Biomass Production Chain and Growth Simulation Model for Kenaf

QLK5-CT-2002-01729 acronym: **BIOKENAF**

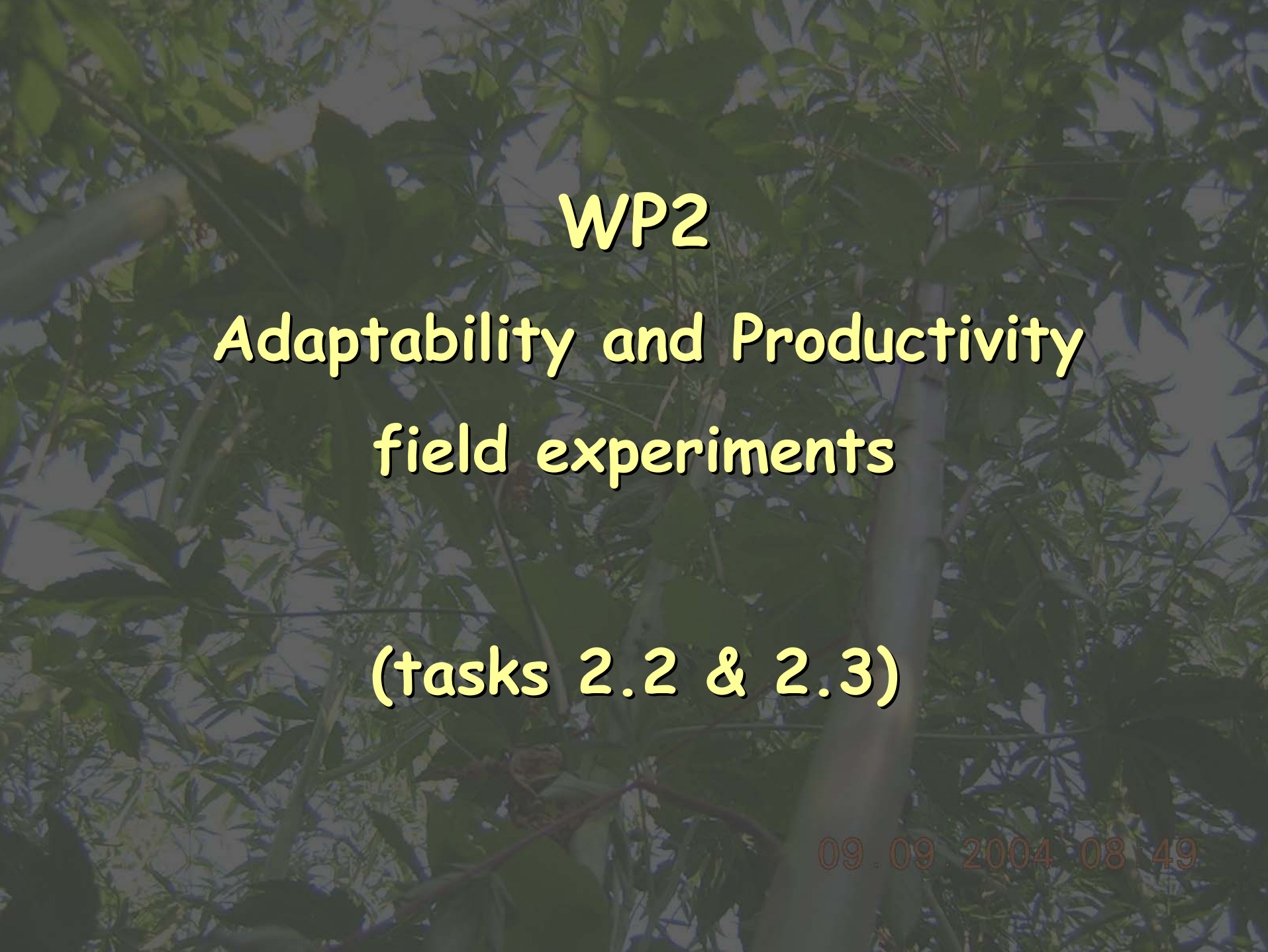
University of Thessaly *(UTH)*

Department of Agriculture,

Crop Production & Agricultural Environment

09 09 2004 08:49

4rth technical meeting, Lisbon 23-24/9/04



WP2

Adaptability and Productivity field experiments

(tasks 2.2 & 2.3)

The field experiments were carried out in Palamas Karditsa, western Thessaly, 3 km south east of the village of Palamas

coordinates:
39°25'43.4"N,
22°05'09.7"E,
altitude 107.5 m

09 09 2004 08 49

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

2x2x2 factorial completely randomized block design in 3 blocks.

S1

Sowing date: 1-6-04

50% emergence: 5-6-04

100% emergence: 7-6-04

Start flowering: 11-9-04

(only Tainnung 2)

