Biomass Production Chain and Growth Simulation Model for Kenaf

QLK5-CT-2002-01729

acronym: **BIOKENAF**

University of Thessaly *(UTH)*

Department of Agriculture, Crop Production & Rural Environment

3rd technical meeting, Roma 13-5-2004

WP2

Adaptability and Productivity field experiments

(tasks 2.2 & 2.3)

The field experiments were carried out on a deep, fertile, loamy soil located in Palamas Karditsa, western Thessaly, Greece, 3 km south east of the village of Palamas

coordinates:
39º25’43.4’’N,
22º05’09.7’’E,
altitude 107.5 m

The soil is classified as

Aquic Xerofluvent,

having groundwater table fluctuating from some 150-200 cm below the surface in May (artificial drainage) to deeper layers later in the summer.

Photo *(15-08-03)**: Soil pit: Ground-water table fluctuated during growing period between a) 1.65 and b) 2.80 m from the surface*

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

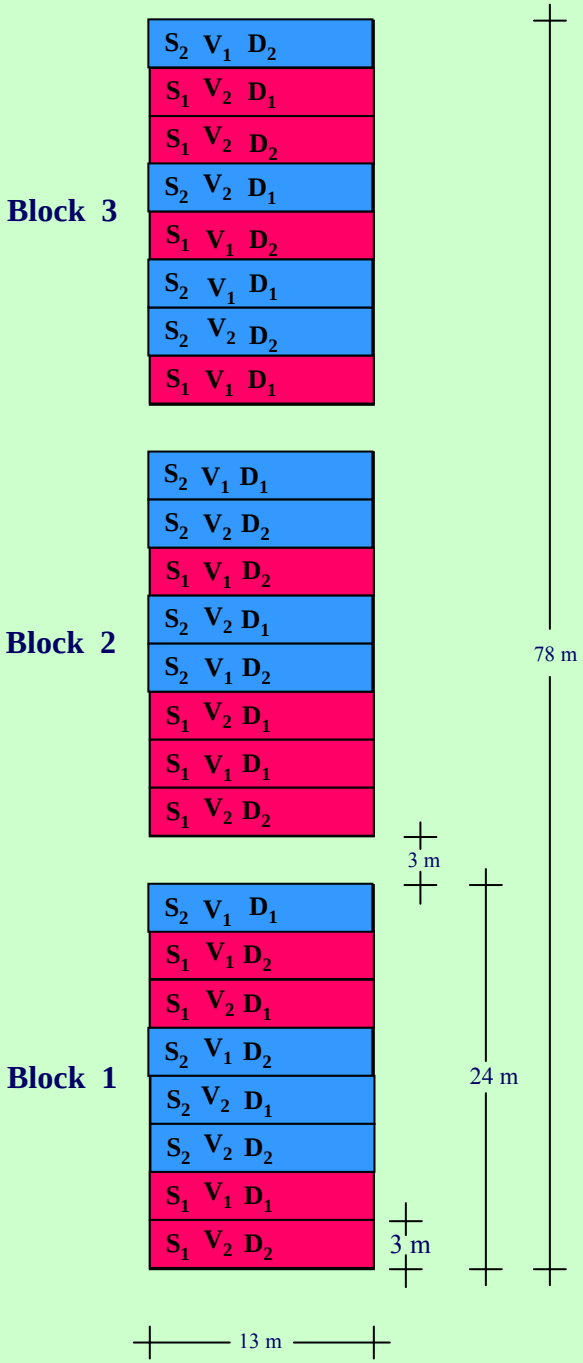
A 2x2x2 factorial completely randomized block design was used in 3 blocks.

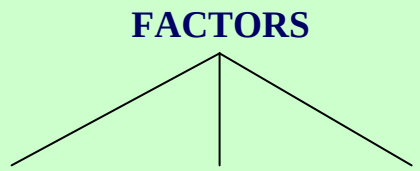
All plots had received a basal dressing of 50 kg P ha^{-1} and 100 kg K ha^{-1} on 18-5-2003, while a top dressing of 100 kg N ha^{-1} (as ammonium sulphate) was applied when the plants reached a height of 0.5 m.

The crop received drip irrigation (348.8 mm until 15/10/2003) at frequent intervals (3-5 days), and for full matching the potential evapotranspiration (100% of PET)

The growth and the biomass productivity of the crop were measured in subsequent harvests throughout the growing period, on the following dates: 30/6, 22/7, 12/8, 5/9, 27/9, 18/10, 8/11, and 28/11/03.

Task 2.2





S Sowing time

V Variety

D Density

S_1=20-5-2003 V_1= Tainnung 2 D_1=200000pl/ha

S_2=13-6-2003 V_2= Everglades D_2=400000pl/ha

In each block 8 plots with all possible treatment combinations (2x2x2).

- **Plot size: 3m x 13m = 39 m^2**
- **6 rows per plot**

Distances:

- **between the rows: 0.50 m**
- **within the rows: 0.05m (D2) – 0.10m (D1)**

Task 2.3. Effect of irrigation and nitrogen fertilization on biomass yield.

A3x4 factorial completely randomized split-plot design was used in 3 blocks.

Water supply as irrigation:

I_1=25% (87.2 mm)
I_2=50% (174.4 mm)
I_3=100% (348.8 mm)

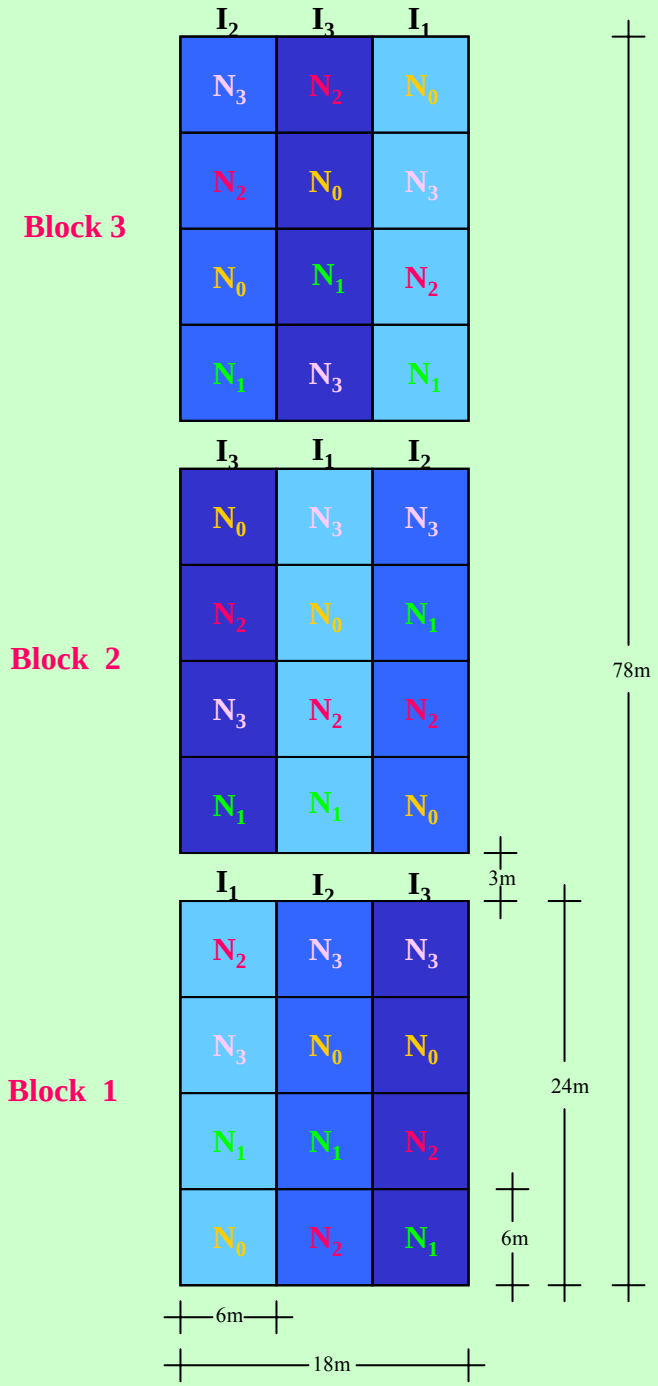
Nitrogen level

N_0=control,
N_1=50 kg N ha^{-1}
N_2=100 kg N ha^{-1}
N_3=150 kg N ha^{-1}.

All plots had received a basal dressing of 50 kg P ha^{-1} and 100 kg K ha^{-1} on 18-5-2003

The growth and the biomass productivity of the crop were measured in subsequent harvests: 29/6, 21/7, 11/8, 4/9, 26/9, 14/10, 8/11, and 7/11/03

Task 2.3



FACTORS

I IRRIGATION

- I_1=25% of PET
- I_2=50% of PET
- I_3=100% of PET

N FERTILISATION

- N_0=control
- N_1=50 Kg/ha
- N_2=100Kg/ha
- N_3=150Kg/ha

Main plots: Irrigation

Sub-plots: Fertilization

- **Plot size: 6m x 6m = 36 m^2**
- **12 rows per plot**

Distances:

- **0.50 m between the rows**
- **0.10 m within the rows**

Task 2.2

Photo 1 (13-6-03):
Just before S_2 planting

Photo 2 (11-7-03): Plant height S_1 = 115 cm & S_2 = 30 cm

Photo 3 (21-7-03):
Plant height S_1 = 160 cm and S_2 = 80 cm

Photo 4 (7-8-03): Plant height

S_1 = 210 & S_2 = 155 cm

Photo 5: Leaf Everglades 41 (left)

Leaf Tainnung 2 (right)

Photo 6: 30-11-2003

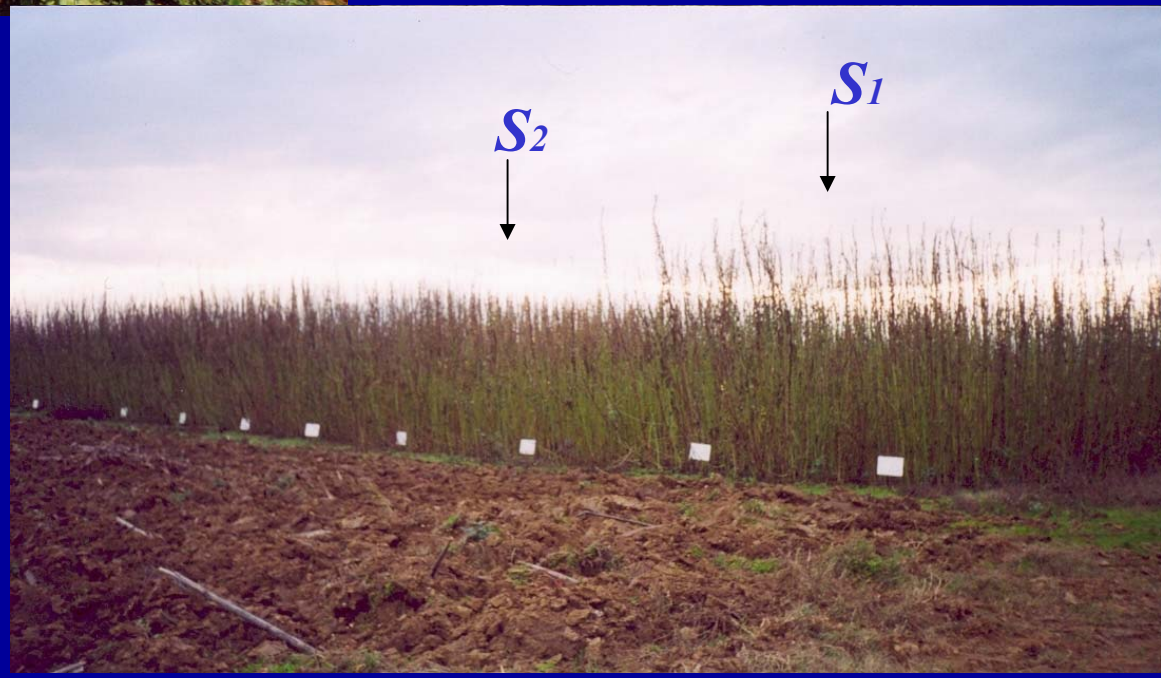


Photo 7 (30-11-03): Plant height S_1 = 382 & S_2 = 342 cm

Task 2.3

Photo 8 (26-5-03): emergence of Tainnung 2 > 50%

Photo 9 : drip irrigation system

Photo 10 (28-9-03): I_3-plants. Plant height 325 cm, Lai = 5, Total dry biomass 20.9 t ha $^{-1}$

