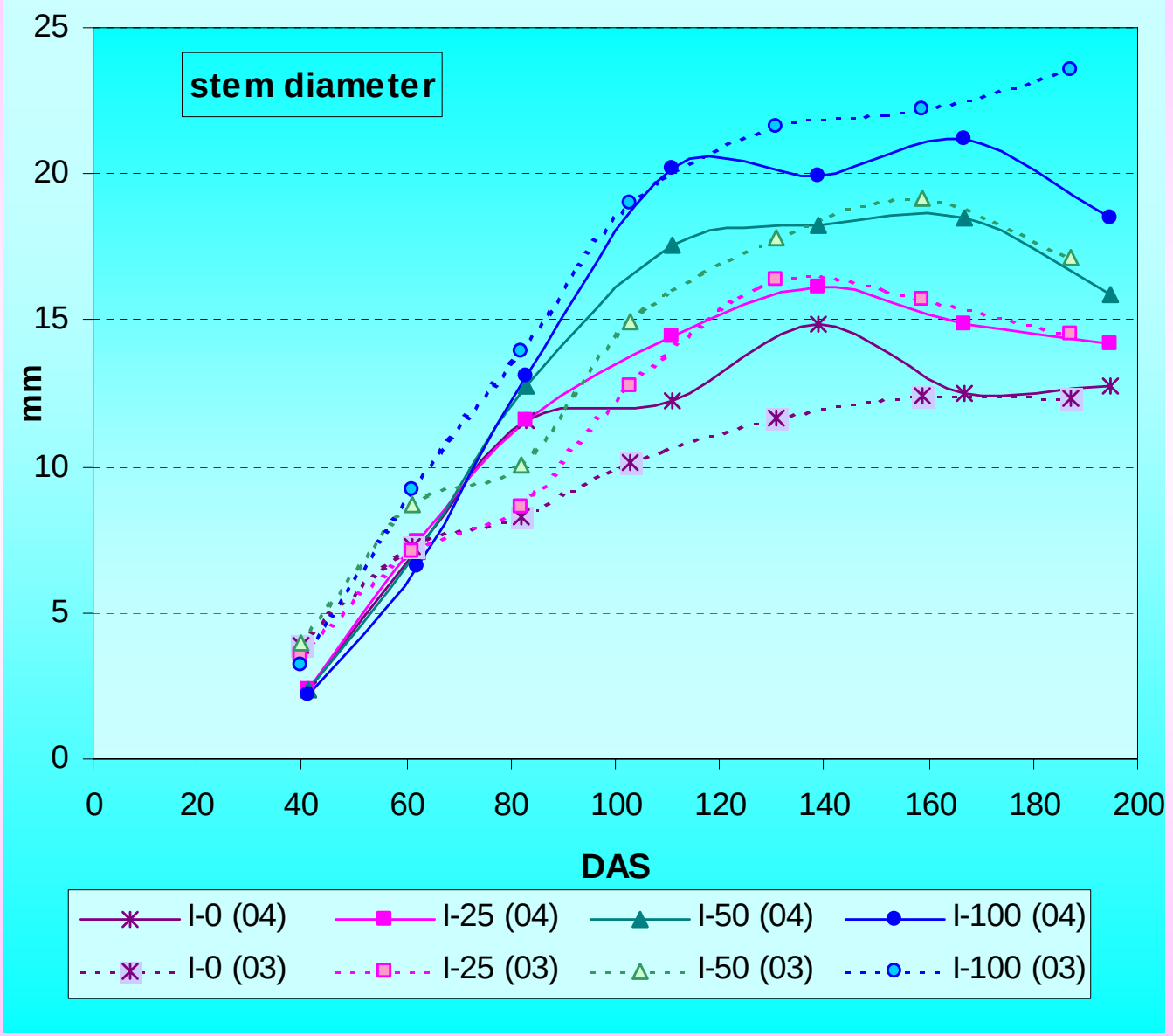
Effect of nitrogen fertilization (N_0, 0 kg N/ha; N_{75}, 75 kg N/ha; N_{150}, 150 kg N/ha) and Irrigation (I_0, without irrigation; I_{25}, 25 % PET; I_{50}, 50 % PET; I_{100}, 100% PET) on the dry stem biomass yield of kenaf(t/ha), plant height (cm), and stem diameter (mm) at the end of growth period 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).

2004

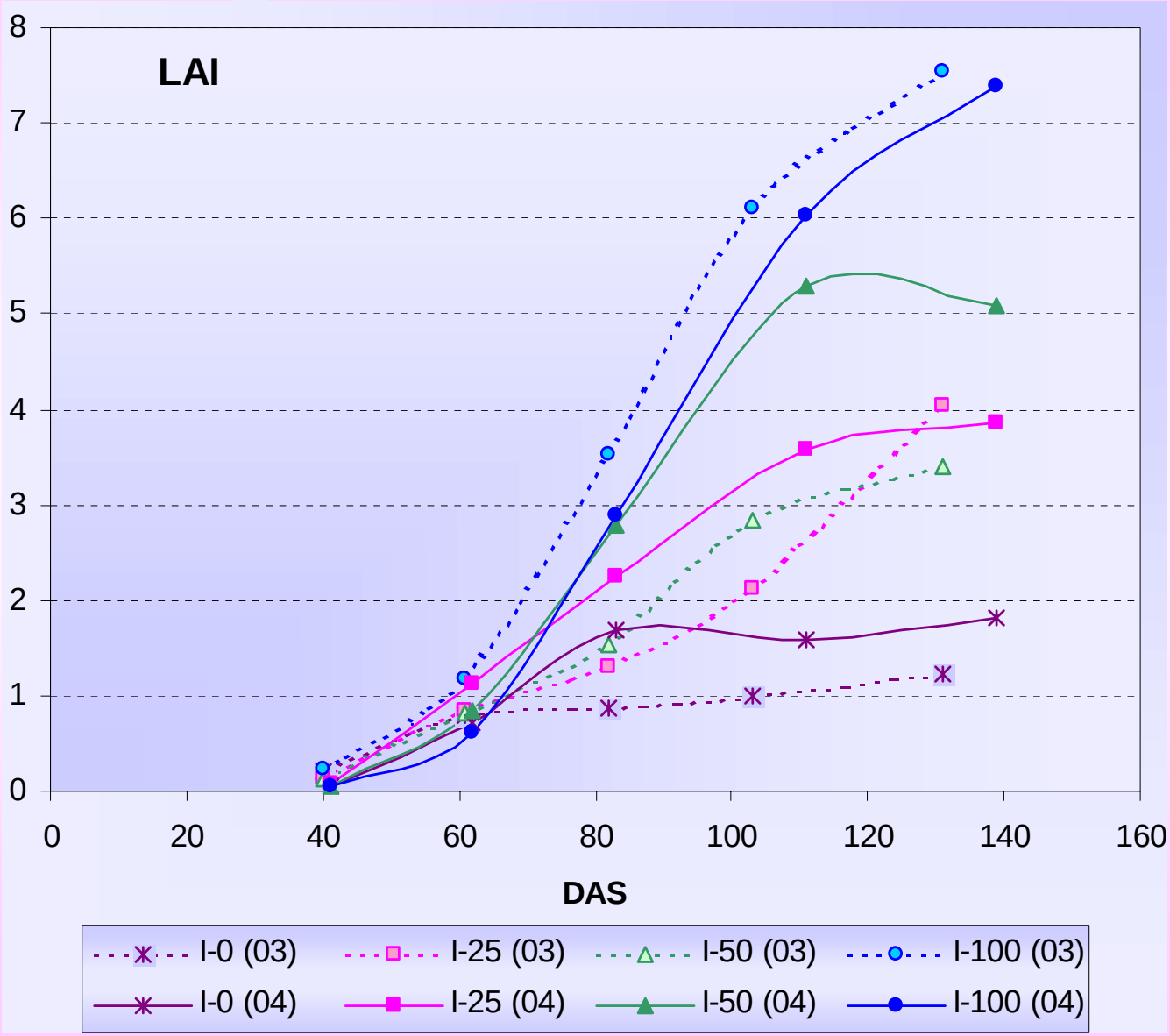
	N	Stem biomass (t/ha)	Plant height (cm)	Stem diameter (mm)
Nitrogen Fertilization				
N_0	12	7.4 a	192.8 a	16.8 a
N_{75}	12	6.9 a	190.1 a	16.0 a
N_{150}	12	7.3 a	193.2 a	16.9 a
Irrigation				
I_0	9	3.8 b	142.3 c	13.0 c
I_{25}	9	6.4 ab	179.8 b	15.6 bc
I_{50}	9	8.1 ab	205.8 ab	17.7 ab
I_{100}	9	9.7 a	228.5 a	19.2 a
OVERALL SCORES	36	7.2	192.2	16.6

Source of variation	DF	Stem biomass	Plant height	Stem diameter
		---------- *P* ----------		
Nitrogen Fertilization (F)	2	0.9971	0.9881	0.8618
Irrigation (I)	3	0.0616	0.0001	0.0011
F x I	6	0.9694	0.7491	0.9981