S2

Sowing date: 1-7-04

50% emergence: 5-7-04

100% emergence: 8-6-04

Start flowering: - - -

Sampling times until now

- 4-7-04
- 21-7-04
- 4-8-04
- 19-8-04
- 8-9-04

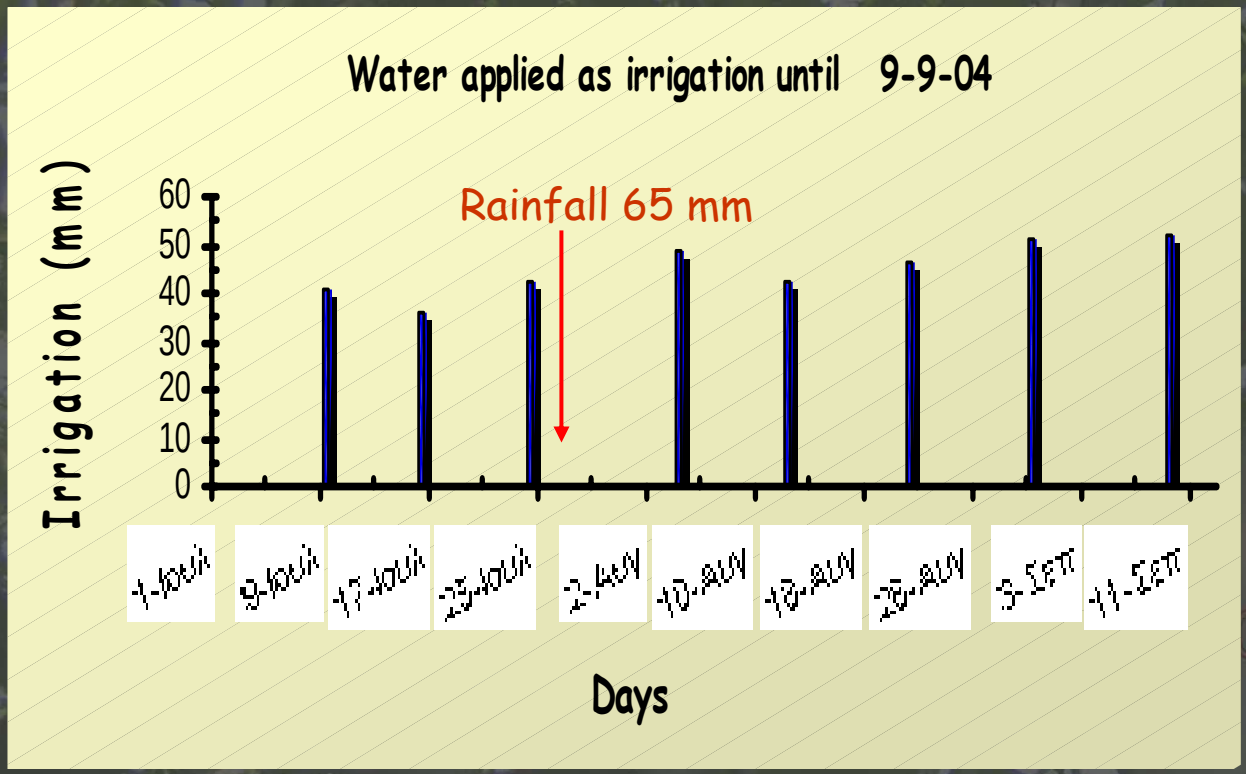
Germination of kenaf varieties = 96%

Weight of 100 seed = 3gr

Fertilization

Basal dressing of 50 kg P and 100 kg K ha^{-1} on 29-5-2004,
Top dressing of 100 kg N ha^{-1} (as ammonium sulphate) on 11-8-2004

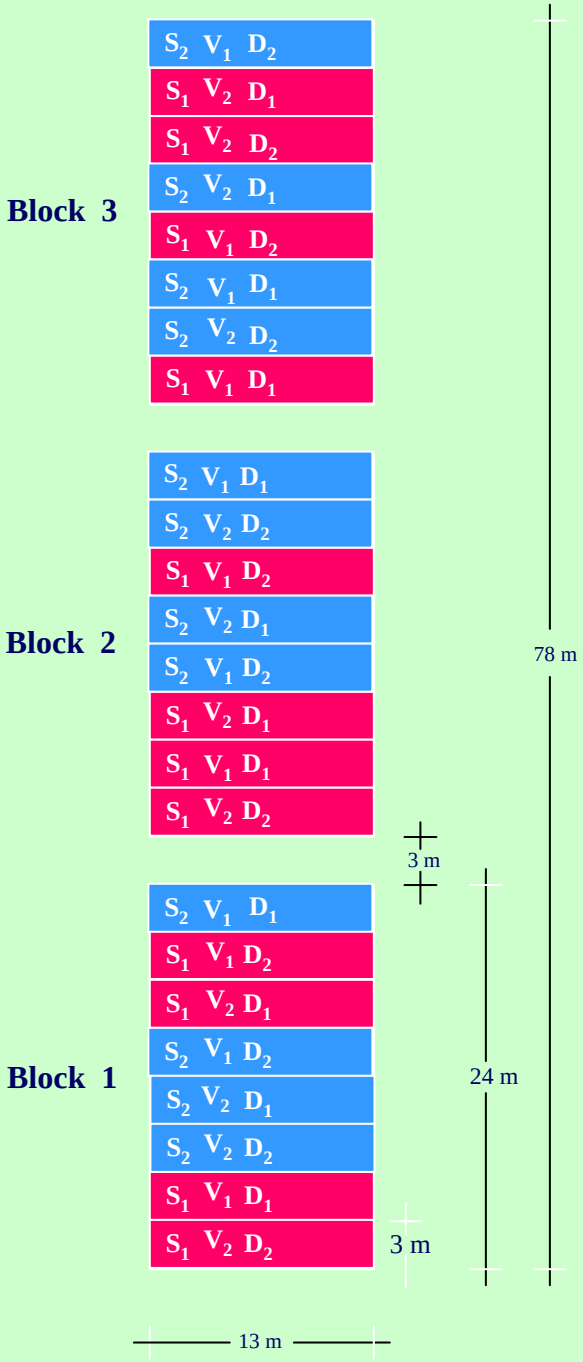
Irrigation

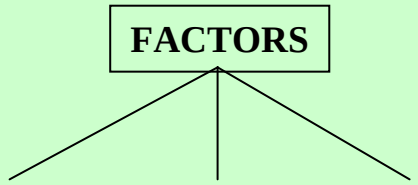


The crop received drip irrigation for full matching the PET

in total 361 mm until 10/9/2004

Task 2.2





S Sowing time

V Variety

D Density

S_1=1-6-2004 V_1= Tainnung 2 D_1=200000pl/ha

S_2=1-7-2004 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.

33x4 factorial completely randomized split-plot design in 3 blocks.

Sowing date: 1-6-04

50% emergence: 5-6-04

100% emergence: 7-6-04

Start flowering: 9-9-04

(only Tainnung 2)