Photo 11 (19-7-03): Plant height = 166 cm, Lai = 4.8 and Total dry biomass = 8.2 t ha^{-1}

Photo 12 (10-10-03): I_3-plants height = 370 cm And total dry biomass 22.1 t ha^{-1}

Photo 13 (15-10-03): flowering is up to 50%

Photo 14 (25-10-03): flowering is up to 70-80%

Climatic conditions

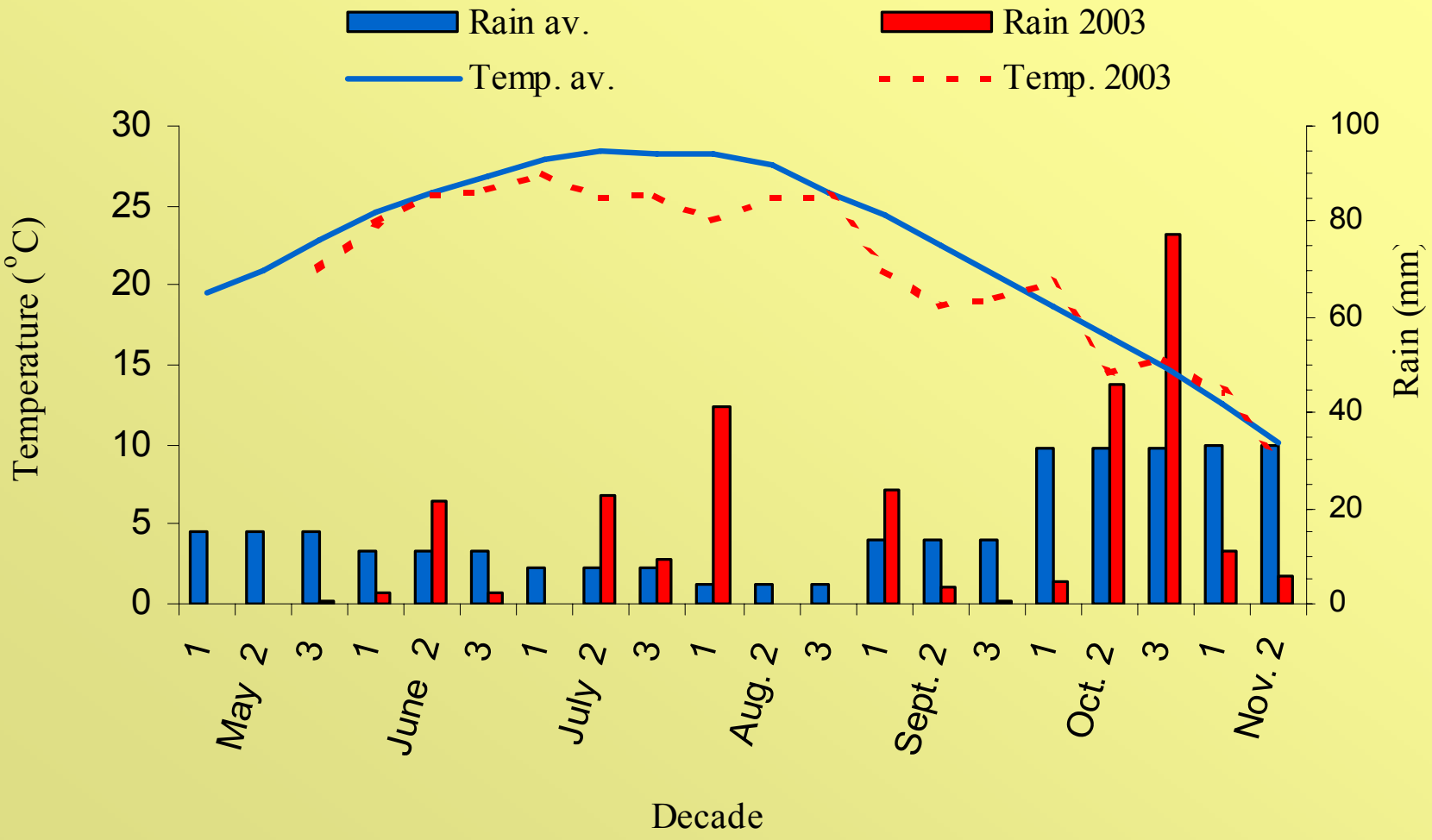
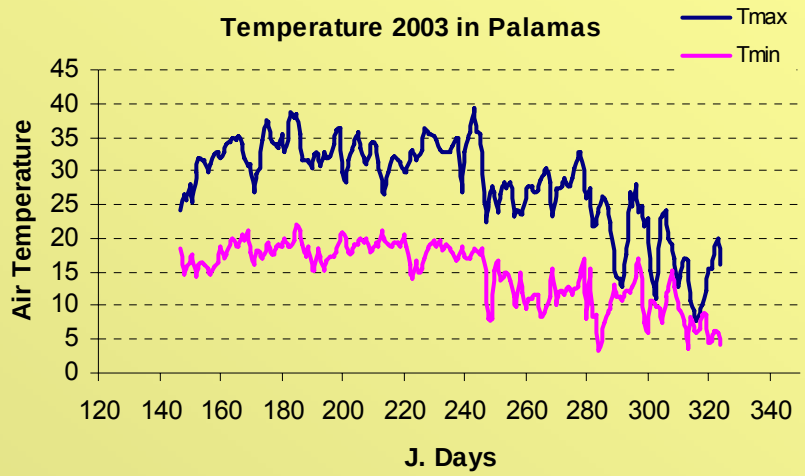
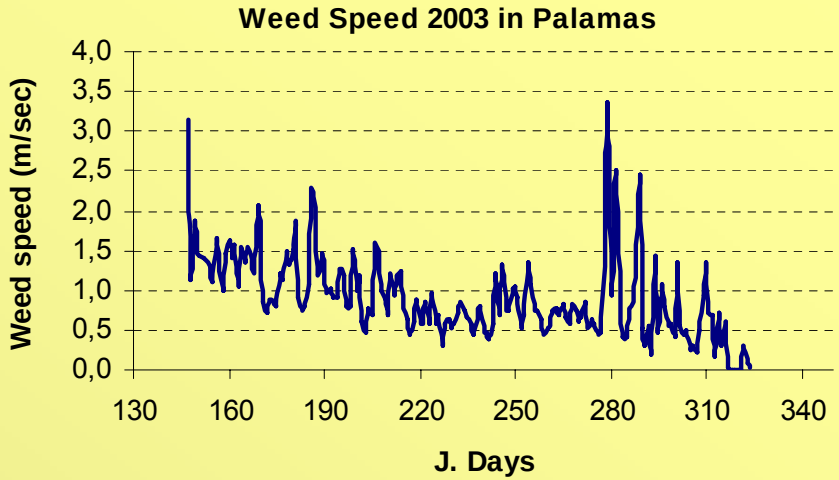
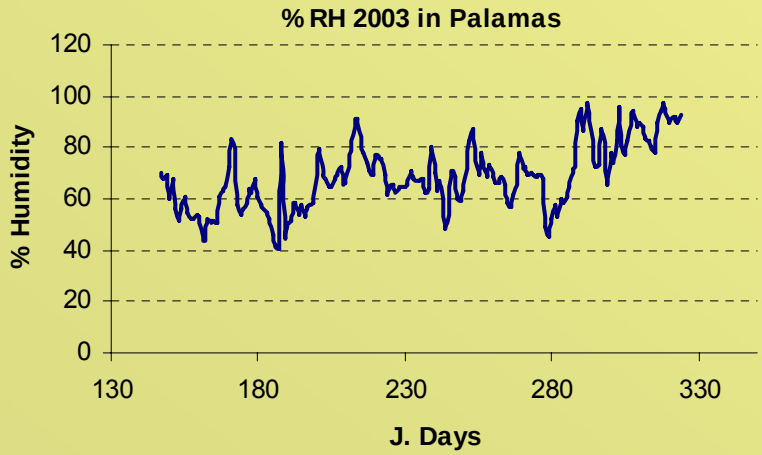


Fig. 1: Air temperature and precipitation (10-day mean values) recorded in the study area in 2003 and in an average year (average of 30 years).







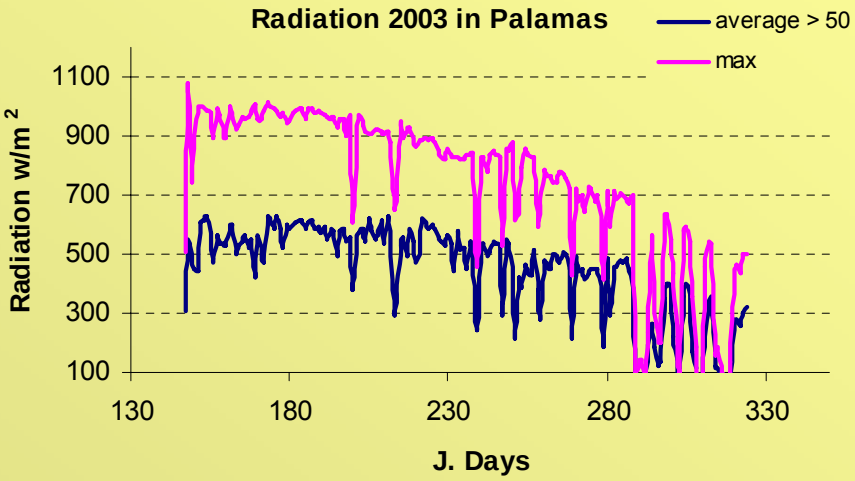
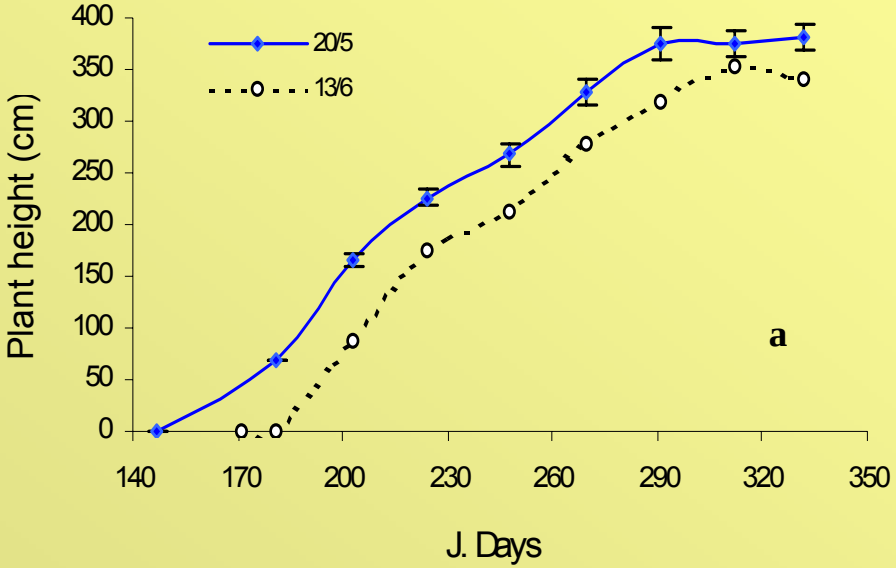


Figure. 2: Daily weather data in the study site during the growing period of 2003.