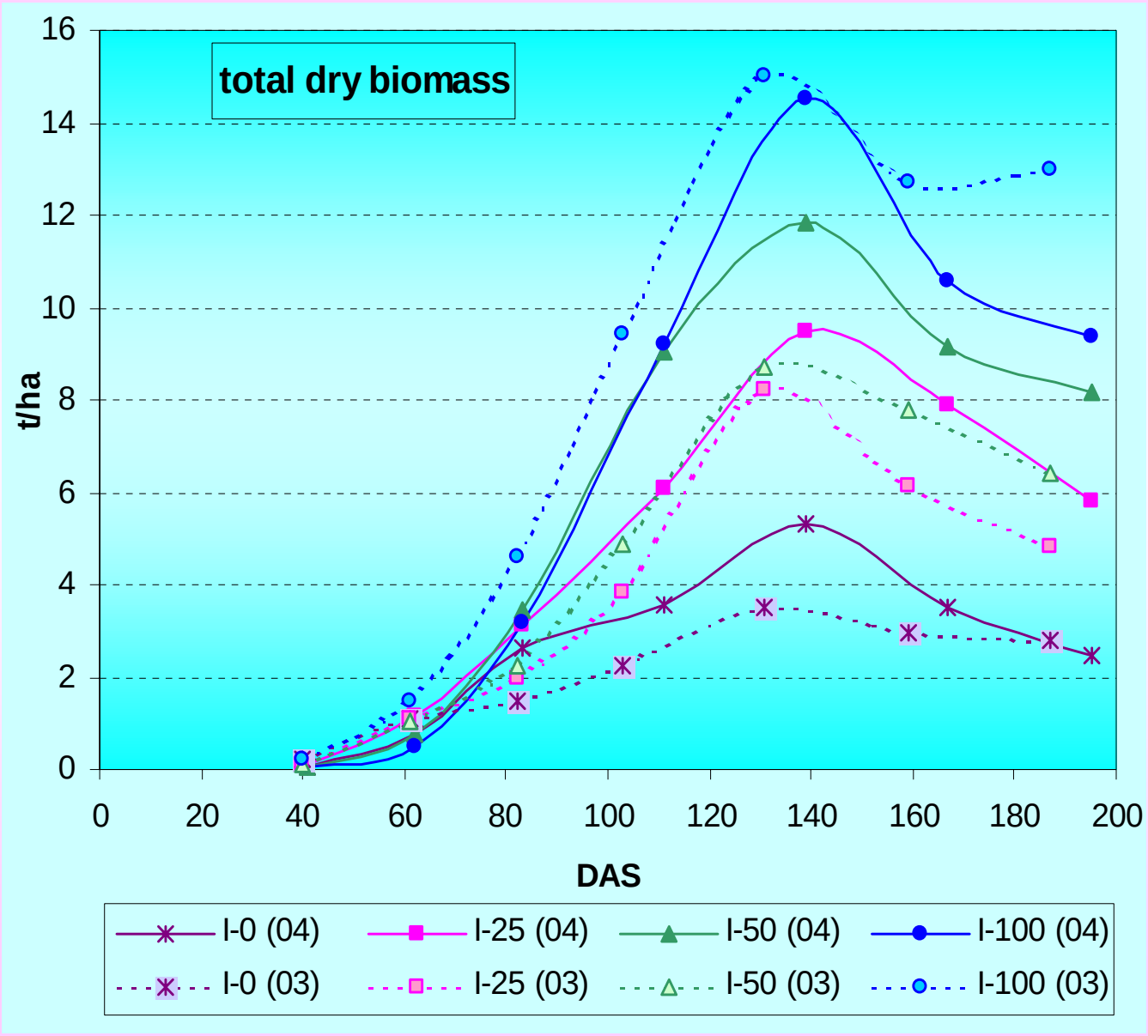
Effect of irrigation on plant growth and biomass yields



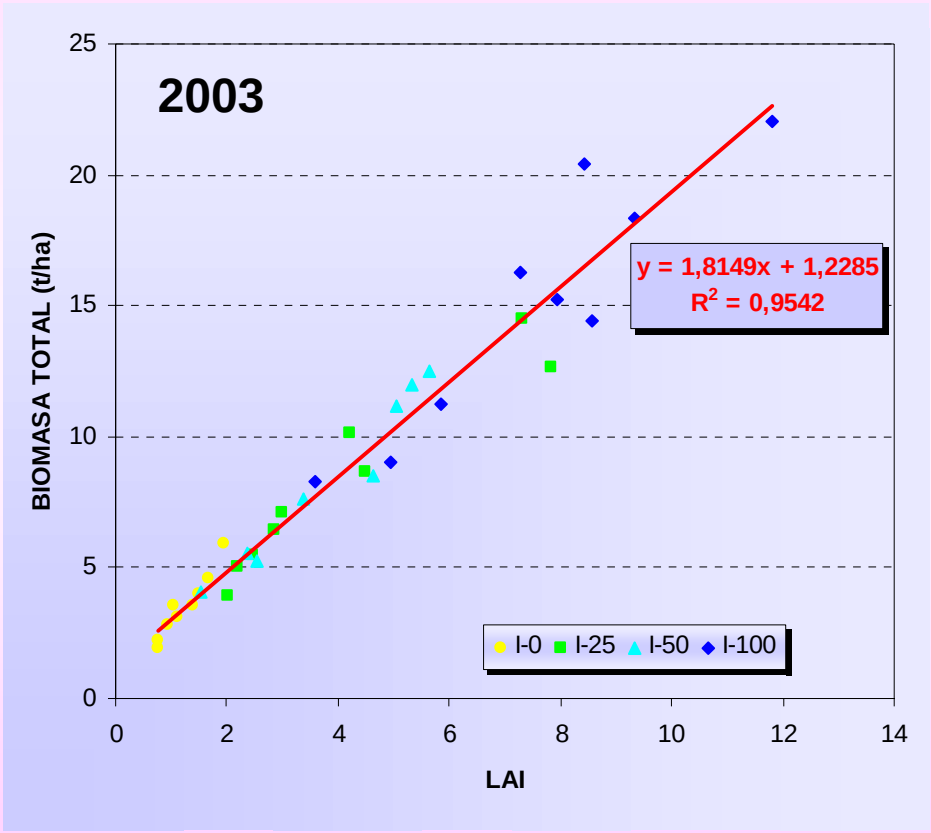
Effect of irrigation on plant growth and biomass yields