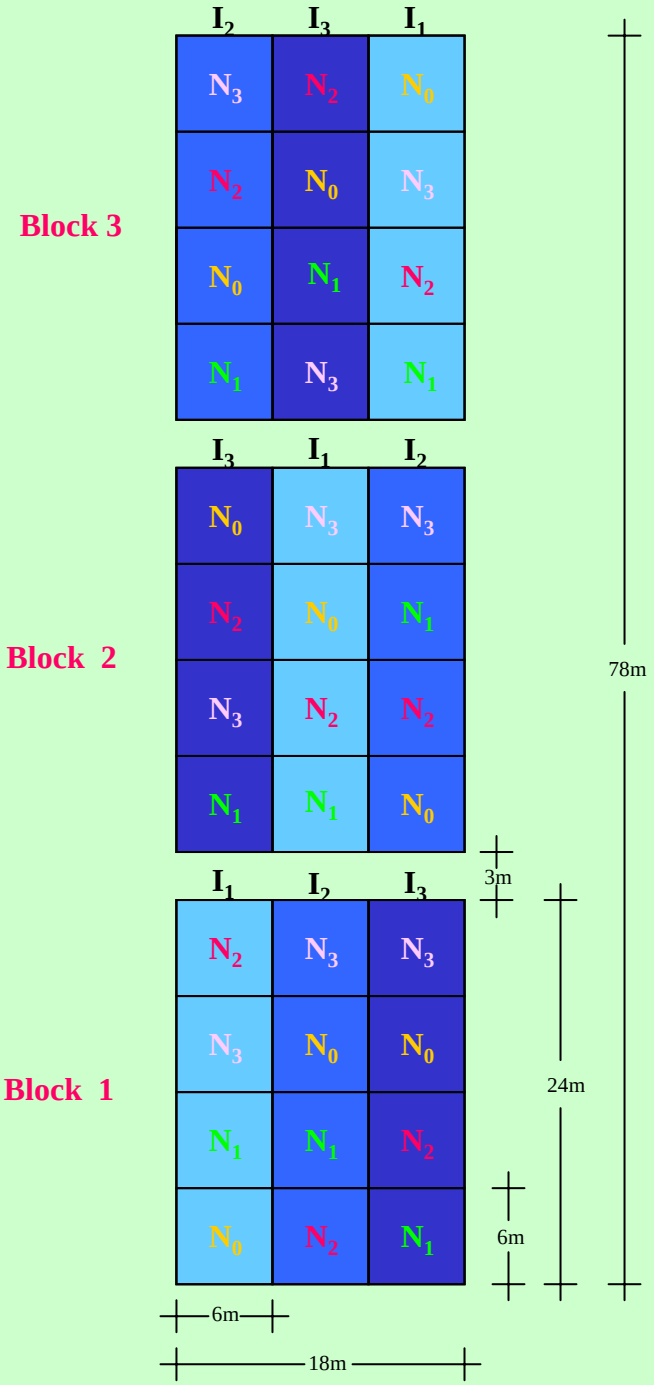
Sampling times until now

- 4-7-04
- 21-7-04
- 4-8-04
- 22-8-04
- 9-9-04

Basal dressing of 50 kg P and 100 kg K ha^{-1} on 29-5-2004,
Top dressing of 0-50-100 and 150 kg N ha^{-1} on 6-7-04

Water supplied as irrigation: *(until 9/9/04)*
I_1 = 25% (90.2 mm), I_2 = 50% (180.5 mm), I_3 = 100% (361 mm)

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**

Ground water level:

30-4-04 = 1,7 m

1-6-04 = 1.8 m

6-8-04 = 3.6 m

Soil moisture content was measured at 3 soil horizons weekly. Data are not yet processed.

The soil under study is an imperfectly drained, calcareous

(pH=8-8.2) loam (sand 40-42%, silt 40-41%, clay 18-19%)

developed in recent deposits and represents a large part of the west Thessaly lowland.

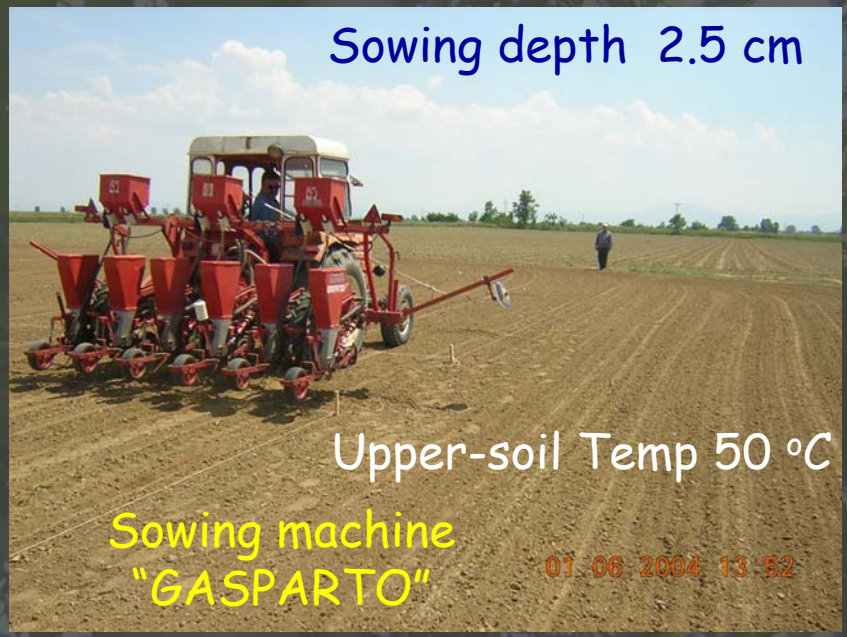
The soil has an organic matter content > 1% at depth of 50 cm

09 2004 08 49


Basal dressing, before sowing
29.05.2004 17:52


Preparation for sowing
29.05.2004 18:44


50 cm
01.06.2004 13:41


Sowing depth 2.5 cm
Upper-soil Temp 50 °C
Sowing machine
"GASPARTO"
01.06.2004 13:52