RESULTS

- Plant height
- LAI
- SLA
- Total dry biomass
- Stem biomass (dry)
- Stem diameter
- Flowering
- Photosynthesis



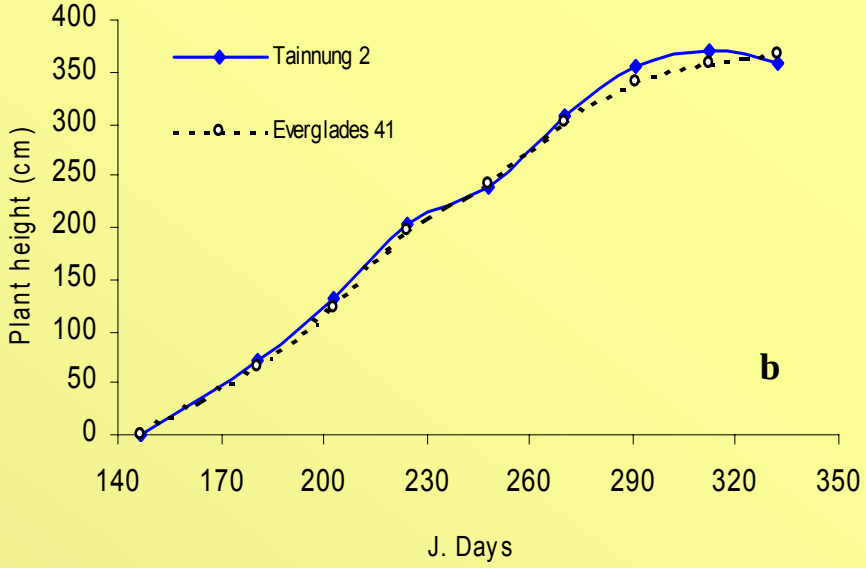


Figure 3: Plant height of Kenaf grown under constraint-free conditions in central Greece in 2003 for the two different a) sowing dates, b) varieties, and c) plant densities. (Vertical lines represent $LSD_{0.01}$ if applicable).

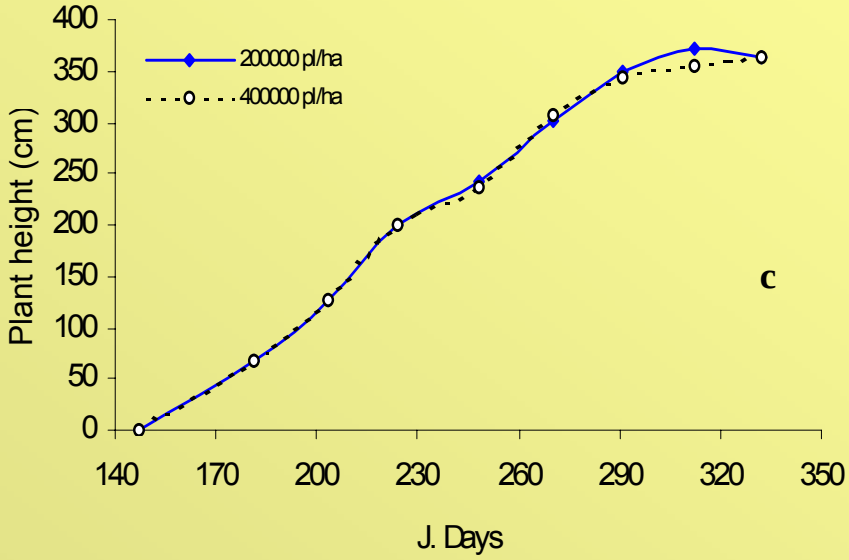
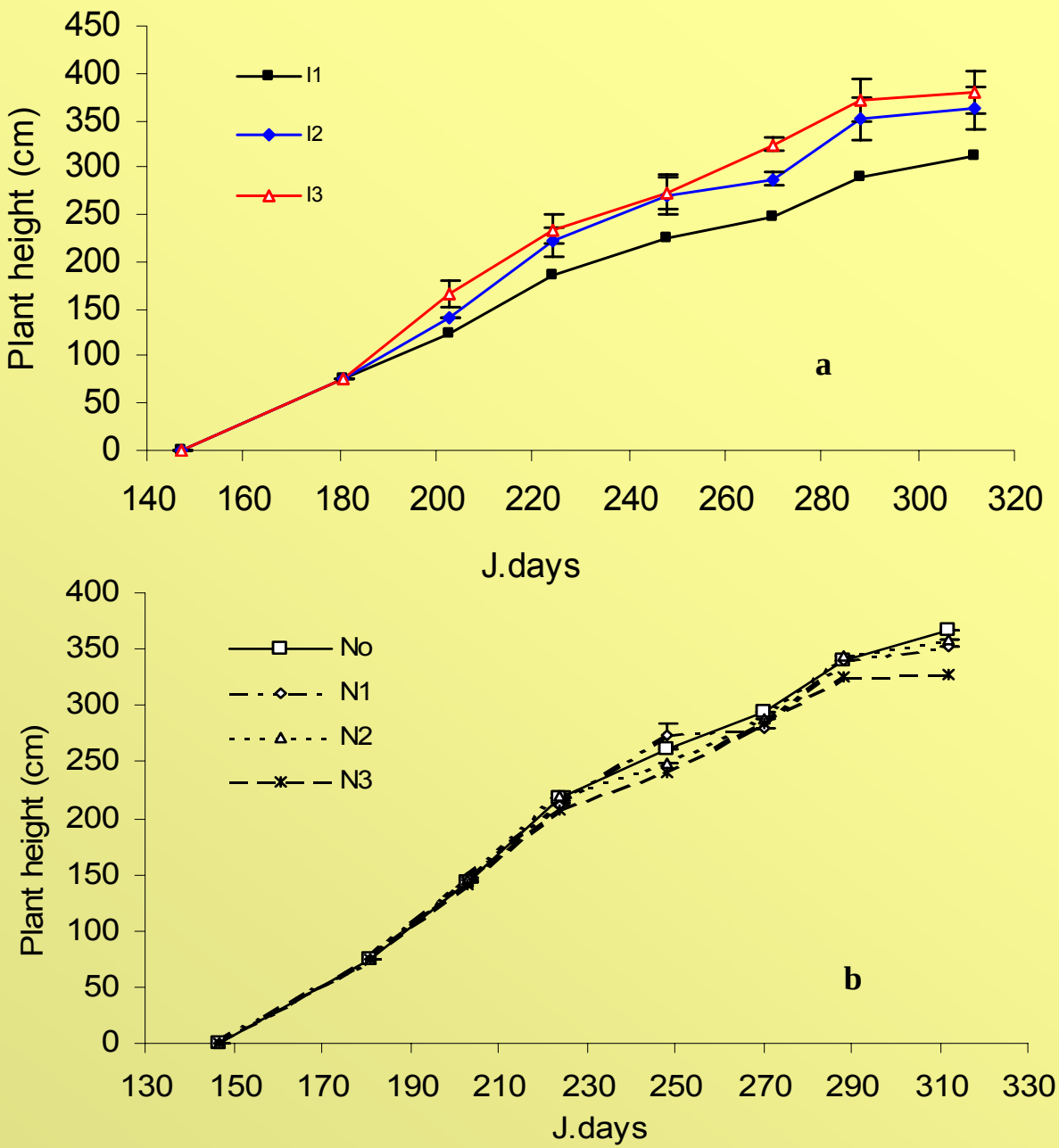
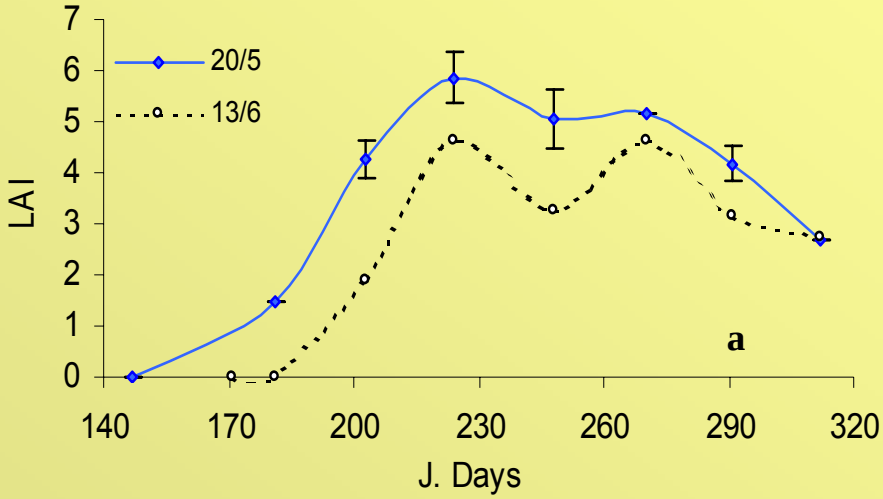
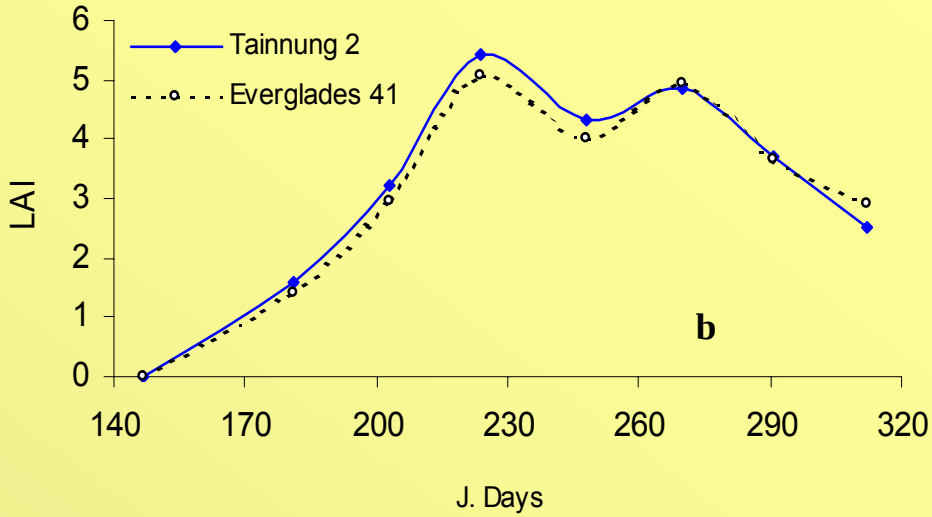