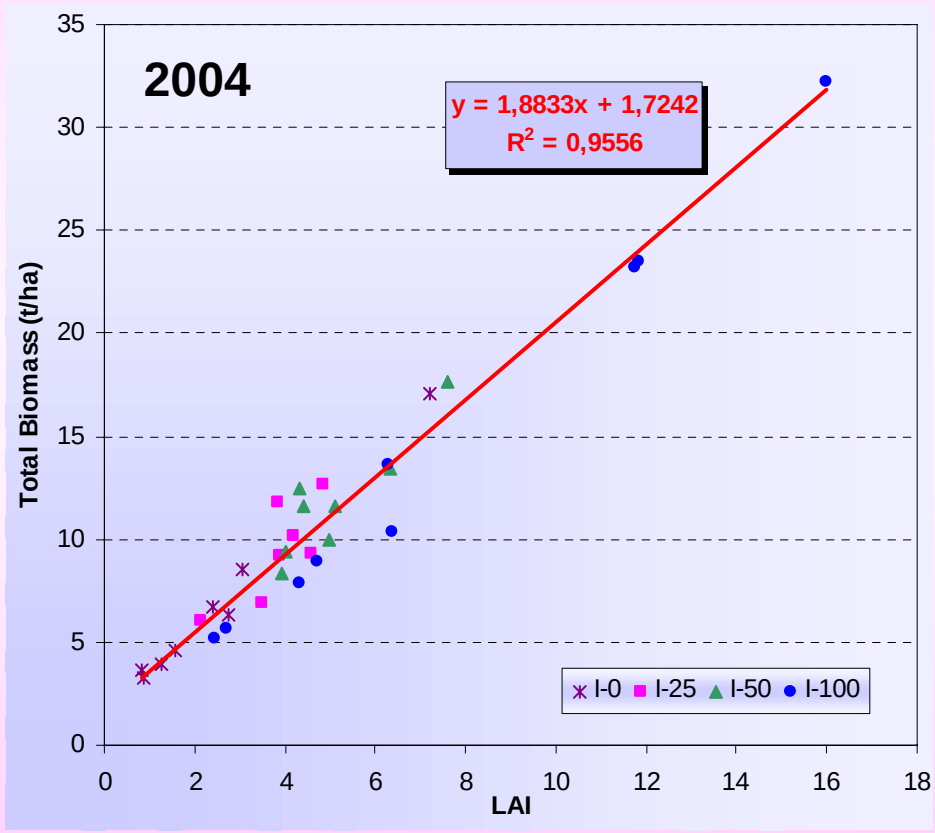


Effect of irrigation on plant growth and biomass yields

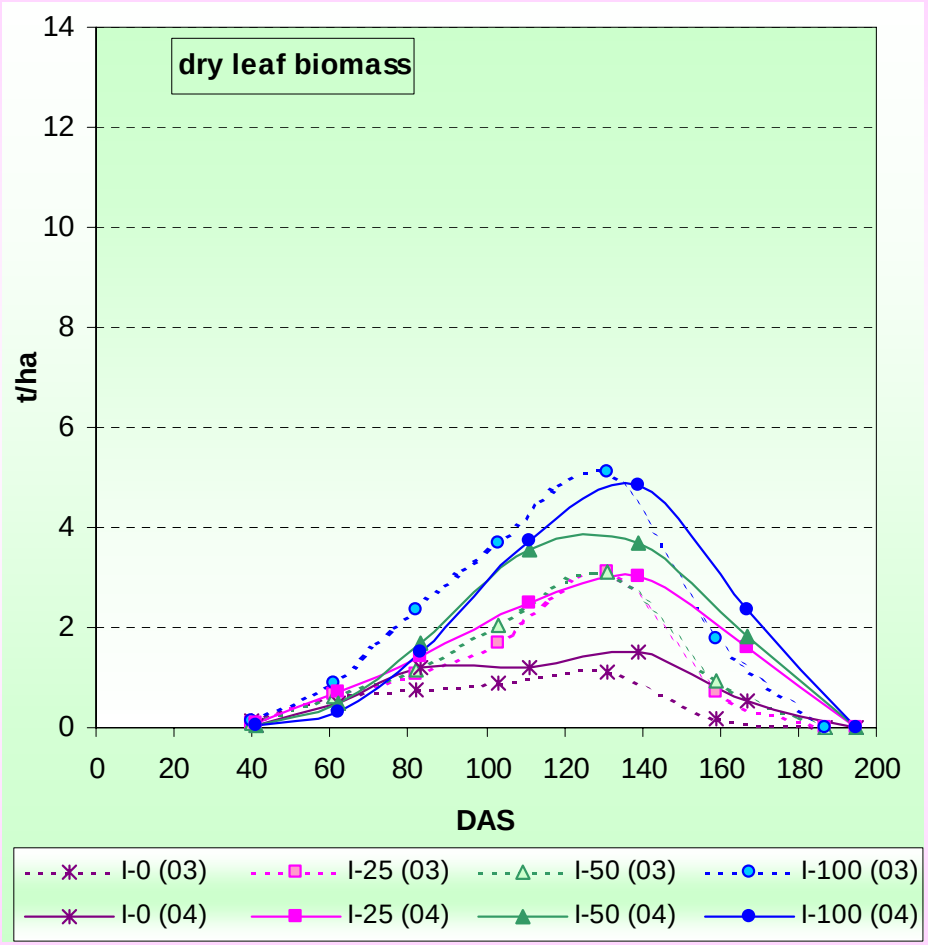


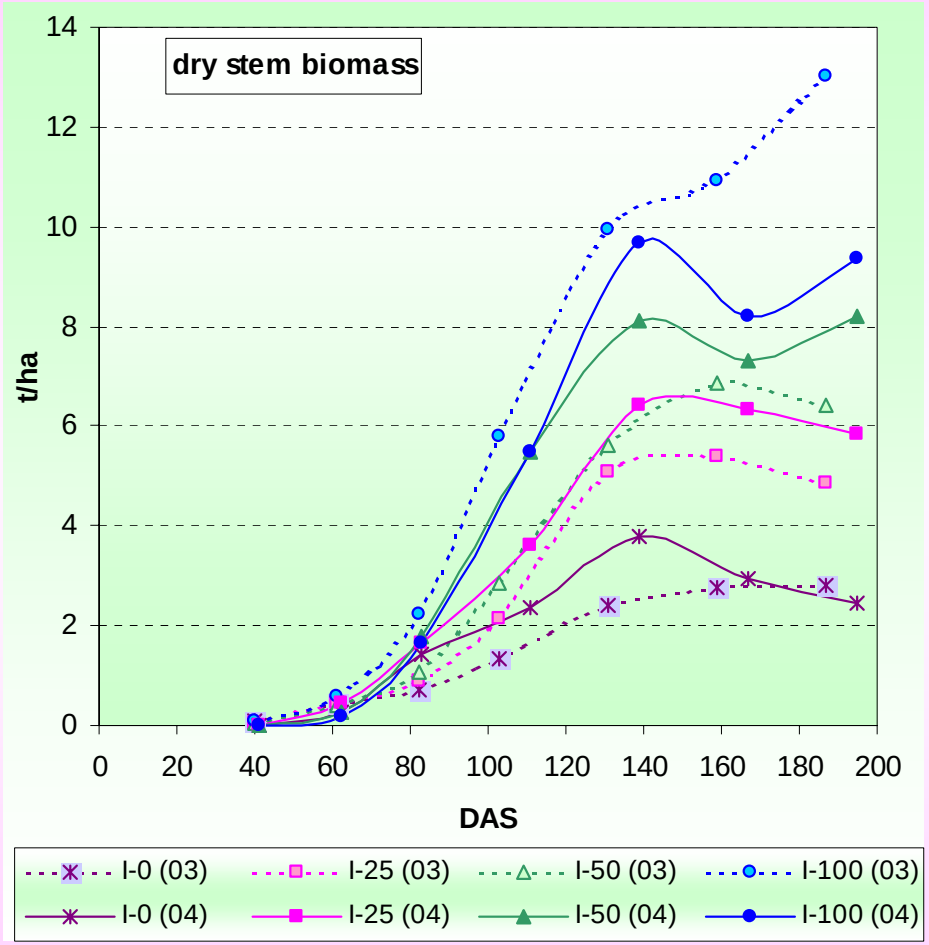
Effect of irrigation on plant growth and biomass yields