Tainnung 2
10 days
after
emergence

Mechanic
destruction
of
weeds


Preparation for S_2 sowing
01.07.2004 15:40

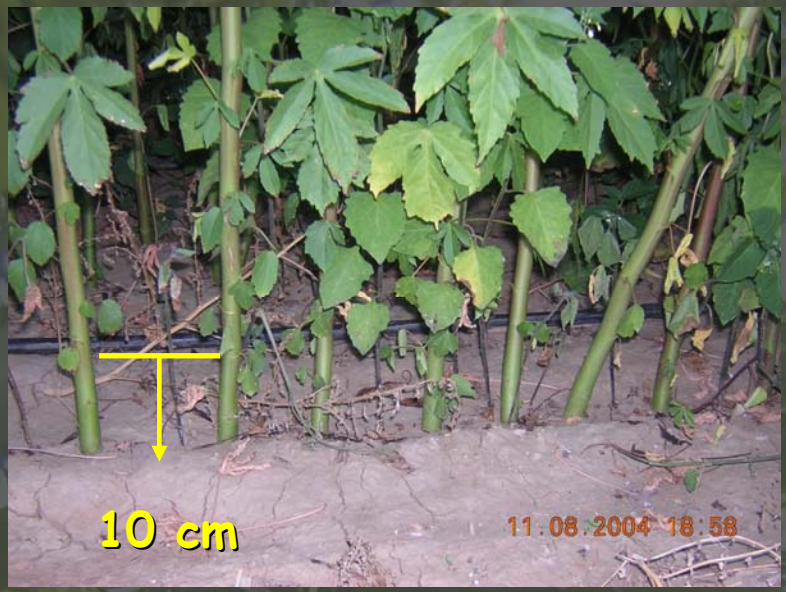

Just before S_2 sowing
01.07.2004 16:11


Tainnung 2
one month after emergence
04.07.2004 09:02

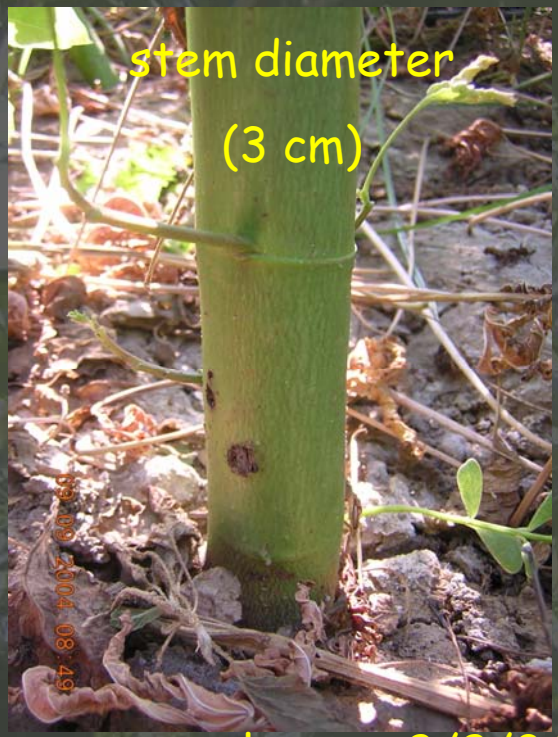

Drip irrigation system
06.07.2004 15:09

Experimental area of Kenaf trials in Palamas

A superiority of S_1 sowing time



Superiority of S_1 sowing time



senescent leaves, 9/9/04

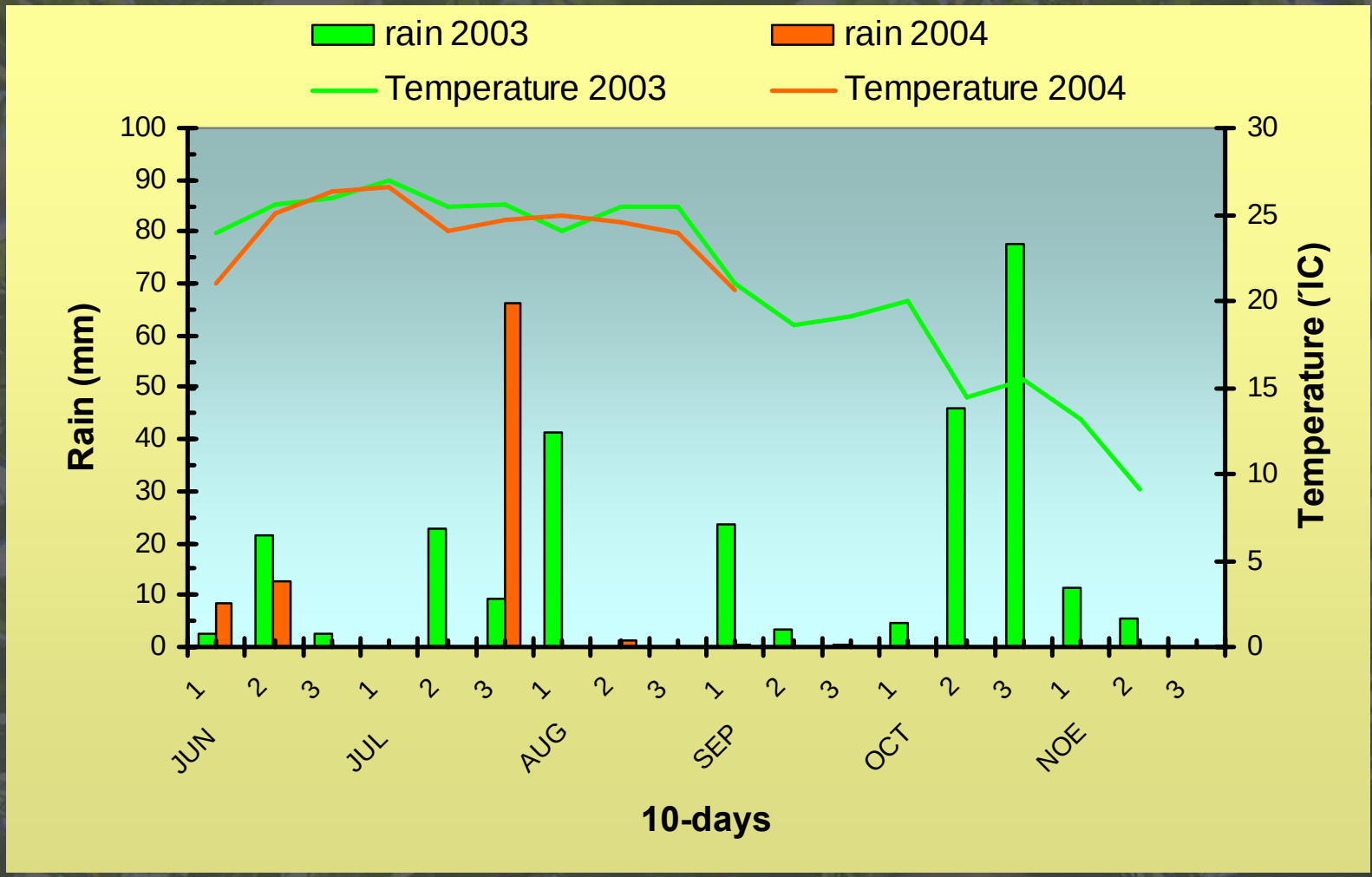
I_3 plants on 9/9/04

Tainnung 2, 9/9/04

Tainnung 2, as affected by irrigation

Photosynthesis
LCpro machine