Figure 4: ***Plant height*** *of Kenaf grown in central Greece in 2003 as affected by three irrigation treatments (a) and four N-fertilization treatments (b). (Vertical lines represent* $LSD_{0.01}$ *if applicable).*







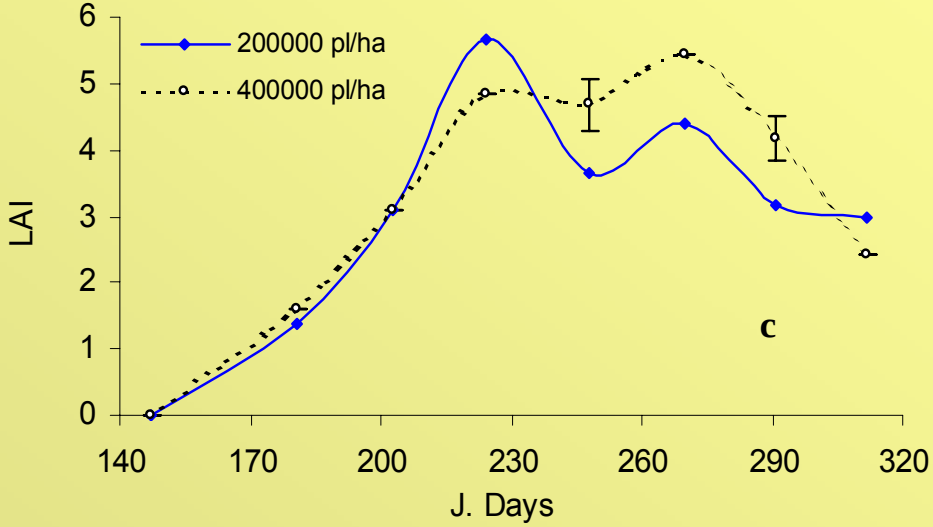
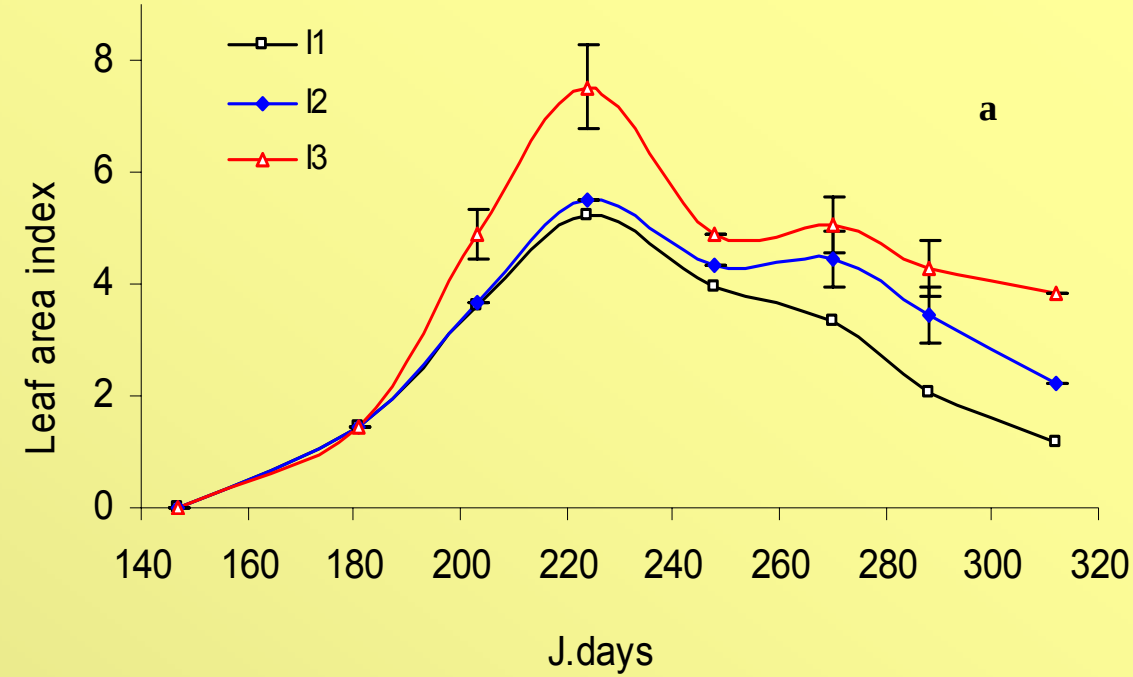
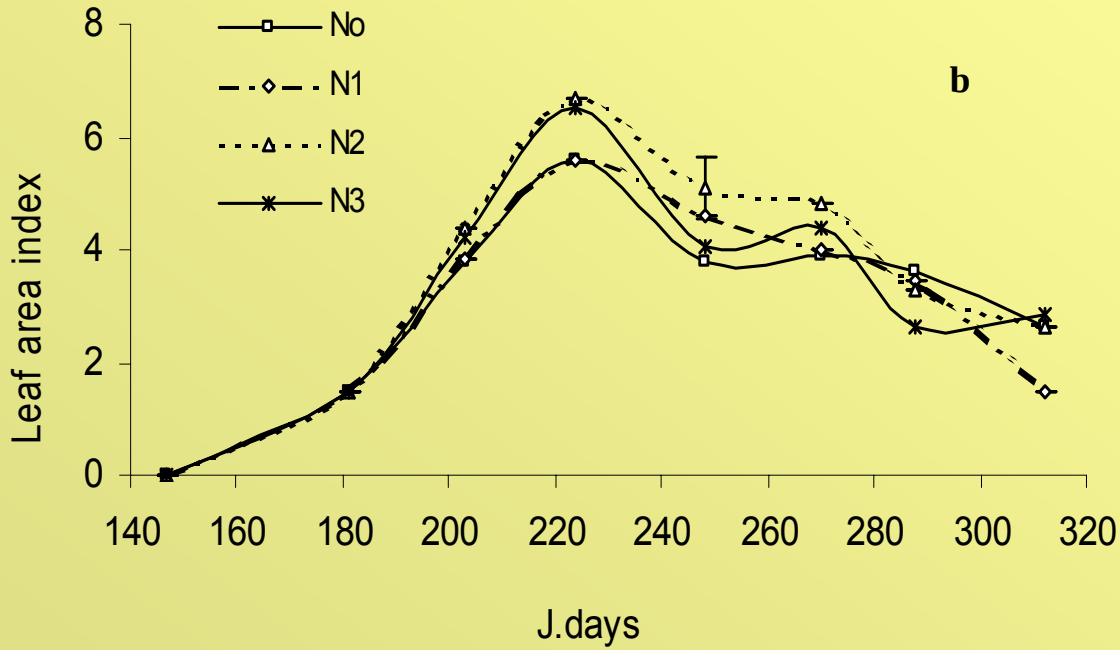
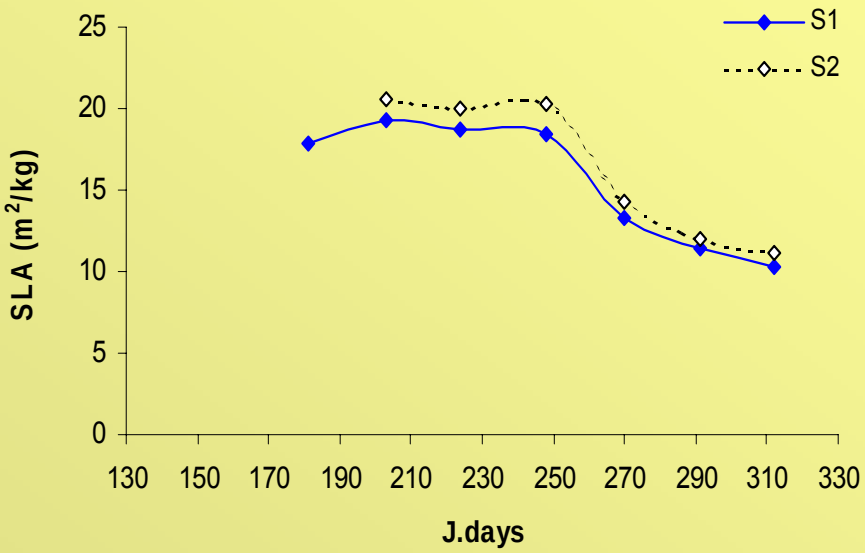


Fig. 5: LAI evolution of Kenaf grown under constraint-free conditions in central Greece in 2003 for the two different a) sowing dates, b) varieties, and c) plant densities. (Vertical lines represent $LSD_{0.01}$ if applicable).

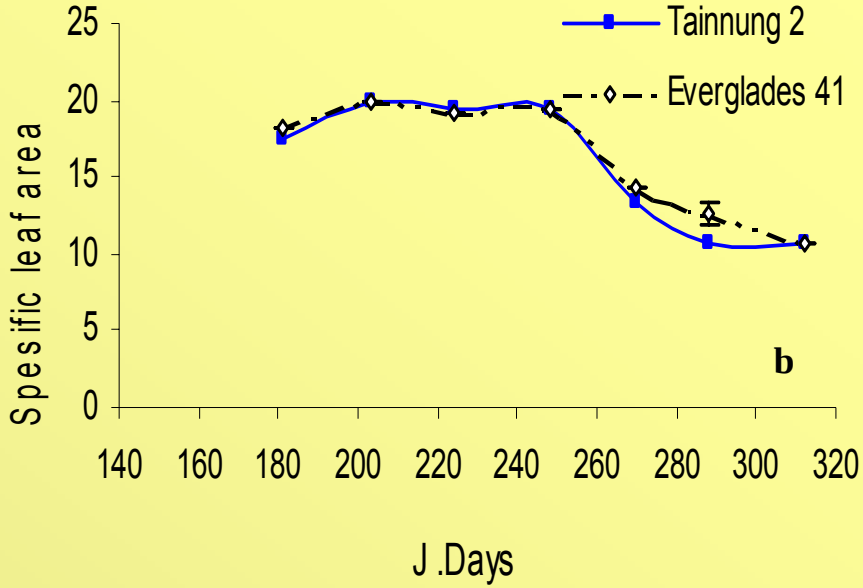
Figure 6: LAI evolution of Kenaf grown in central Greece in 2003 as affected by three irrigation treatments (a) and four N-fertilization inputs (b). (Vertical lines represent $LSD_{0.01}$ if applicable).