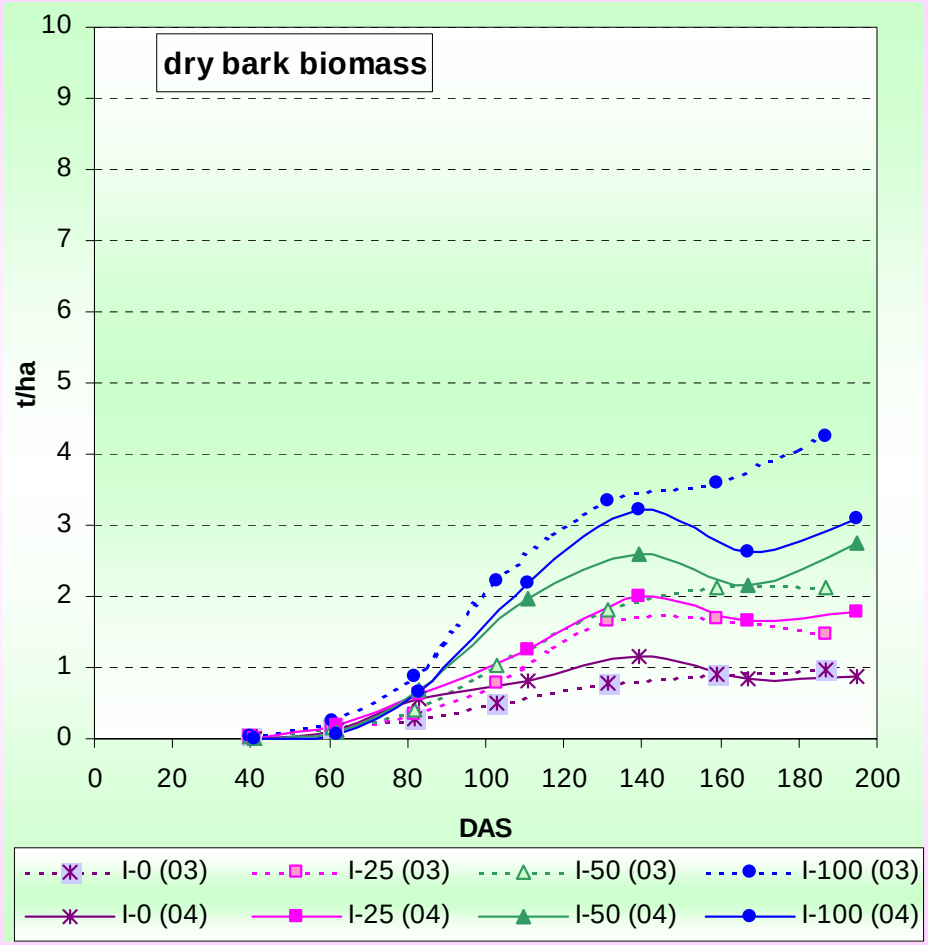


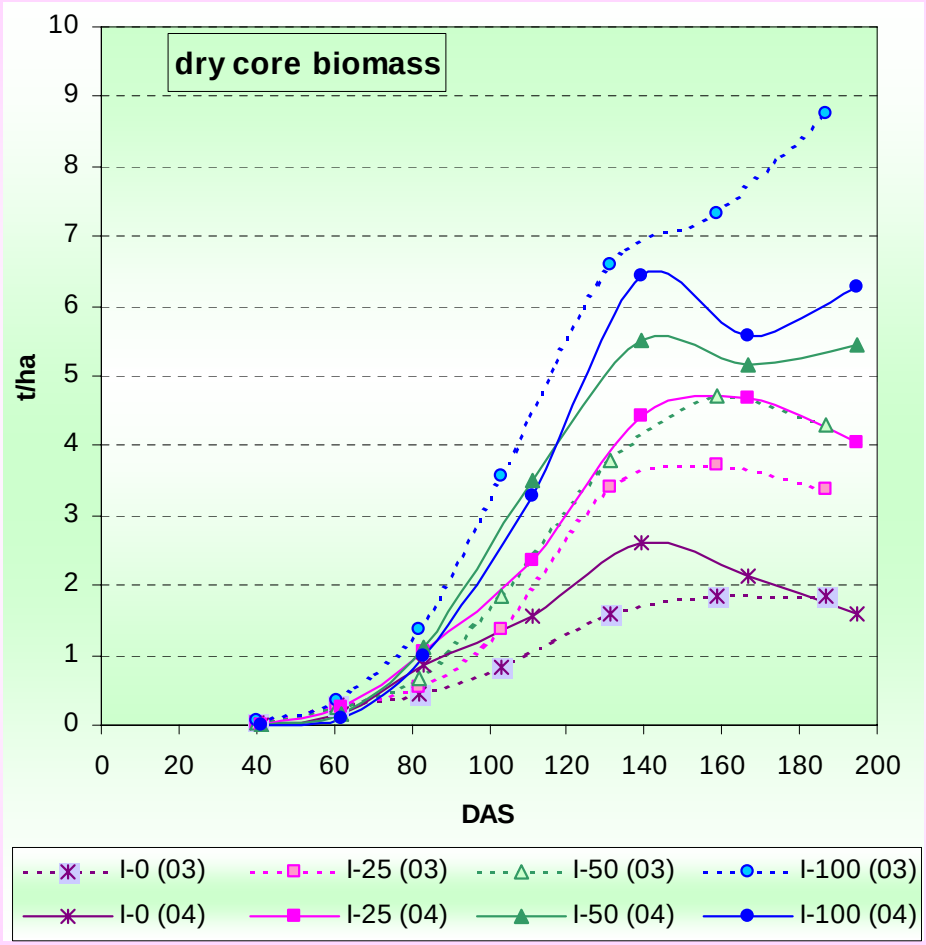
Effect of irrigation on plant growth and biomass yields

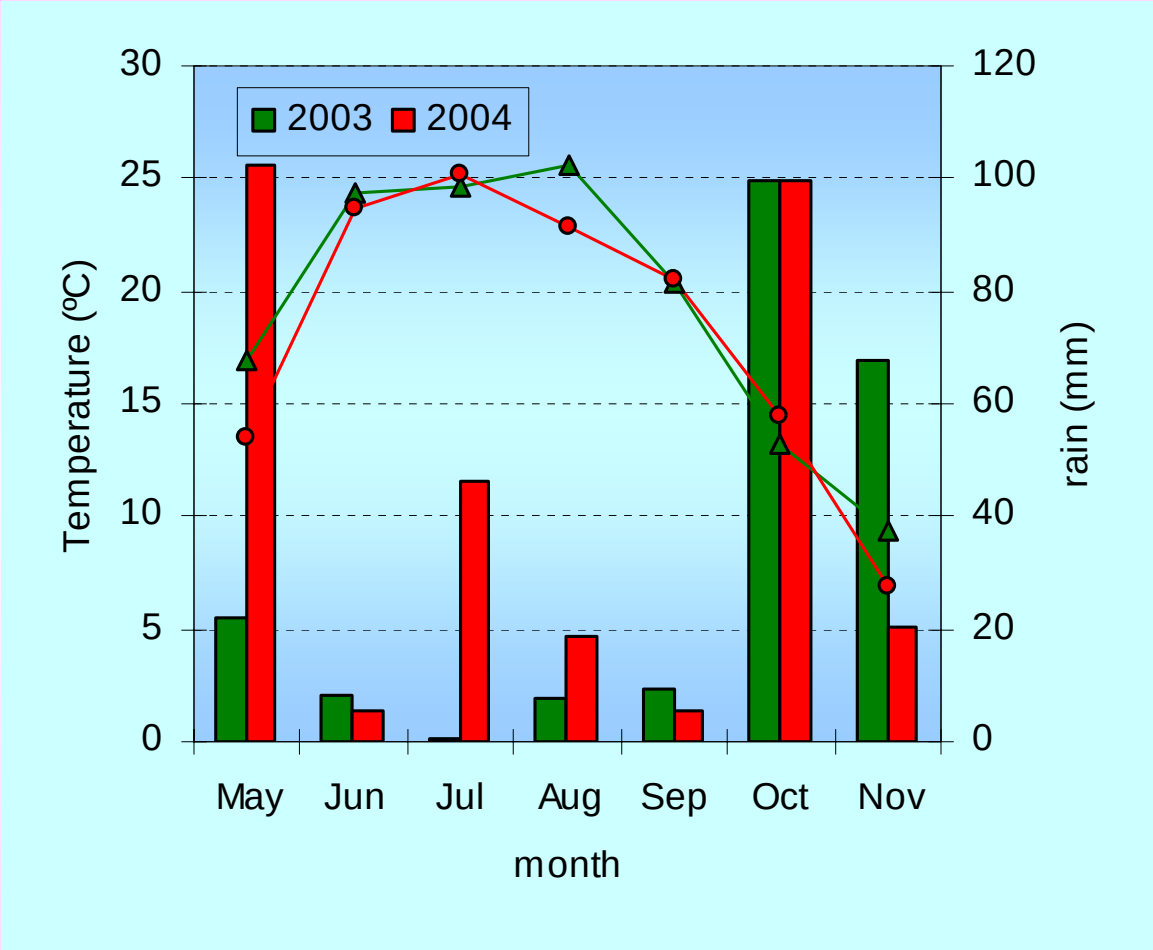




Effect of irrigation on plant growth and biomass yields





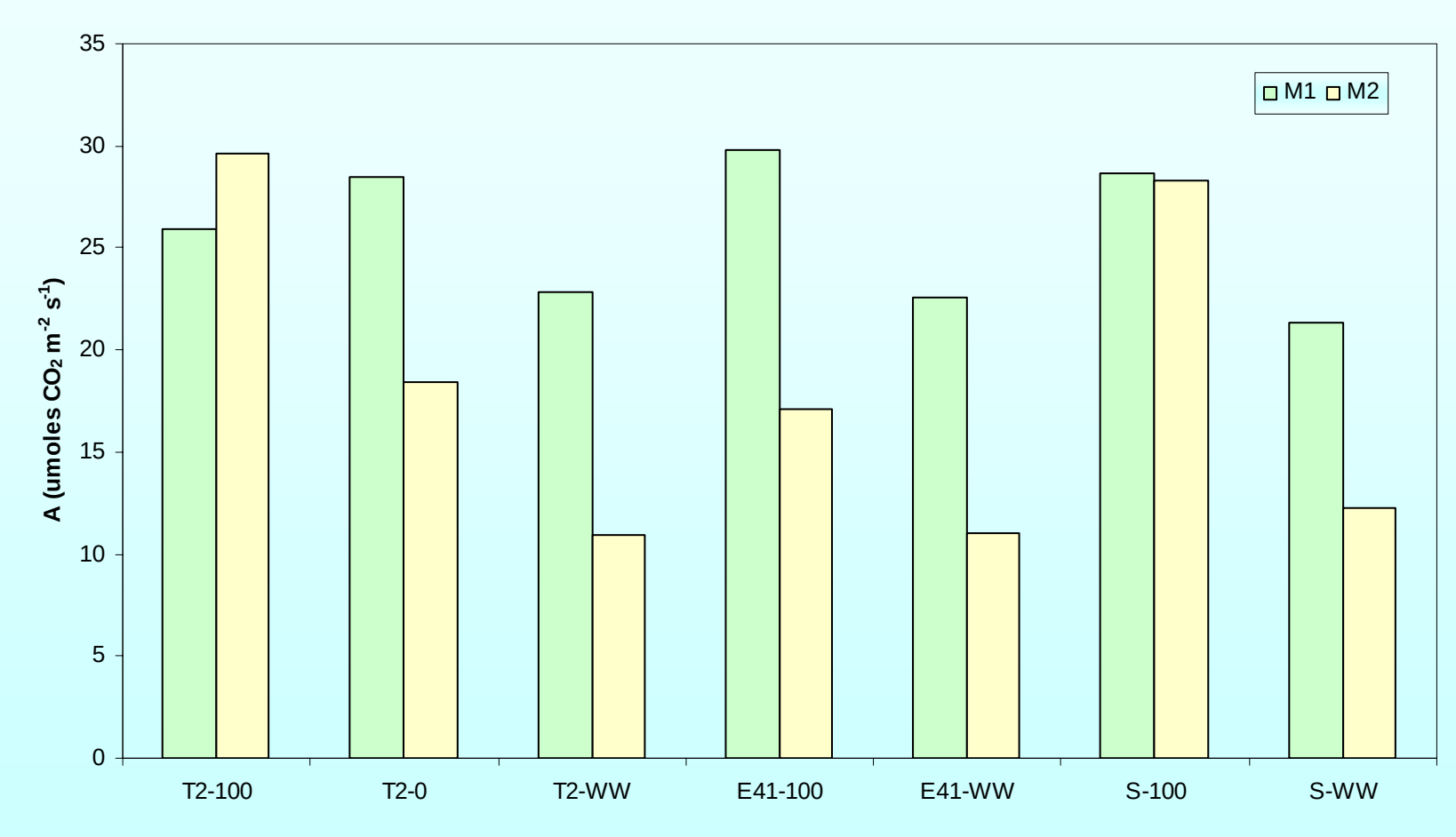

2003
2004
Temperature (ºC)
rain (mm)
30
25
20
15
10
5
0
120
100
80
60
40
20
0
May
Jun
Jul
Aug
Sep
Oct
Nov
month