Climatic conditions

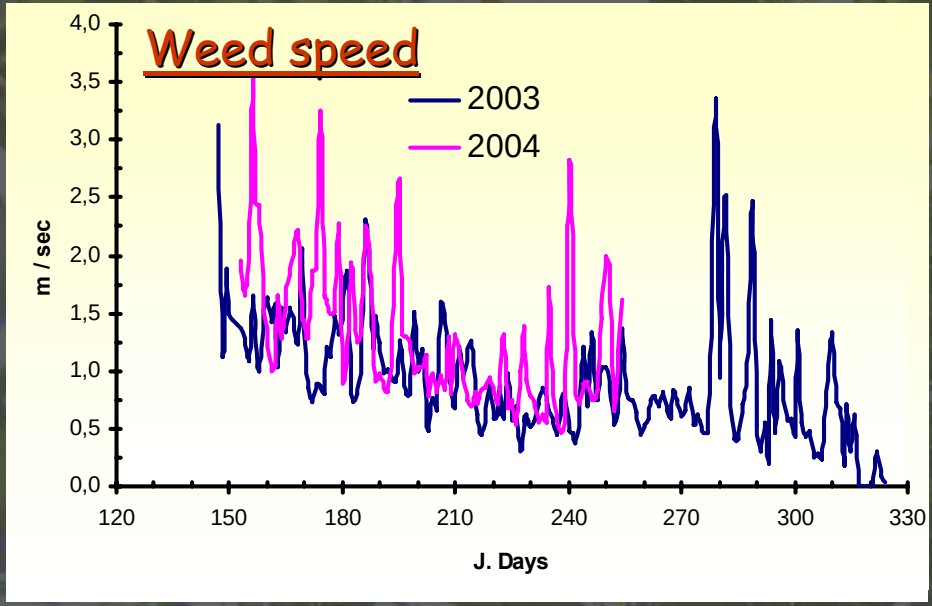


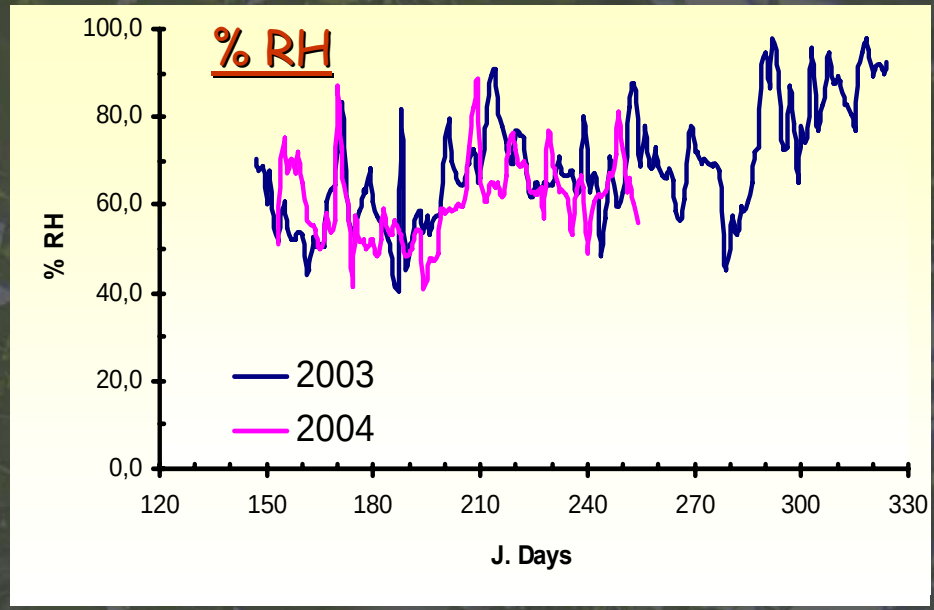
Air temperature and precipitation (10-day mean values)

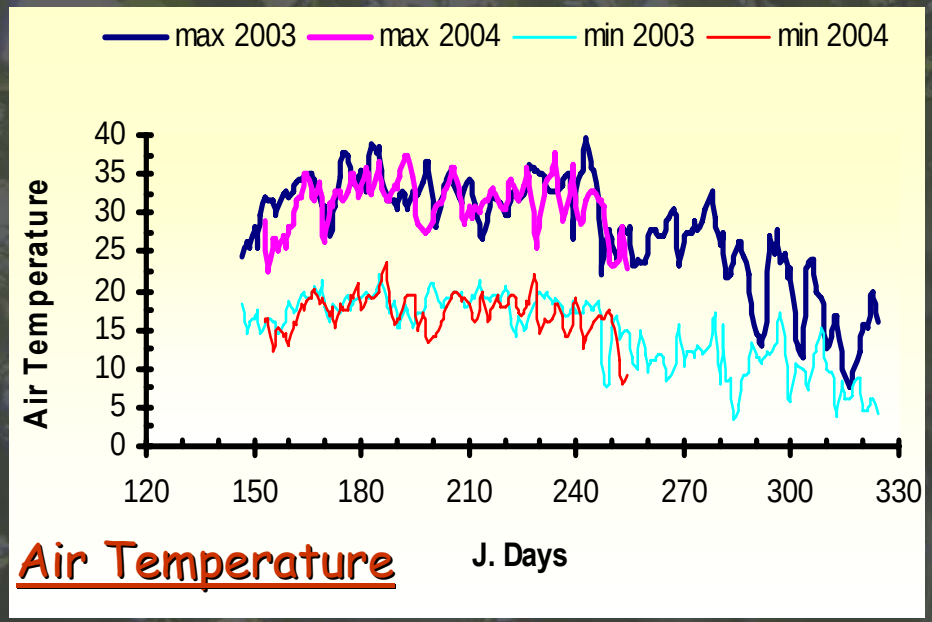
Evaporation: from 20-6-**04** to 10-9-**04** (450 mm)

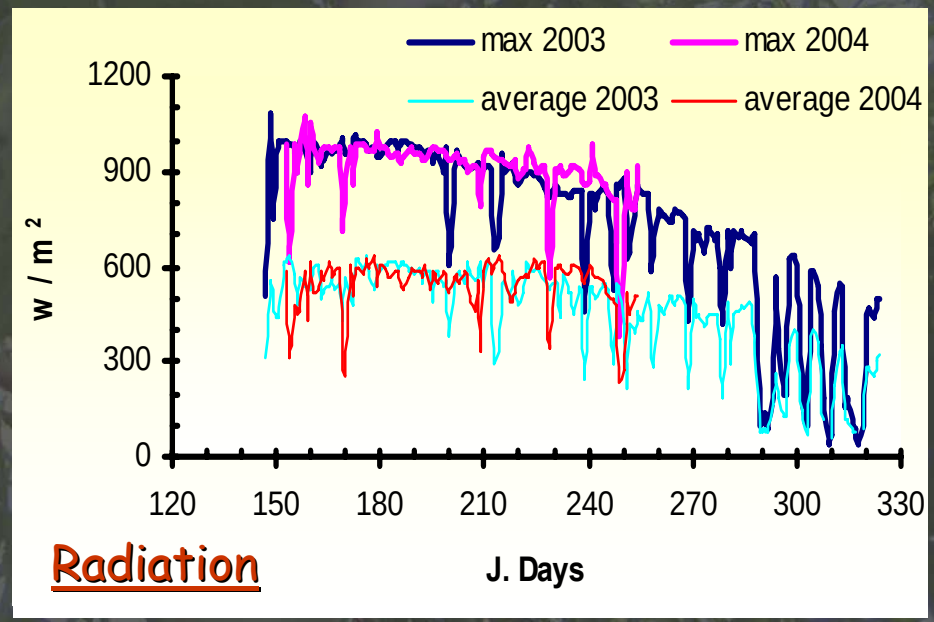
from 20-6-**03** to 10-9-**03** (400 mm)

Daily weather data, 2003-2004









RESULTS

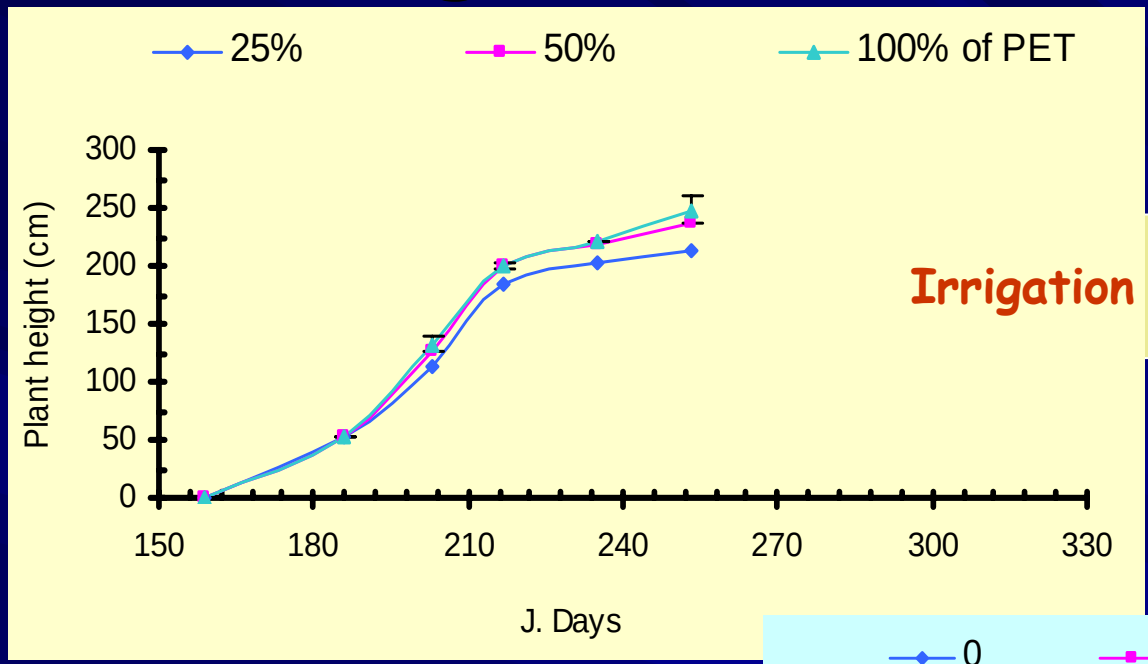
Growth Characteristics

- Plant height (cm)
- Basal stem diameter (cm)
- Number of main nodes per plant
- Plants per m^2
- Dry / fresh ratio
- SLA (m^2 kg^{-1})
- LAI
- Assimilation rates