a



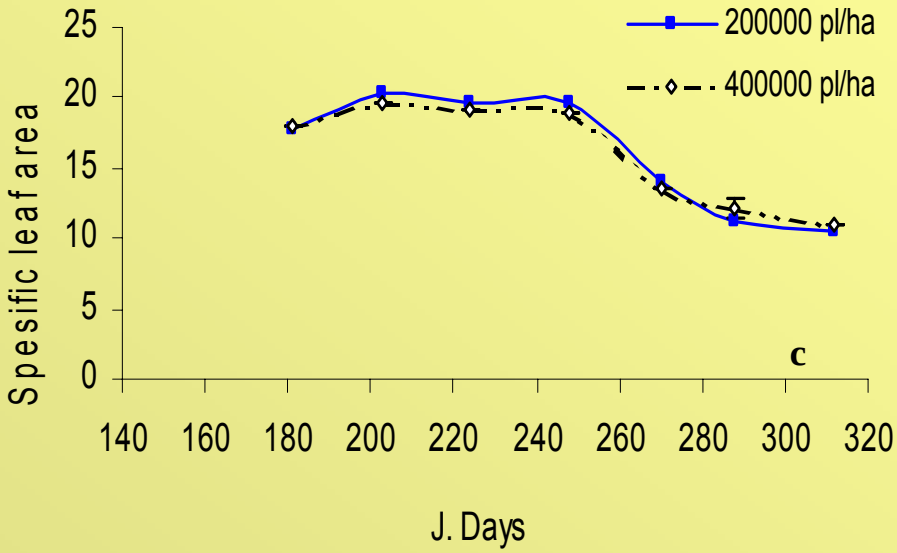
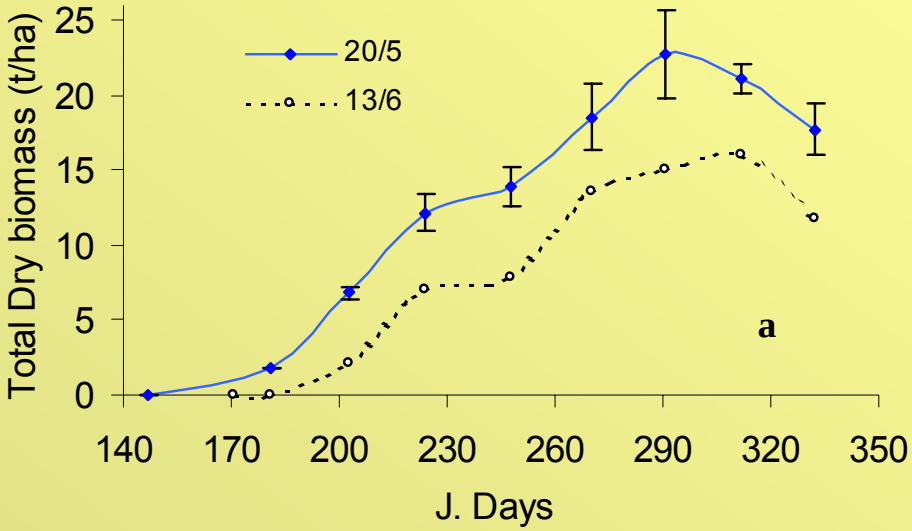


Fig. 7: Specific leaf area of Kenaf grown under constraint-free conditions in central Greece in 2003 for the two different a) sowing dates, b) varieties, and c) plant densities. (Vertical lines represent $LSD_{0.01}$ if applicable).



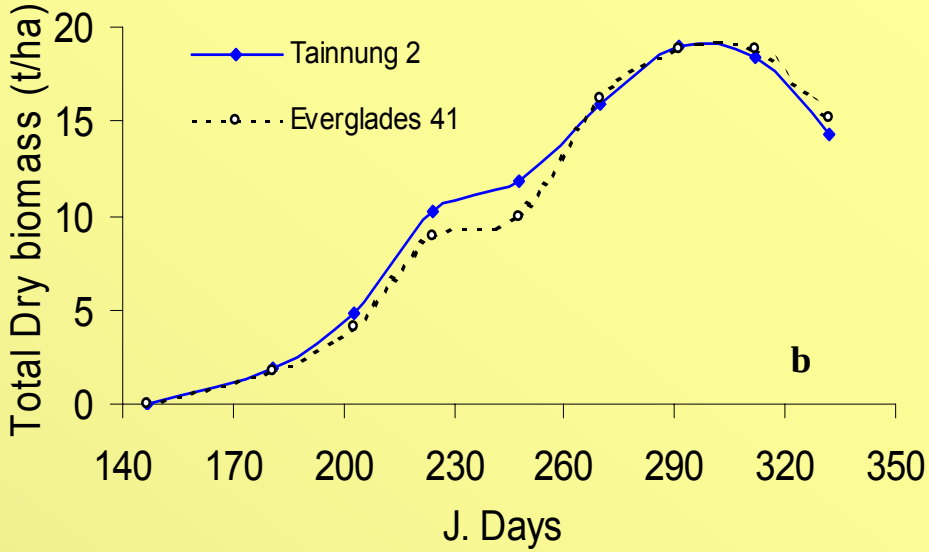


Fig. 8: Evolution of total (above-ground) dry biomass of Kenaf grown under constraint-free conditions in central Greece in 2003 for two different a) sowing dates, b) varieties, and c) plant densities. (Vertical lines represent $LSD_{0.01}$ if applicable).

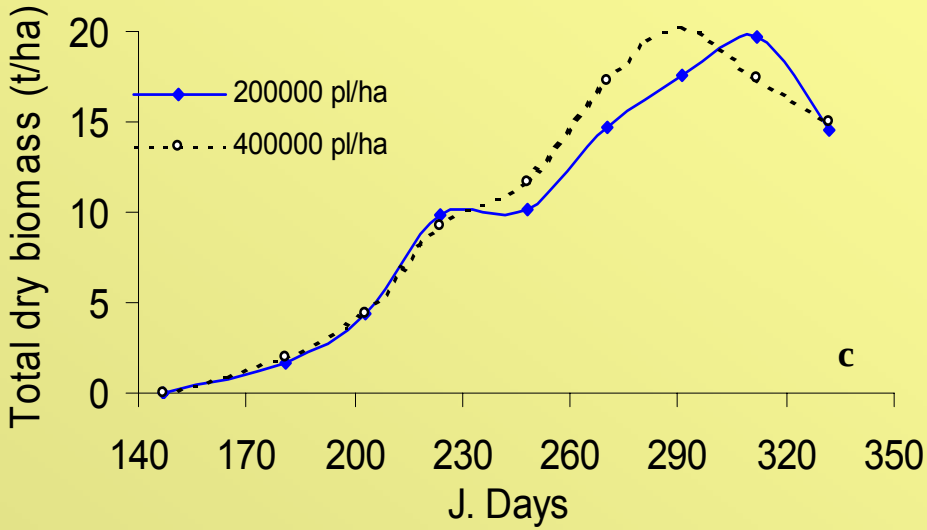
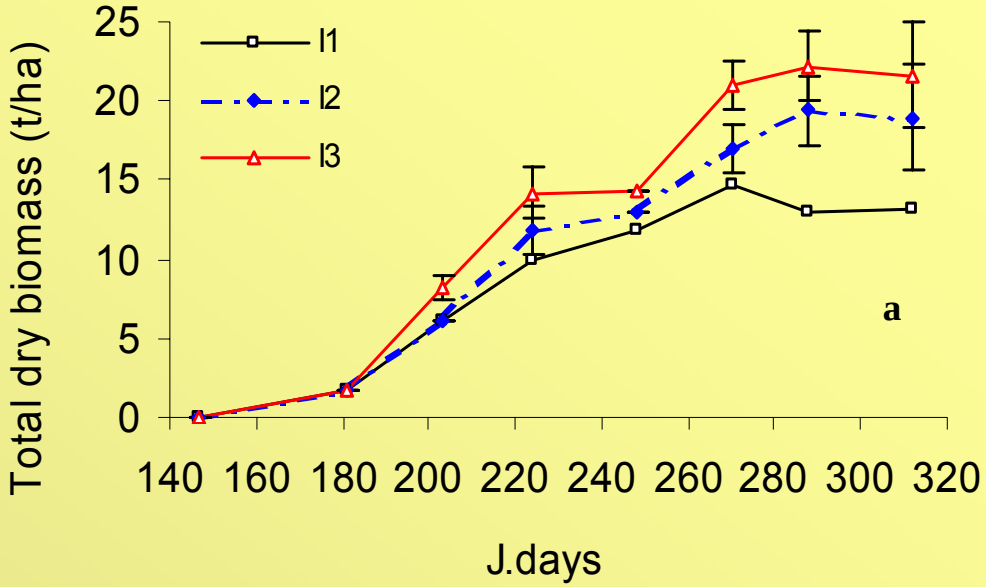
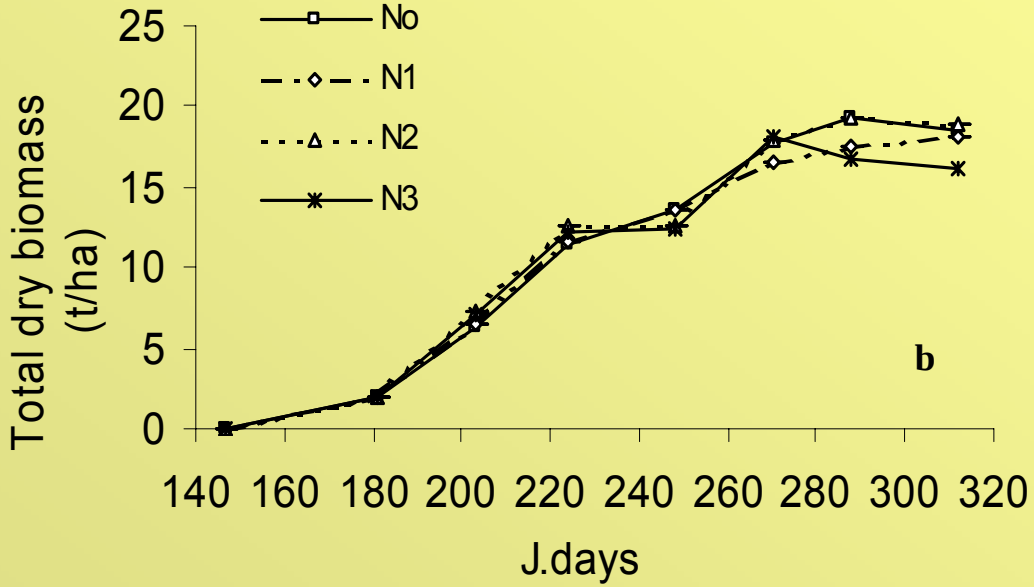
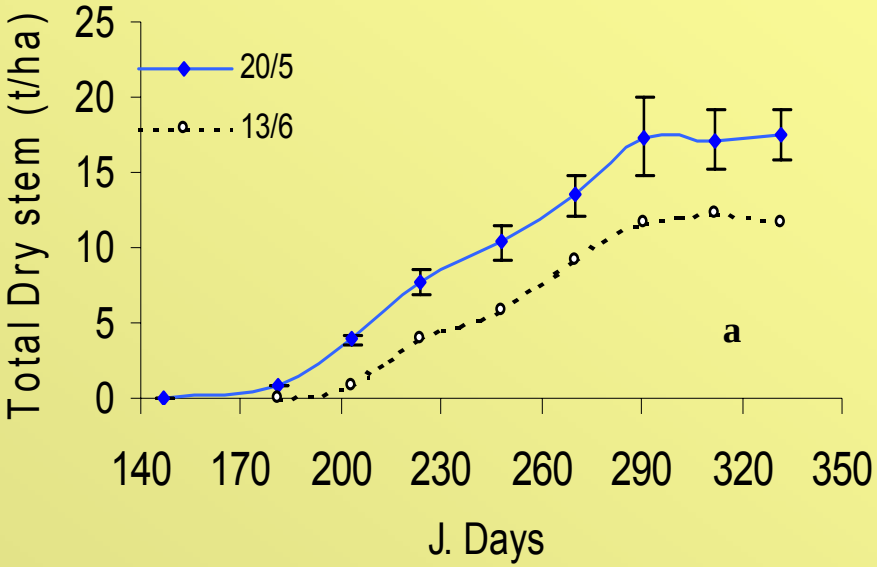