water supplied in each irrigation treatment

2003	irrigation (l/m^2)
I-0	0
I-25	147
I-50	294
I-100	589

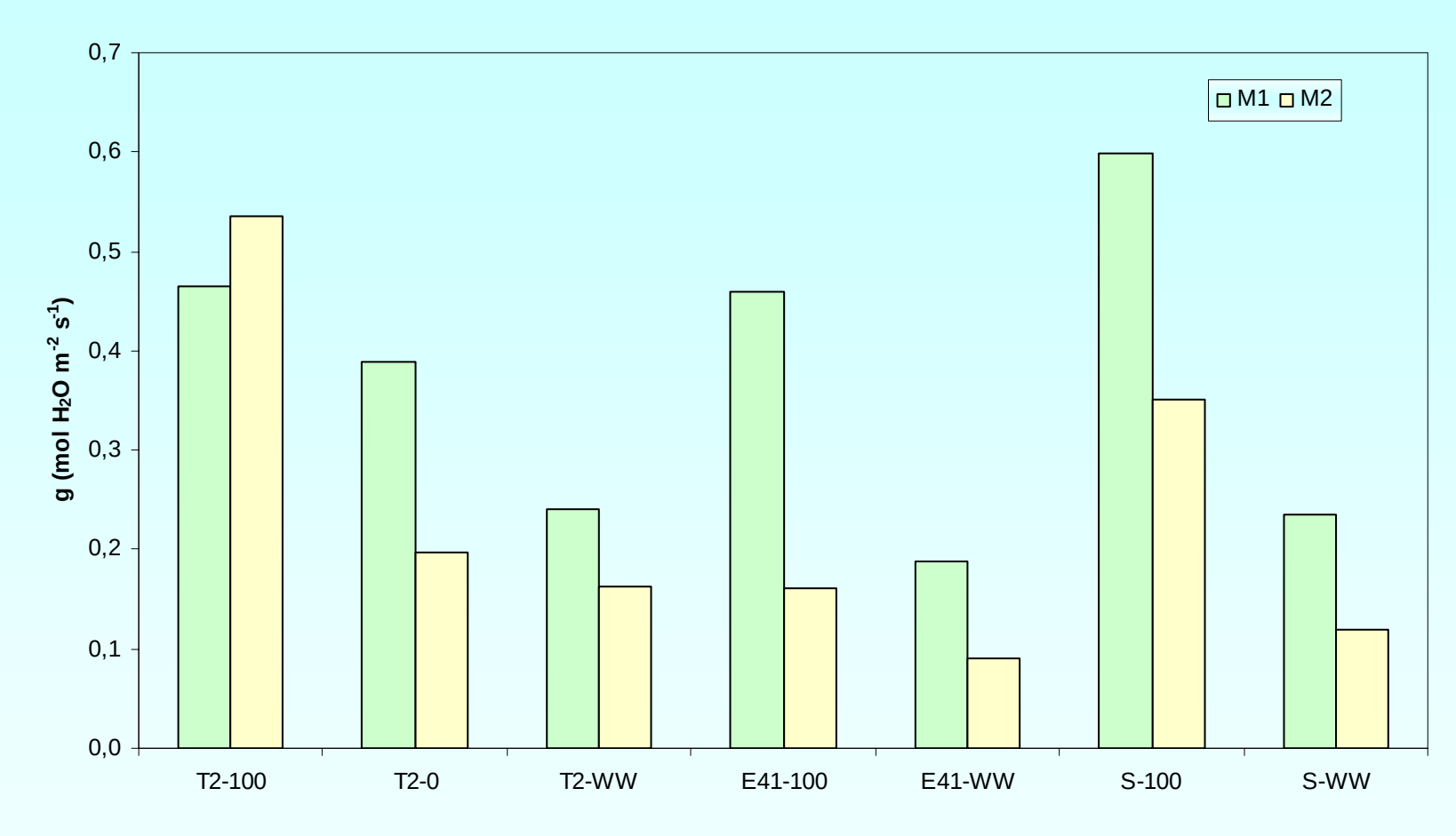
2004	irrigation (l/m^2)
I-0	0
I-25	184
I-50	370
I-100	743

Effect of irrigation on net photosynthesis



Effect of water disponibilty (100, 100% PET; 0, without irrigation; WW, without irrigation and rain) on net photosynthesis (A) of different kenaf varieties (T2, Tainung 2; E41, Everglades 41; and S, Salvador) in Alcalá de Henares (Madrid, Spain). (M1, beginning of August; M2, end of August).

Effect of irrigation on stomatal conductance



Effect of water disponibilty (100, 100% PET; 0, without irrigation; WW, without irrigation and rain) on stomatal conductance (g) of different kenaf varieties (T2, Tainung 2; E41, Everglades 41; and S, Salvador) in Alcalá de Henares (Madrid, Spain). (M1, beginning of August; M2, end of August).

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

Conclusions

- In our climatic and crop rotation conditions it is not necessary the application of nitrogen fertilization.
- Kenaf dry yields of 15 t/ha in total biomass and 10 t/ha in stem biomass may be obtainable under optimal conditions in central plateau of Spain.
- The maximum kenaf yield were obtained 140-150 days after sowing.
- In the central region of Spain, the irrigation practices should be performed at 100 % PET.
- The reduction of water amount significantly decrease the production of plant kenaf biomass in our climatic conditions, but the use of regulated deficit irrigation strategies in specific growing periods of kenaf crop may be investigated in order to optimise the water inputs without to reduce the biomass production.

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

Field experiments in Alcalá de Henares, Madrid, Spain

2003

Sowing dates
- sowing dates:
  - S1: 28/05/03
  - S2: 11/06/03
- Tainung 2
- 200000 plants/ha

Plant population
- plant density:
  - D1: 200000 plants/ha
  - D2: 400000 plants/ha
- Tainung 2
- sowing date: 28/05/03

Varieties
- kenaf variety:
  - Tainung 2
  - Everglades 41
  - Salvador
- 200000 plants/ha
- sowing date: 11/06/03

2004

Sowing dates
- sowing dates:
  - S1: 01/06/04
  - S2: 15/06/04
- Tainung 2
- 200000 plants/ha

Plant population
- plant density:
  - D1: 200000 plants/ha
  - D2: 400000 plants/ha
- Tainung 2
- sowing date: 01/06/04

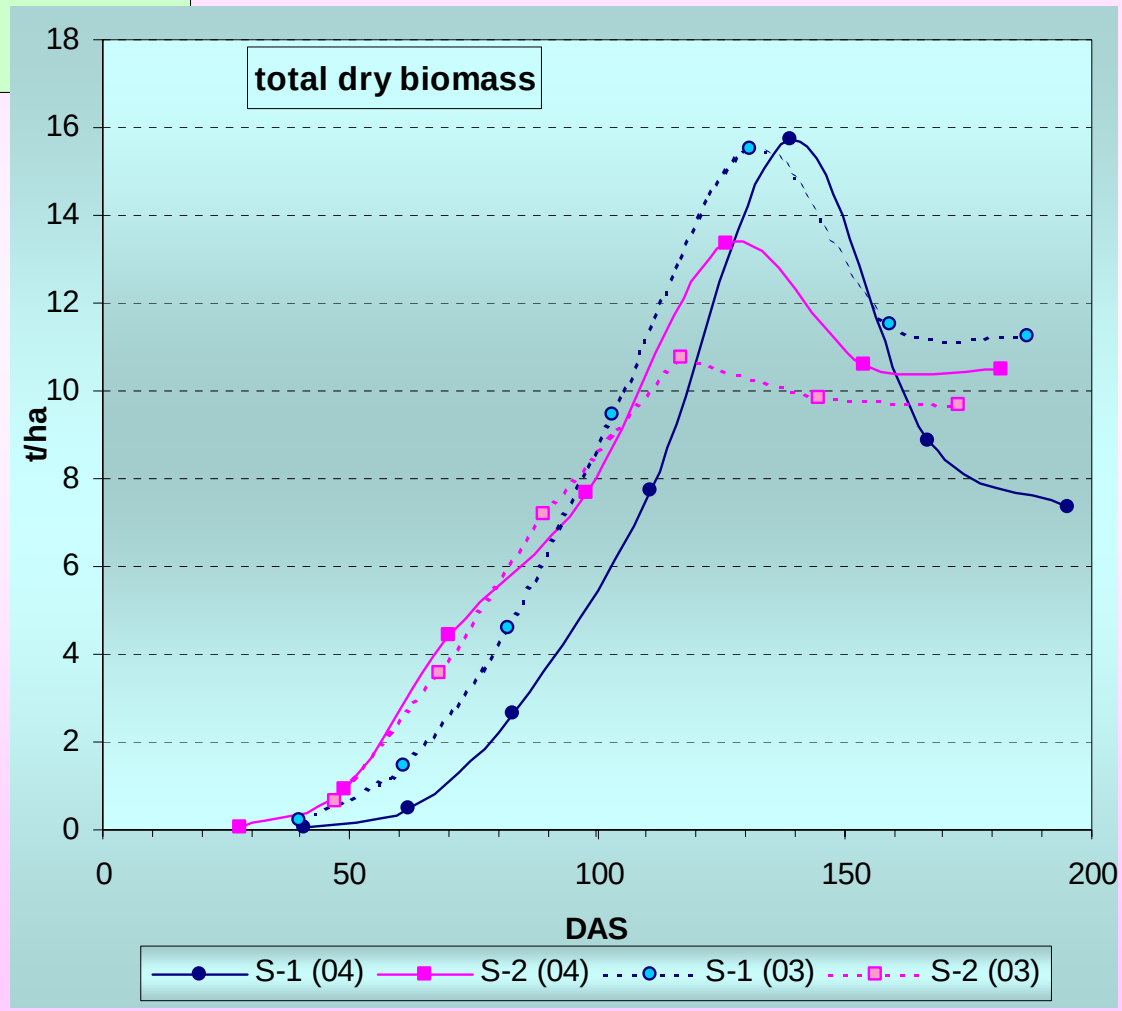
Varieties
- kenaf variety:
  - Tainung 2
  - Everglades 41
  - Salvador
- 200000 plants/ha
- sowing date: 01/06/04