Biomass Production

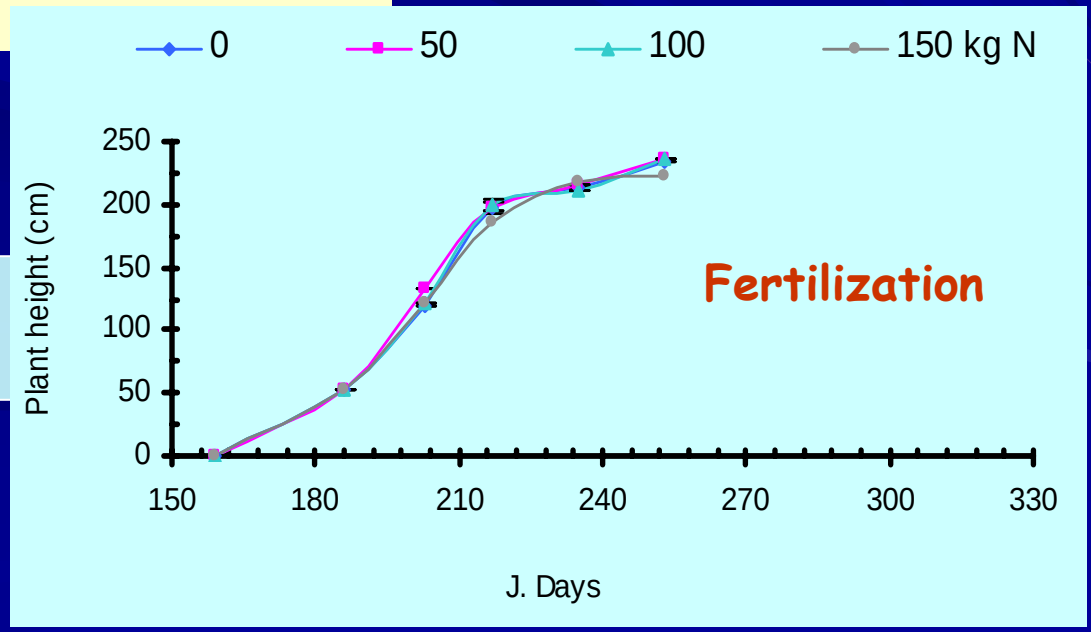
- Fresh biomass (t ha^{-1})
- Total dry biomass (t ha^{-1})
- Dry stem biomass (t ha^{-1})
- Dry matter distribution

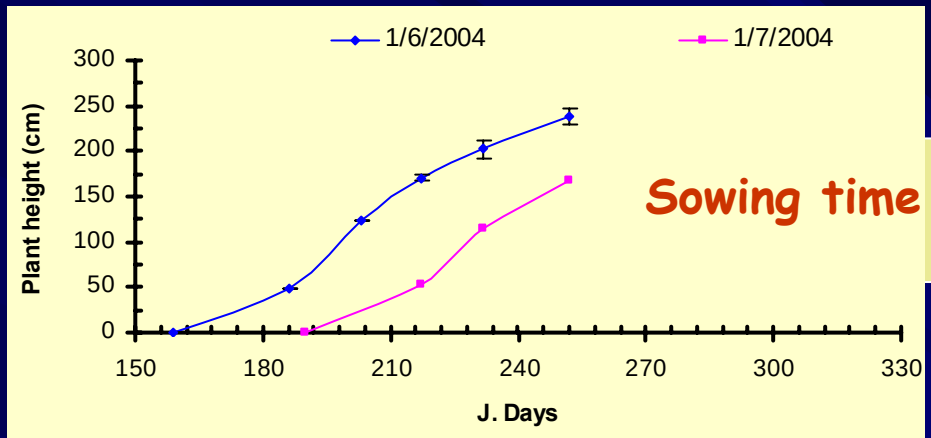
Plant height (cm)



- maximum growth rate 4.7 cm/day
- Same height as 2003 until now
- a slight superiority of I_3-irrigation
  - I_3-I_1 = 35 cm
  - (253 J.day)

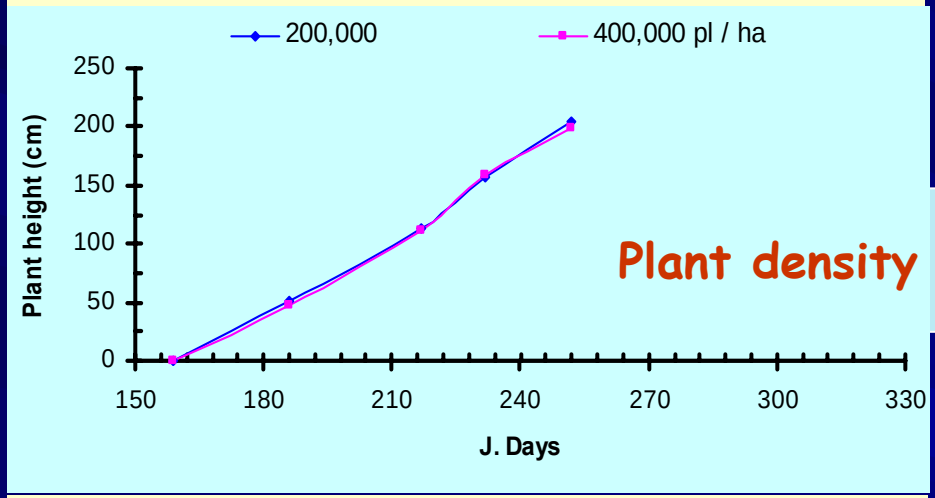
No effect of fertilization as in the first year