Figure 9: ***Total dry biomass*** *of Kenaf grown in central Greece in 2003 as affected by three irrigation treatments (above) and four N-fertilization treatments (below). (Vertical lines represent* $LSD_{0.01}$ *if applicable).*







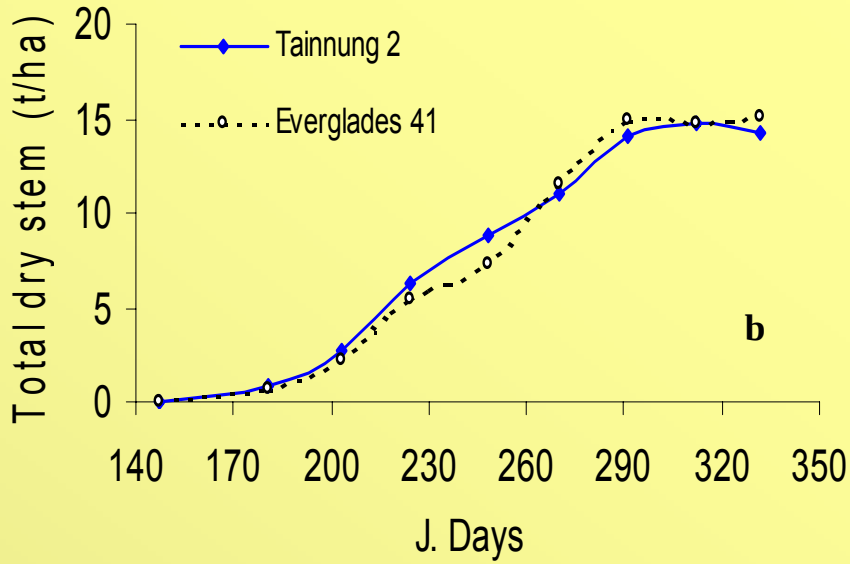


Fig. 10: Evolution of dry stem weight of Kenaf grown under constraint-free conditions in central Greece in 2003 for two different a) sowing dates, b) varieties, and c) plant densities. (Vertical lines represent $LSD_{0.01}$ if applicable).

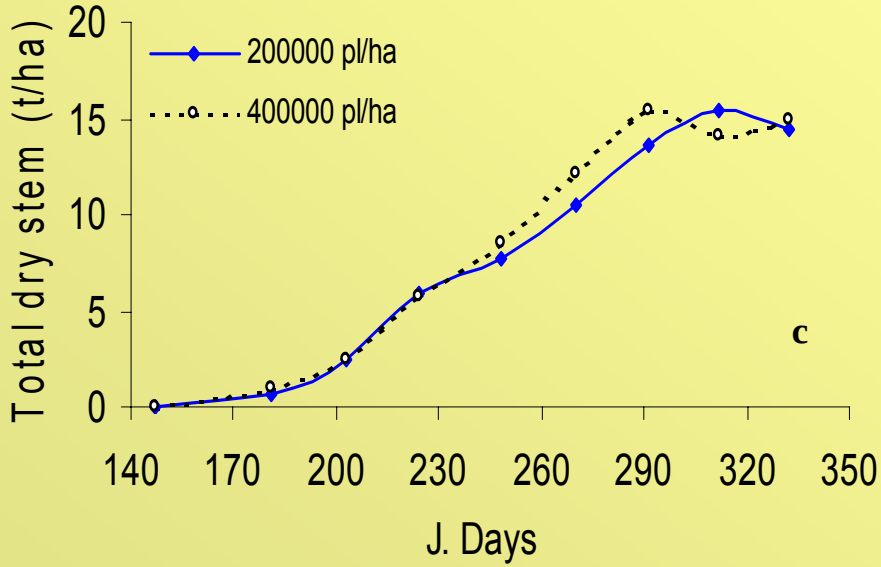
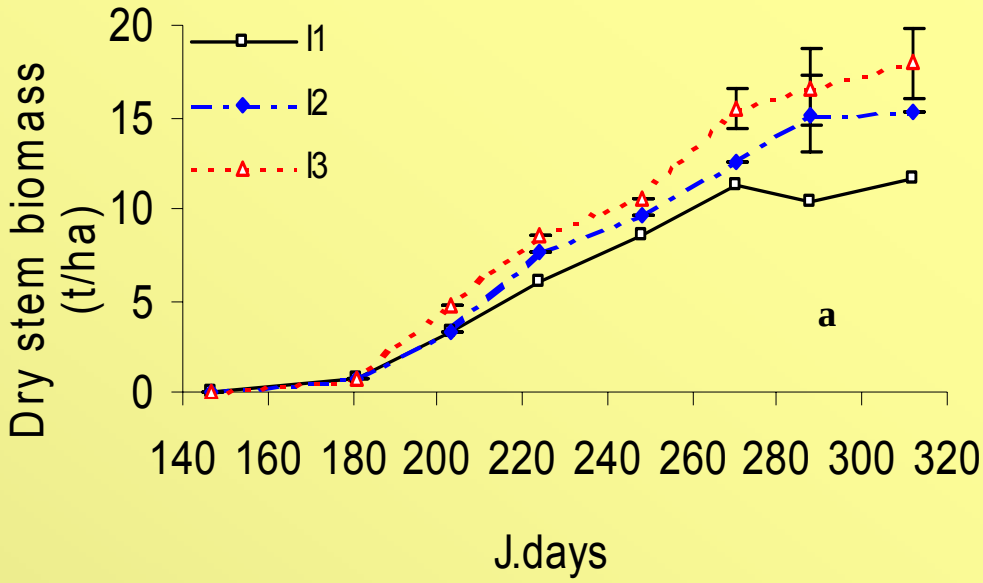
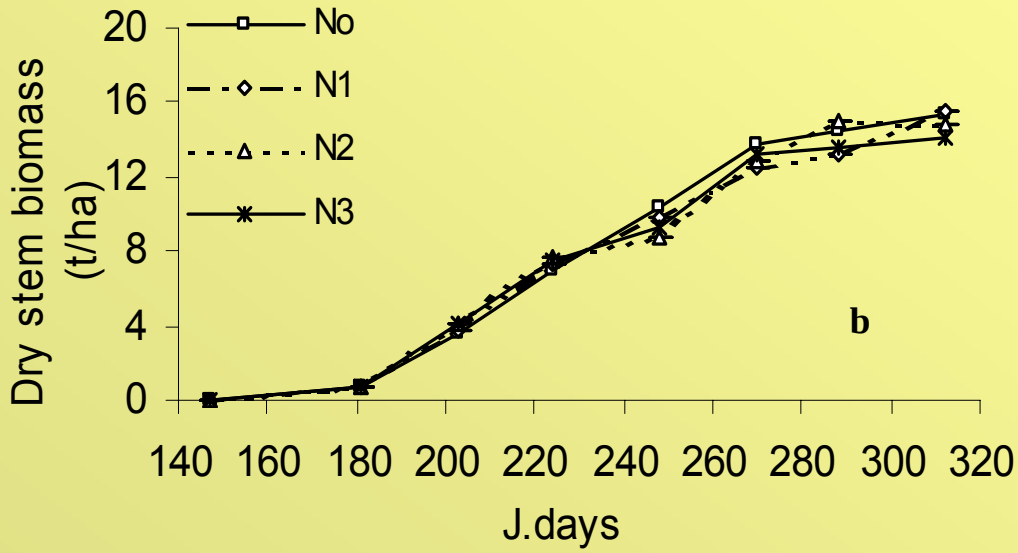
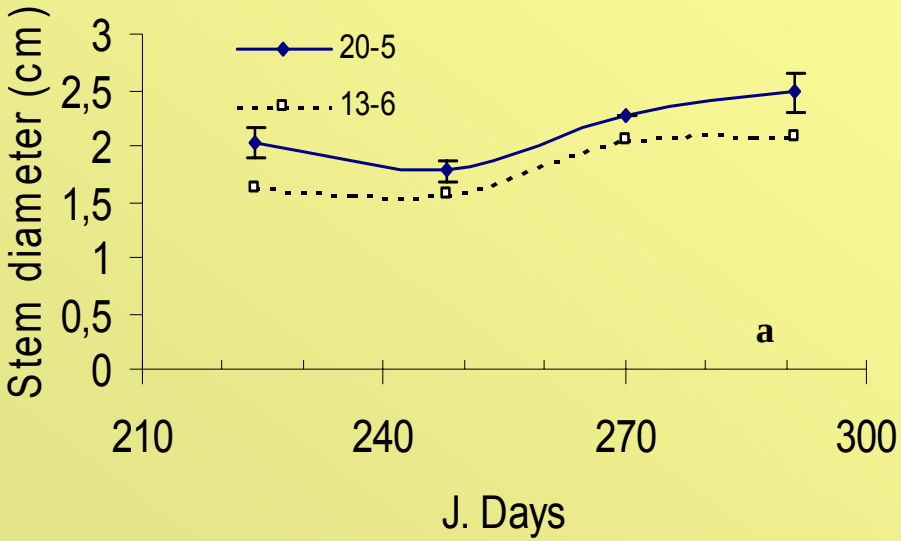


Figure 11: Dry stem biomass of Kenaf grown in central Greece in 2003 as affected by three irrigation treatments (a) and four N-fertilization treatments (b). (Vertical lines represent $LSD_{0.01}$ if applicable).







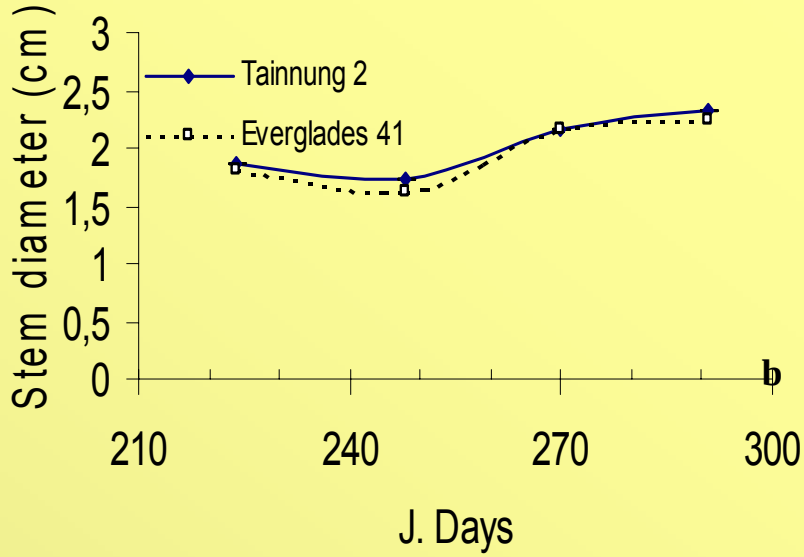


Fig. 12: Stem diameter of Kenaf grown under constraint-free conditions in central Greece in 2003 for the two different a) sowing dates, b) varieties, and c) plant densities. (Vertical lines represent $LSD_{0.01}$ if applicable).