Effect of sowing date on plant growth and biomass yields

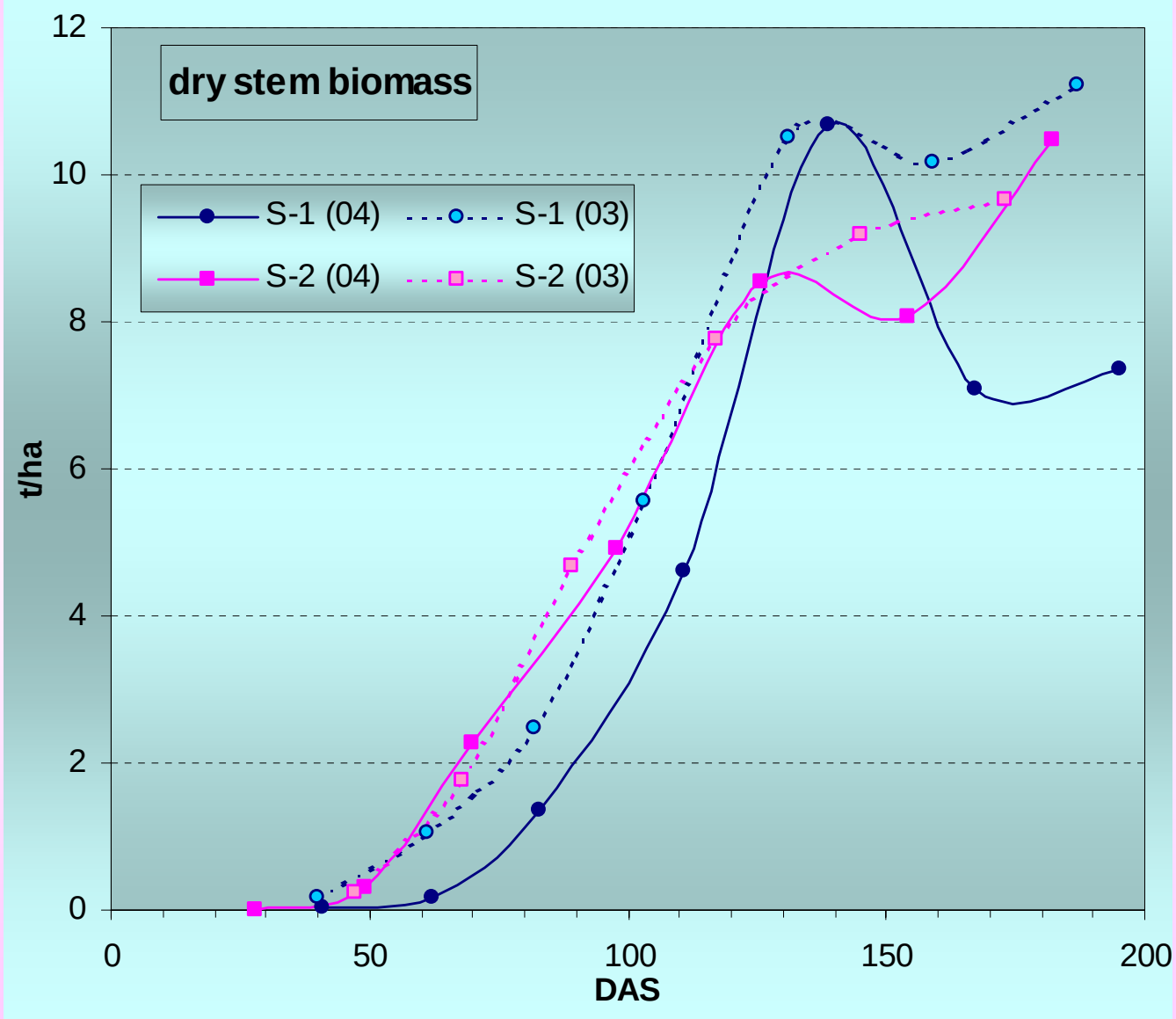
- sowing dates:

S1 (03): 28/05/03	S1 (04): 01/06/04
S2 (03): 11/06/03	S2 (04): 15/06/04

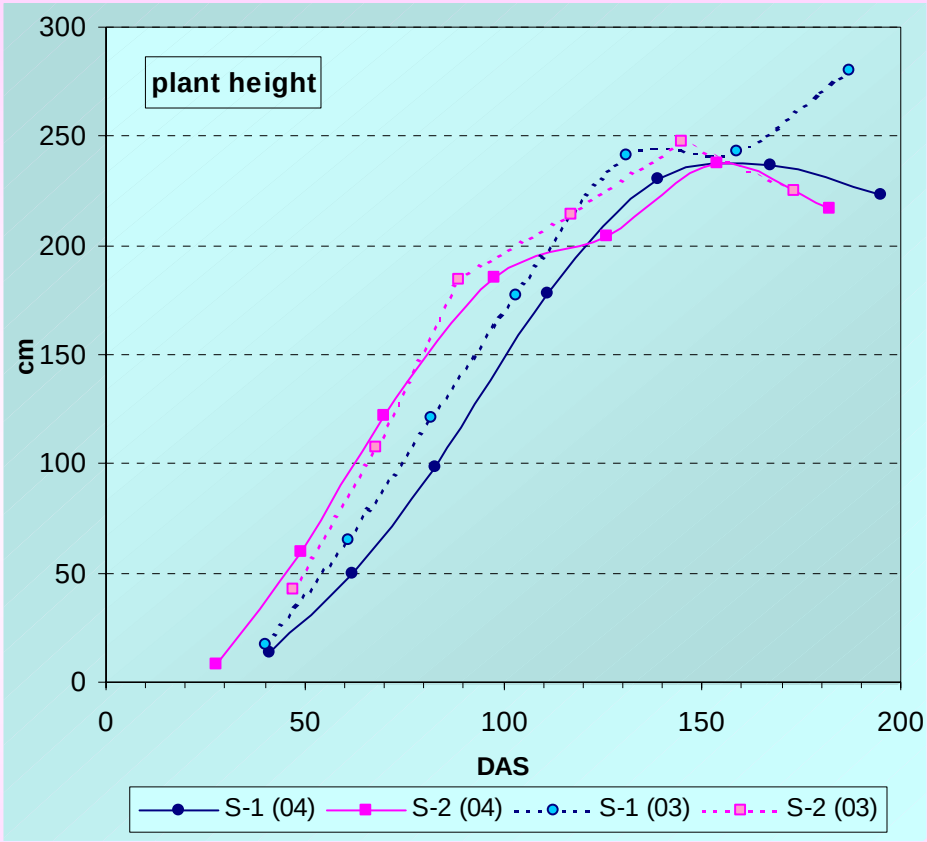
-Tainung 2
- 200000 plants/ha

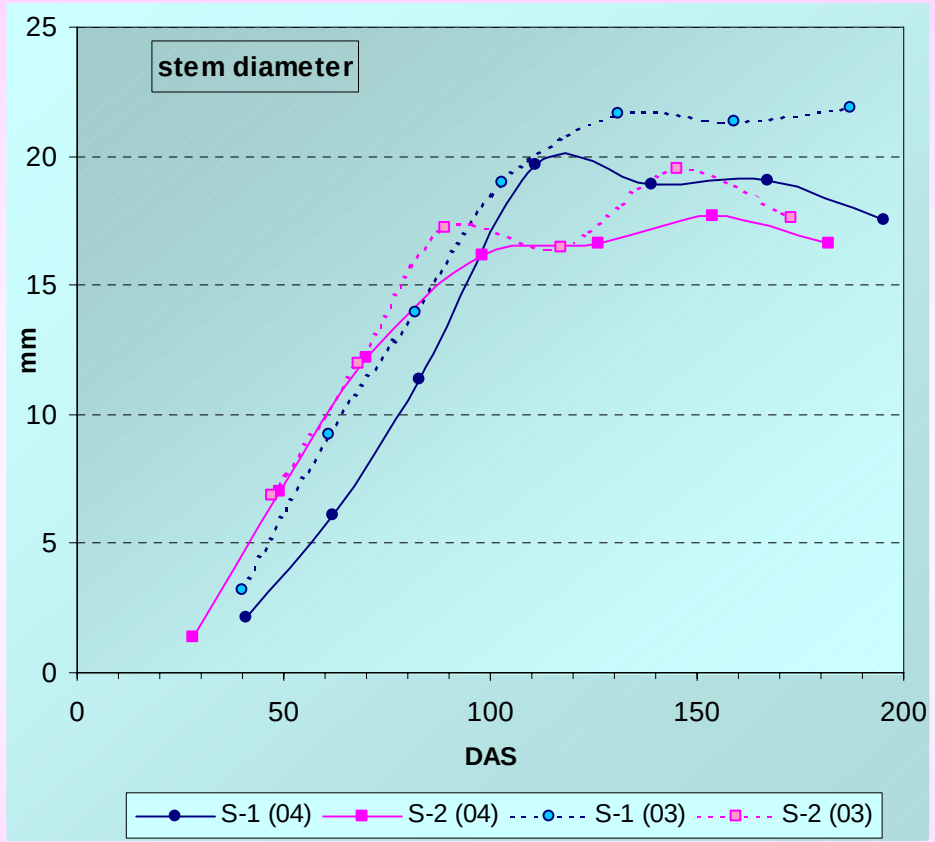


Effect of sowing date on plant growth and biomass yields



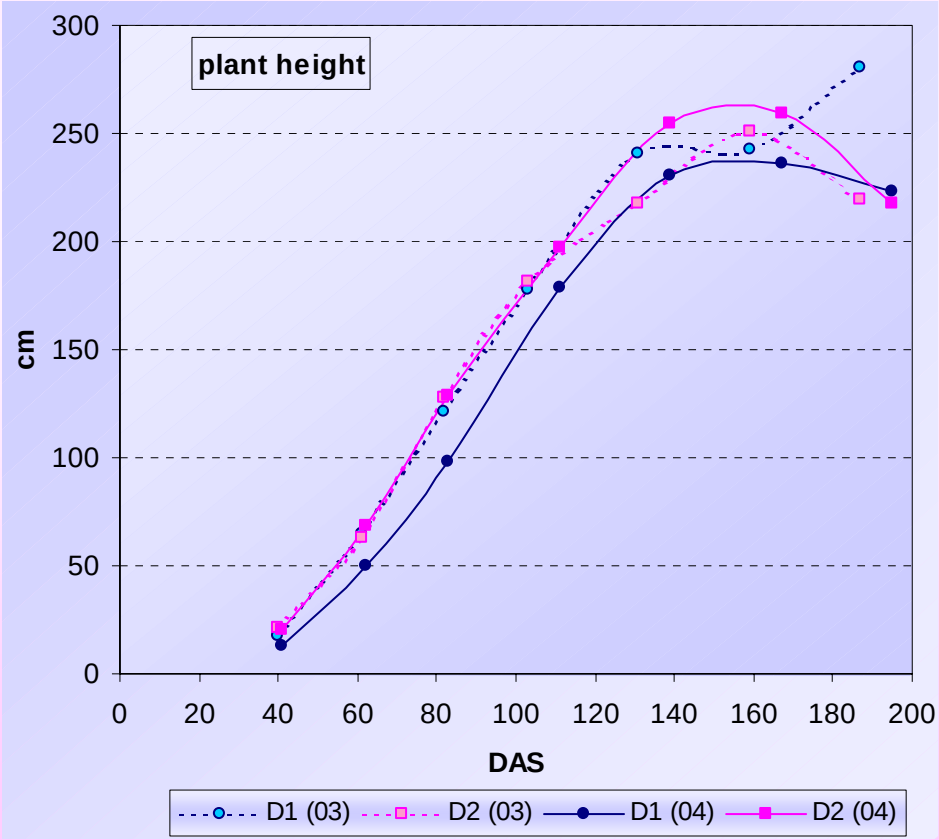
Effect of sowing date on plant growth and biomass yields

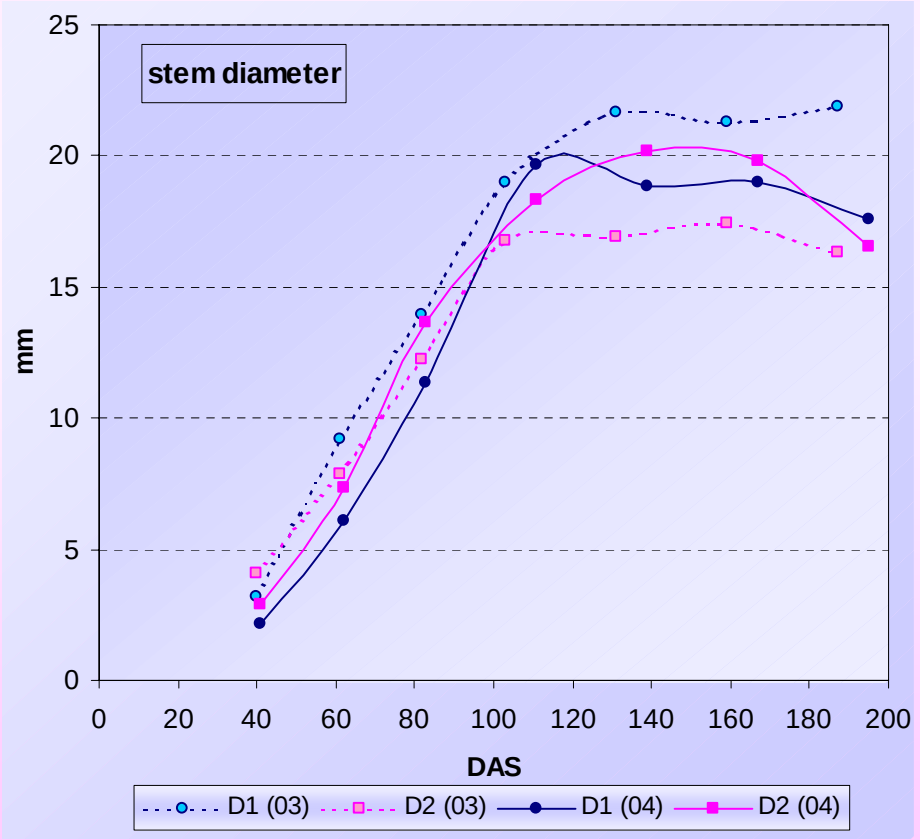




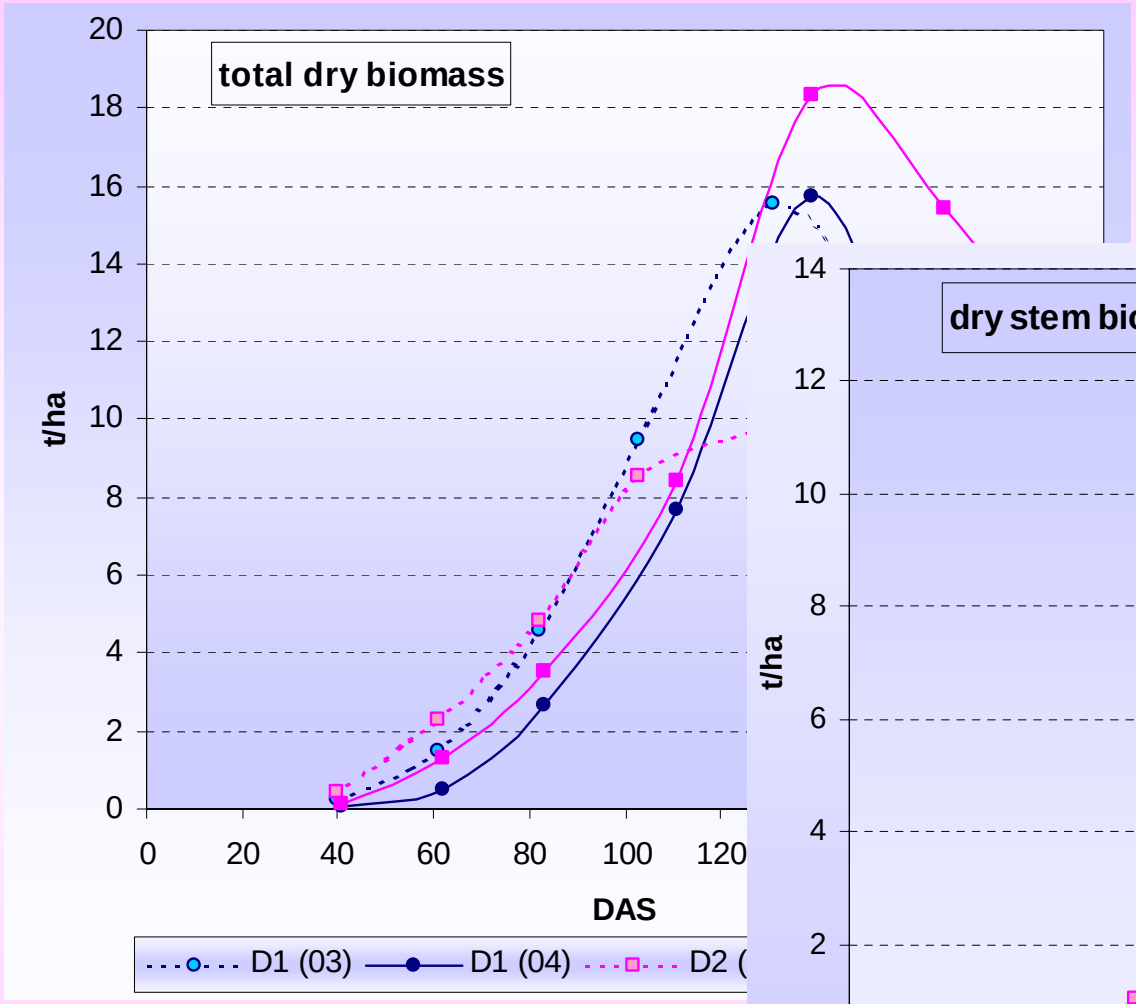
Effect of plant population on plant growth and biomass yields