20 cm smaller S1 plants than in 2003

40 cm smaller S2 plants than in 2003



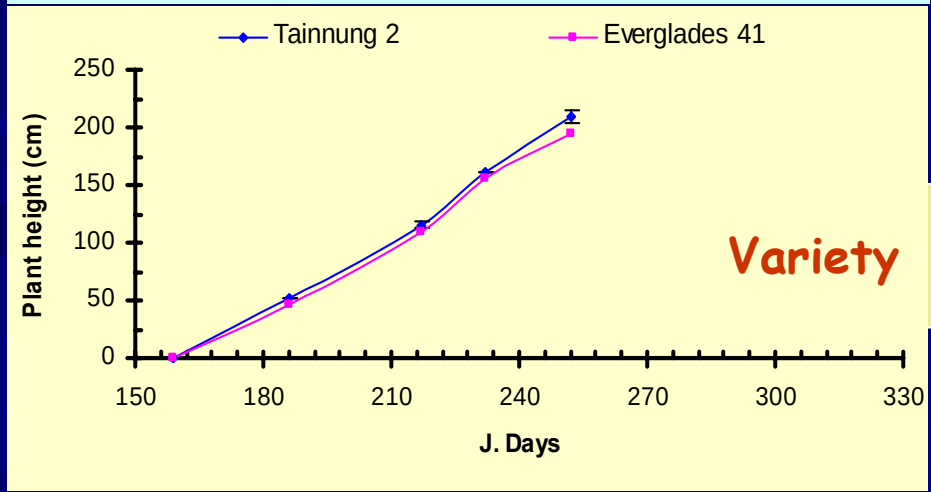
max growth rate :

S_1: 4.4 cm/day

S_2: 4.0 cm/day

(at early development stage)

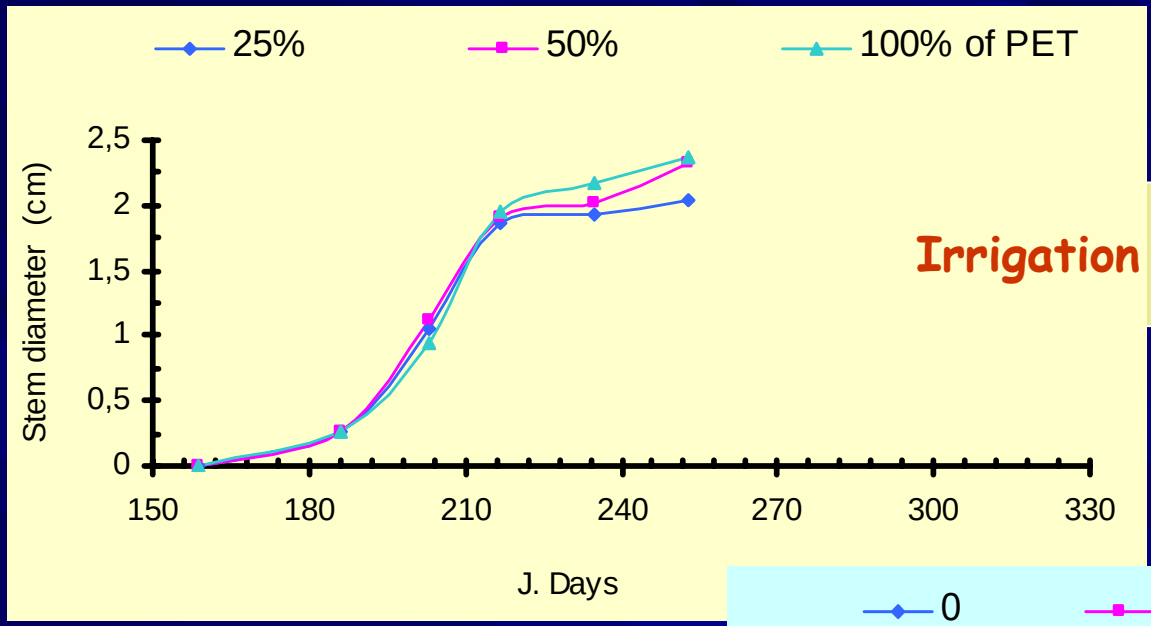
A high superiority ($LSD_{0.01}$) of S_1 sowing



No effect of plant density.

A slight superiority of Tainnung 2 was observed in the last sampling (same as 2003)

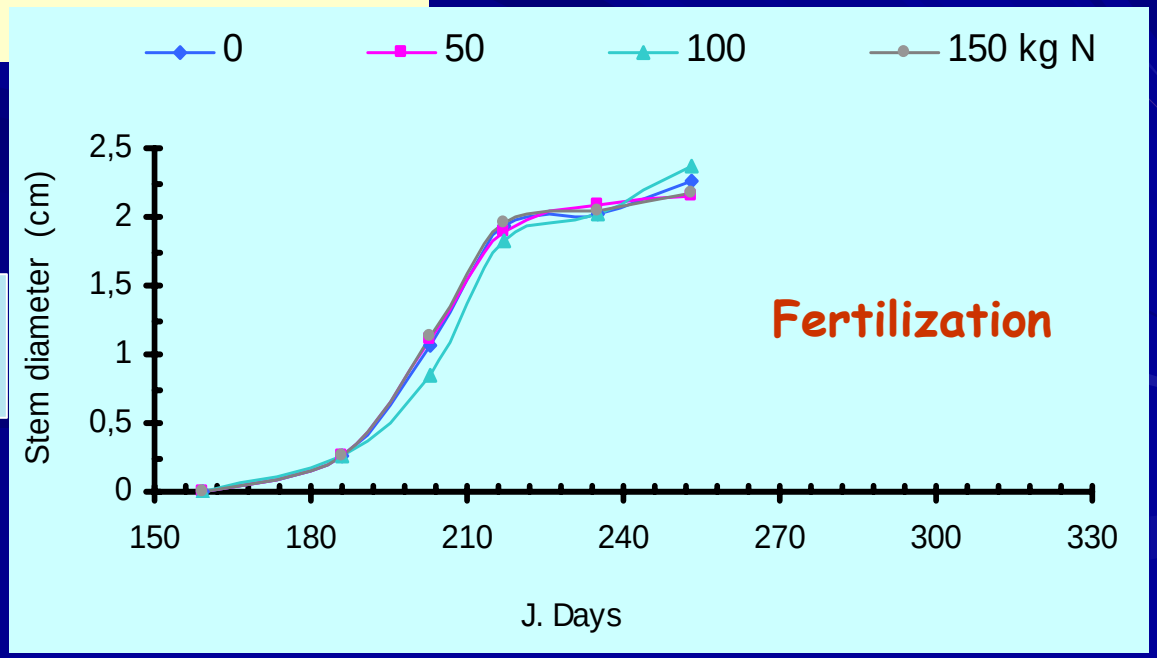
Basal Stem diameter (cm)