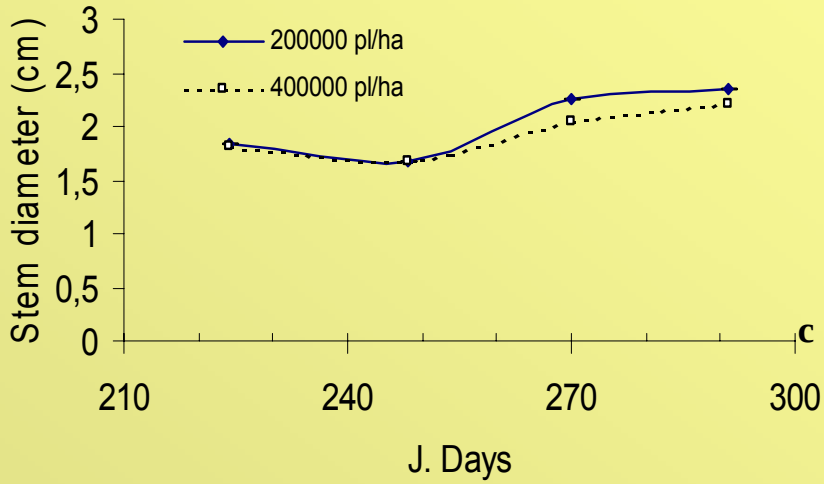
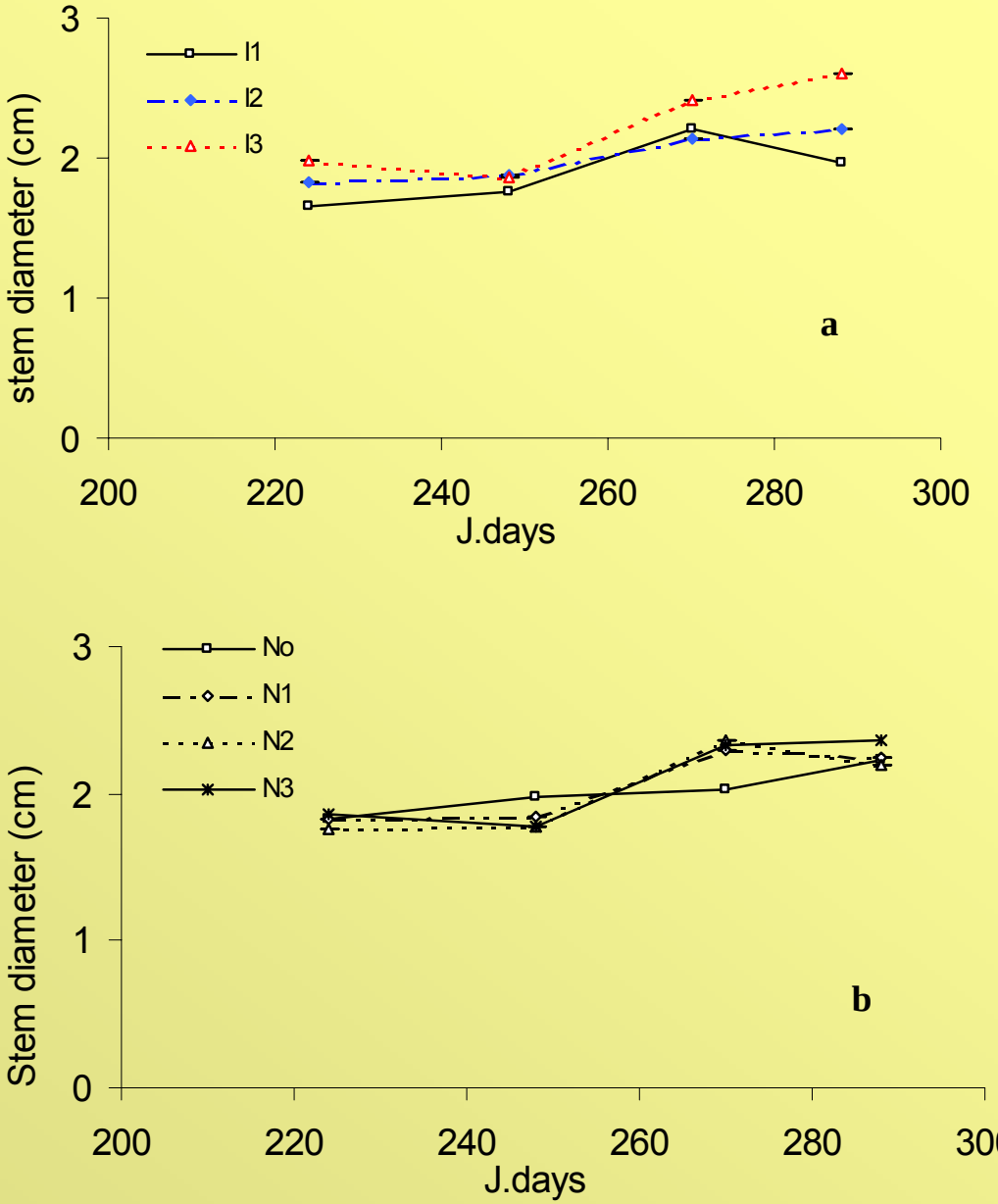


Fig. 13: ***Stem diameter*** *of Kenaf grown in central Greece in 2003 as affected by three irrigation treatments (above) and four N-fertilization treatments (below). (Vertical lines represent* $LSD_{0.01}$ *if applicable).*