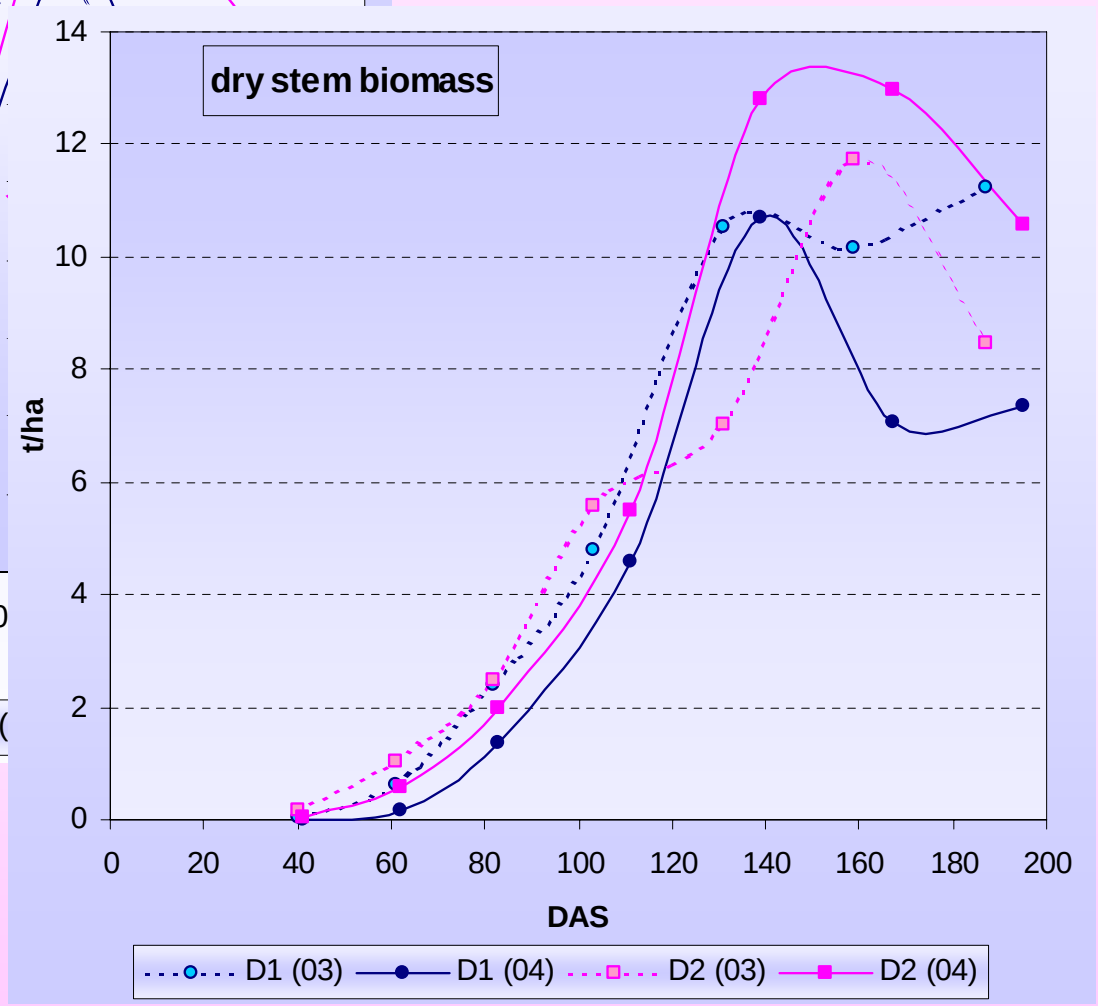
- plant density:
  - D1: 200000 plants/ha
  - D2: 400000 plants/ha
- Tainung 2
- sowing dates:
  - 28/05/03
  - 01/06/04





Effect of plant population on plant growth and biomass yields

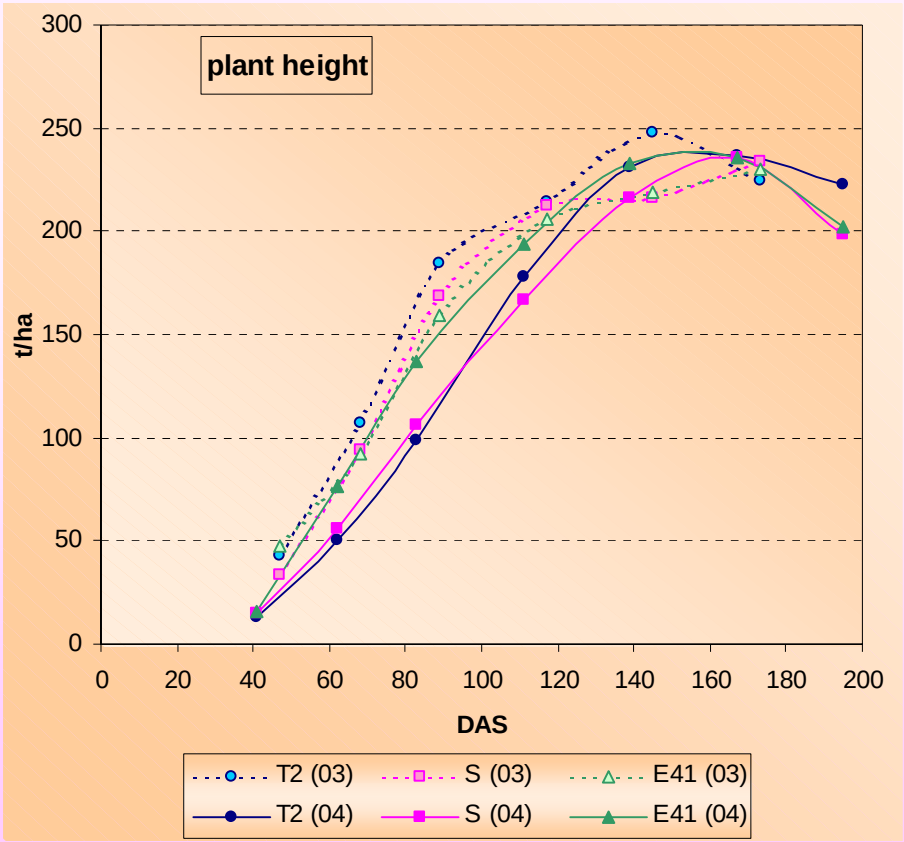


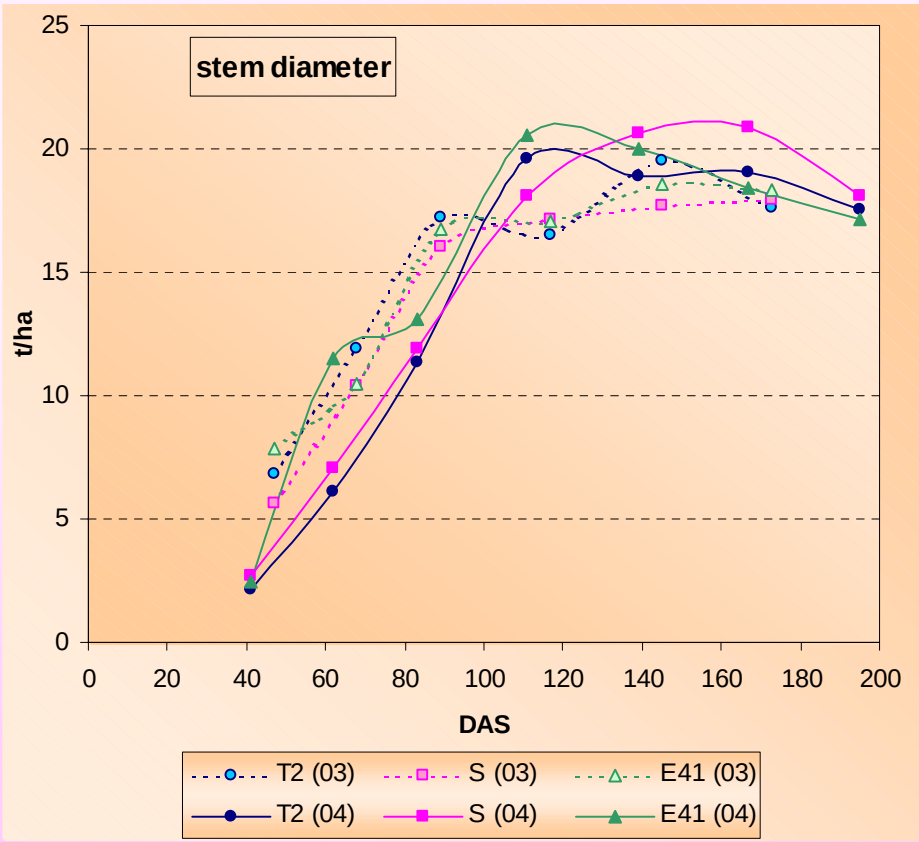


Effect of kenaf varieties on plant growth and biomass yields

-Kenaf variety:
- Tainung 2
- Everglades 41
- Salvador

- 200000 plants/ha
- Sowing date:
  - 28/05/03
  - 01/06/04





Effect of kenaf varieties on plant growth and biomass yields