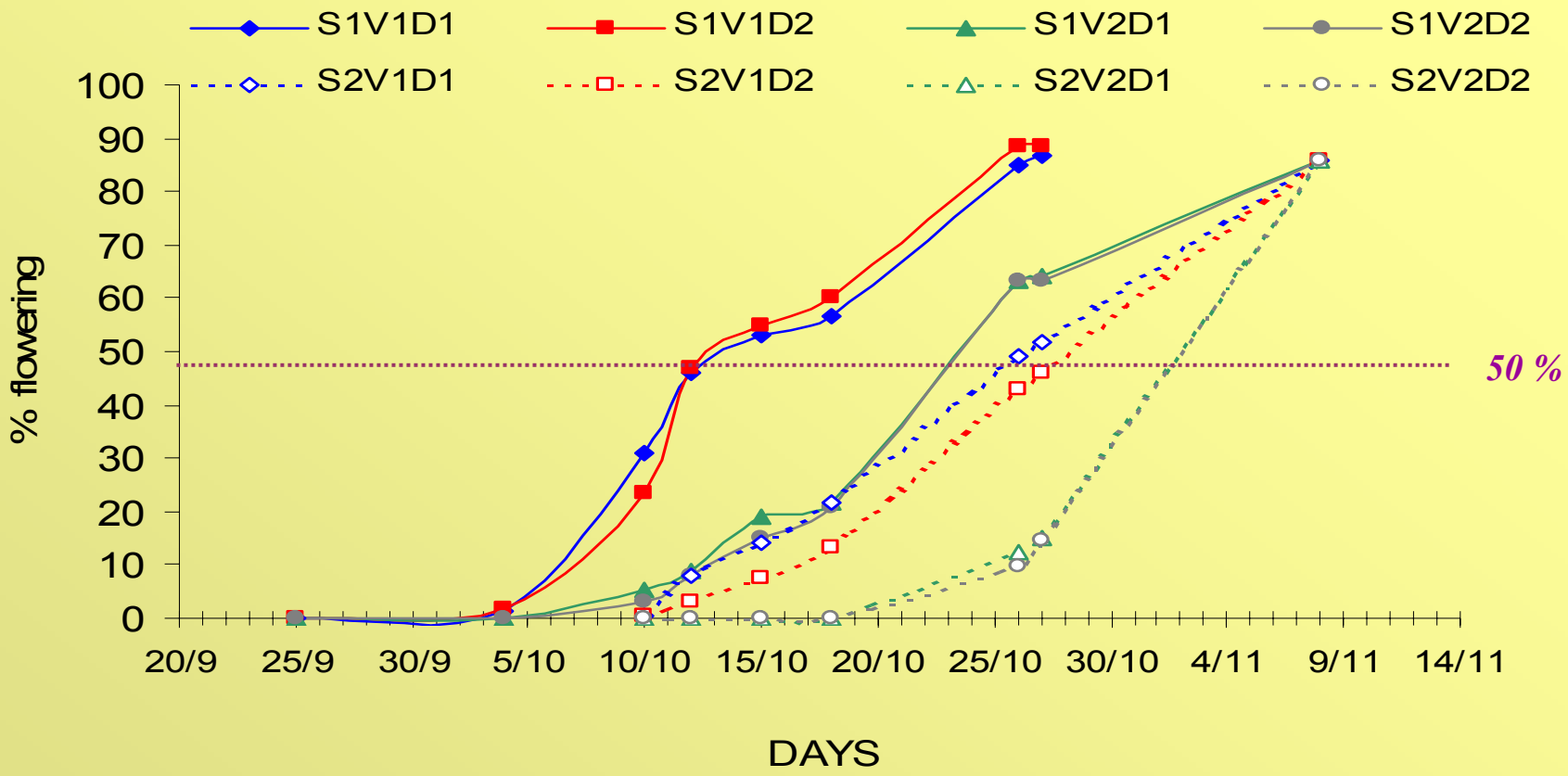


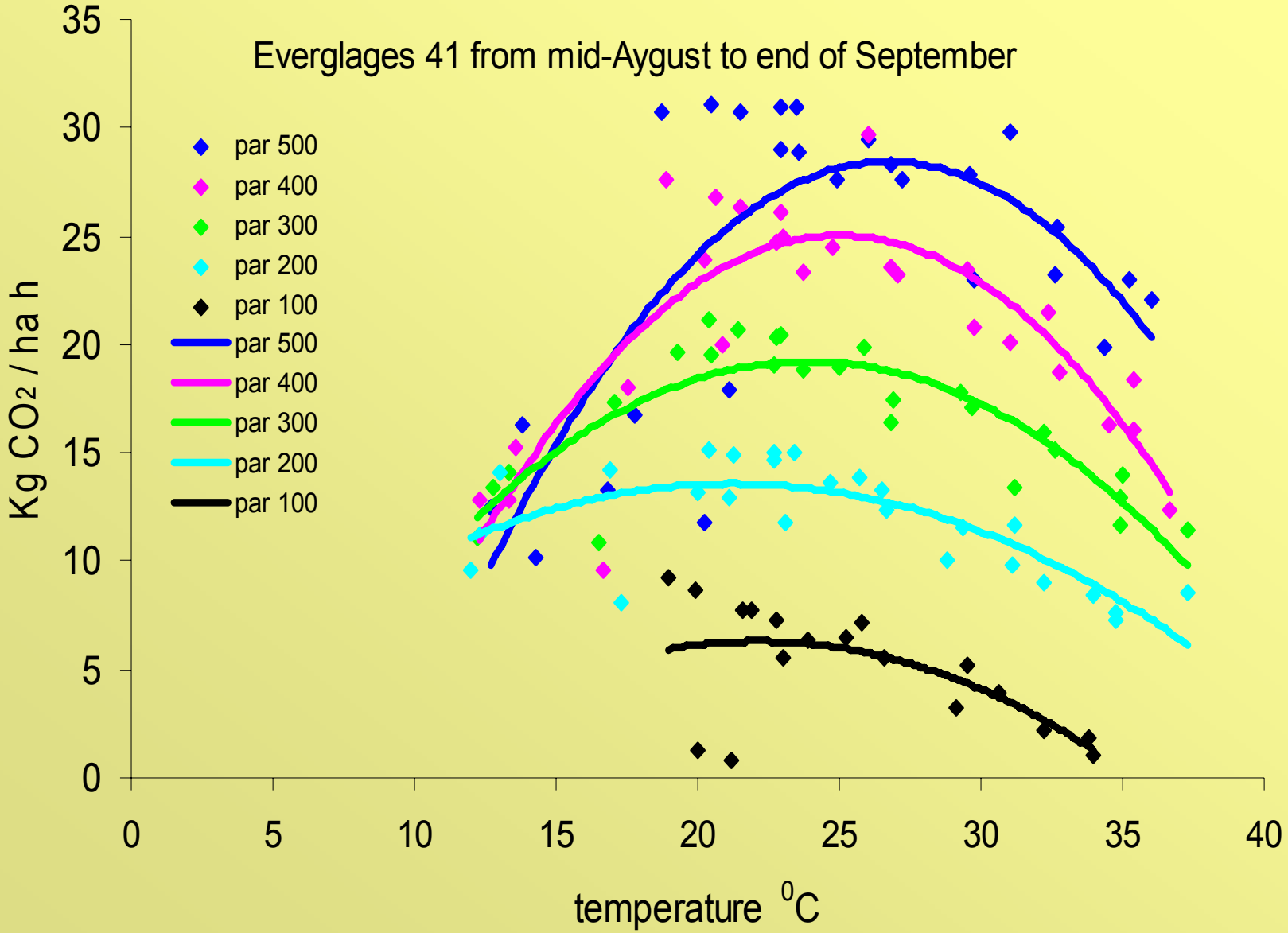
Figure 14: flowering of kenaf varieties

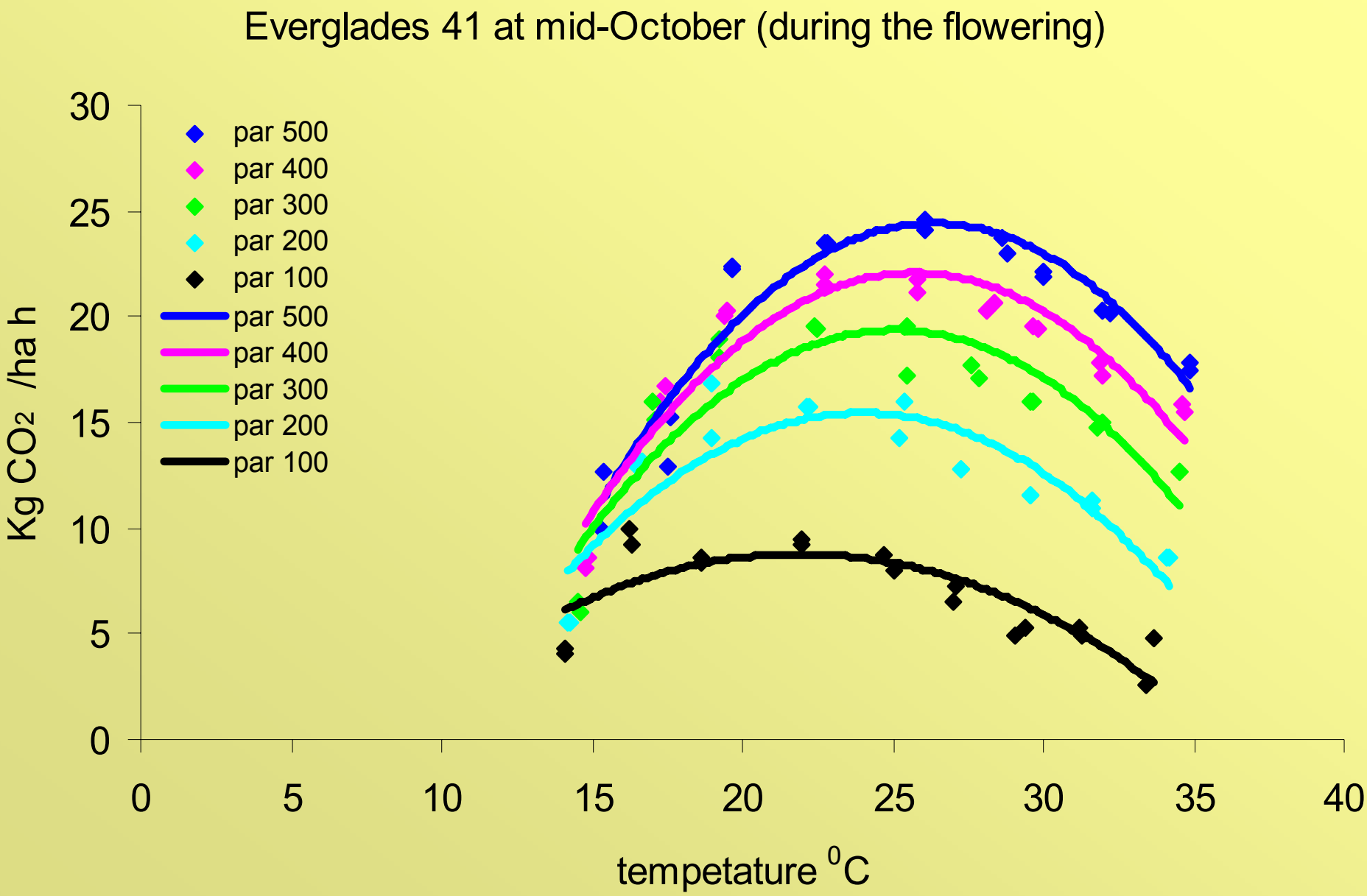
Early crop (S_1)

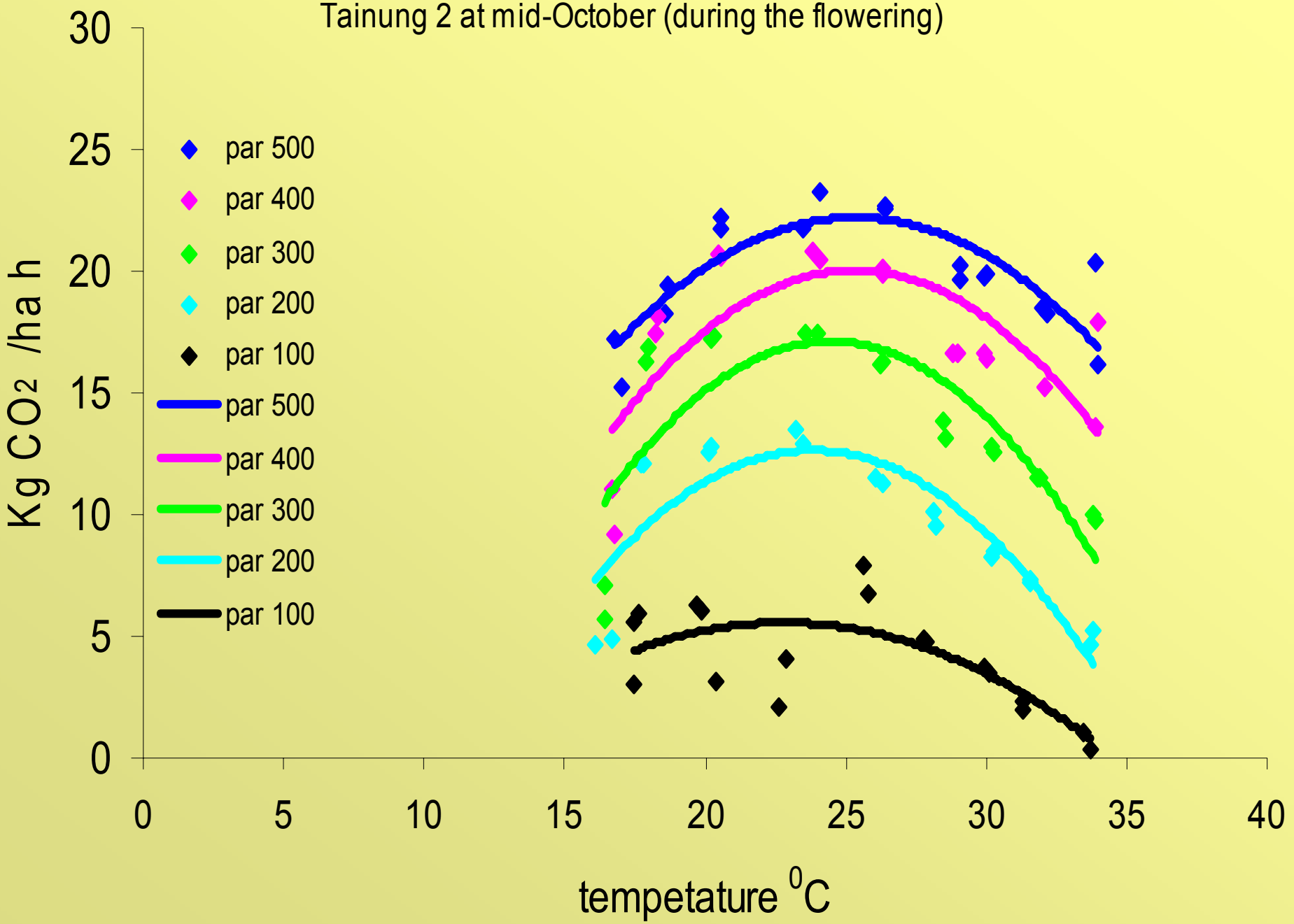
***Start flowering**: variety Tainnung 2 (V_1) on 25/9 and Everglades 41 (V_2) on 4/10.*
***50% of flowering** were recorded on 13/10 (Tainnung 2) and 23/10 for Everglades 41.*

Late crop (S_2)

Start flowering: variety Tainnung 2 (V_1) on 10/10 and Everglades 41 (V_2) on 18/10.
50% of flowering were recorded on 27/10 (Tainnung 2) and 3/11 for Everglades 41.


Everglages 41 from mid-Aygust to end of September
par 500
par 400
par 300
par 200
par 100
par 500
par 400
par 300
par 200
par 100
Kg CO2 / ha h
temperature 0C
0
5
10
15
20
25
30
35
40


Everglades 41 at mid-October (during the flowering)
Kg CO2 /ha h
tempetature 0C
par 500
par 400
par 300
par 200
par 100
par 500
par 400
par 300
par 200
par 100
0
5
10
15
20
25
30
0
5
10
15
20
25
30
35
40


Tainung 2 at mid-October (during the flowering)
Kg CO2 /ha h
tempetature 0C
par 500
par 400
par 300
par 200
par 100
par 500
par 400
par 300
par 200
par 100
0
5
10
15
20
25
30
0
5
10
15
20
25
30
35
40

Kenaf maximum assimilation rate (25-27°C)