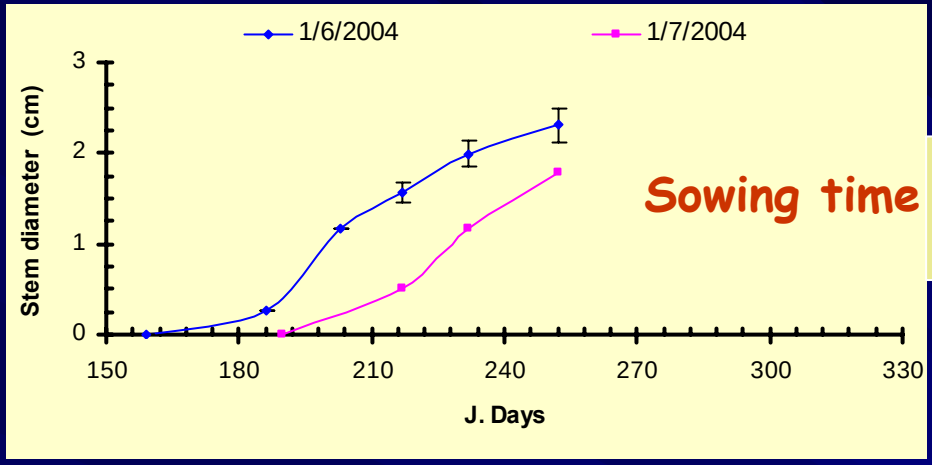
Irrigation

- High increase from 4/7 to 22/8
- Max 2.4 cm (I_3) at 9/9/04
- greater (0.67 cm) than 2003 (I_3) in same period

No effect of fertilization as in the first year

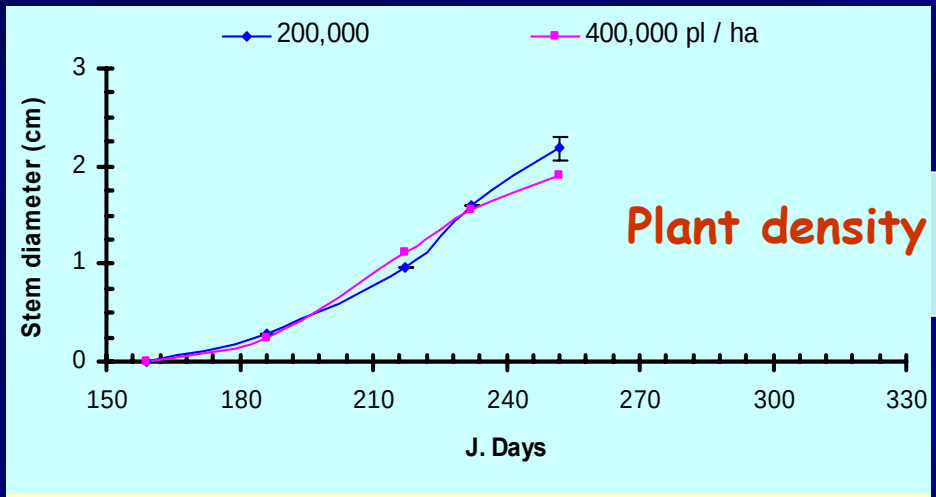


Fertilization

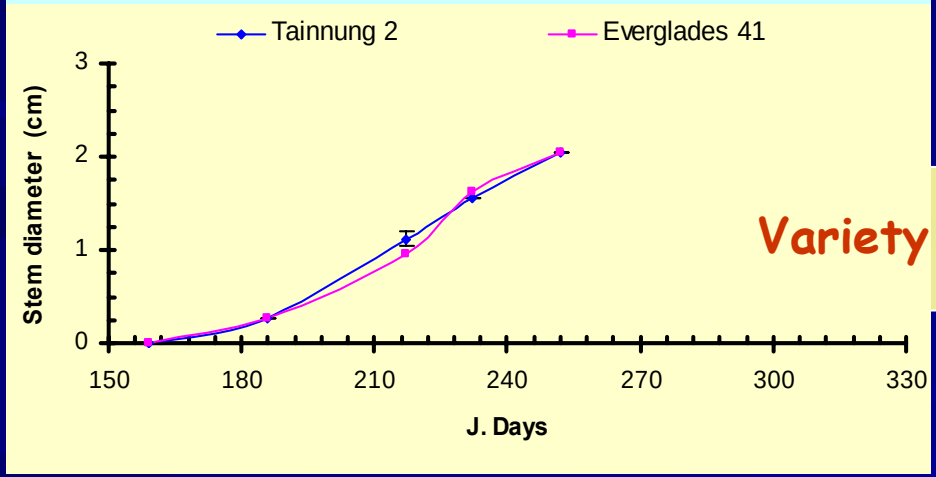


2.3 cm maximum for S_1
1.78 cm maximum for S_2
on 252 J. Day

A high superiority ($LSD_{0.01}$) of S_1 sowing throughout the growing period until now

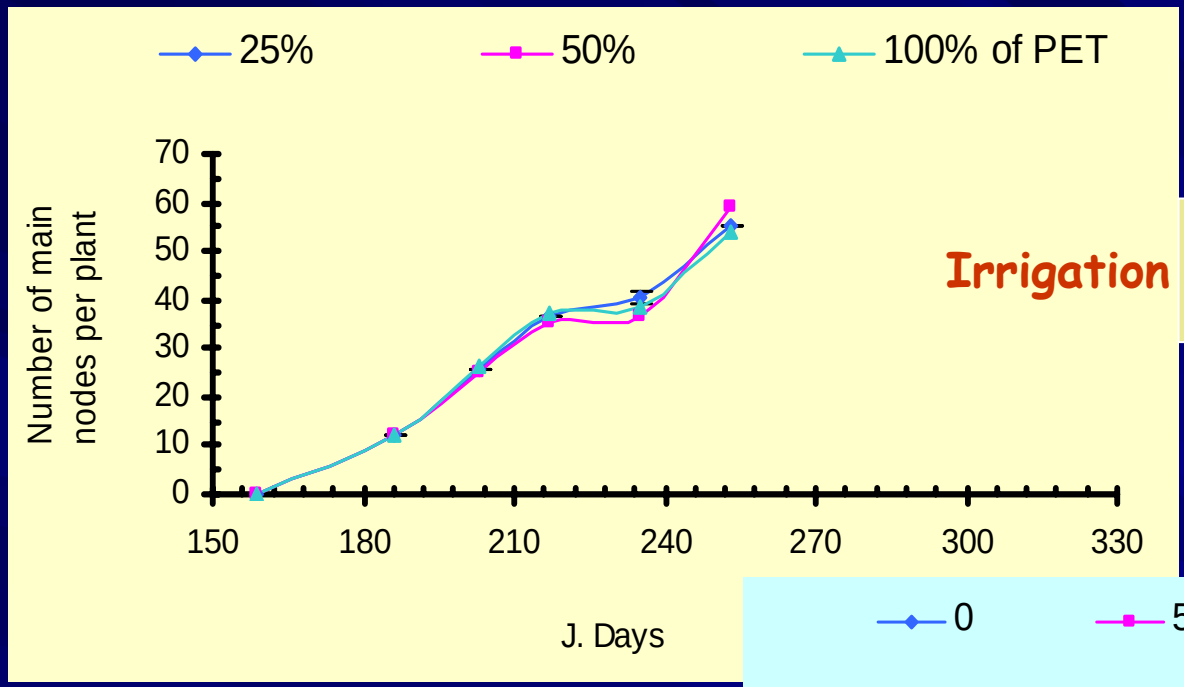


minimal effect of plant density



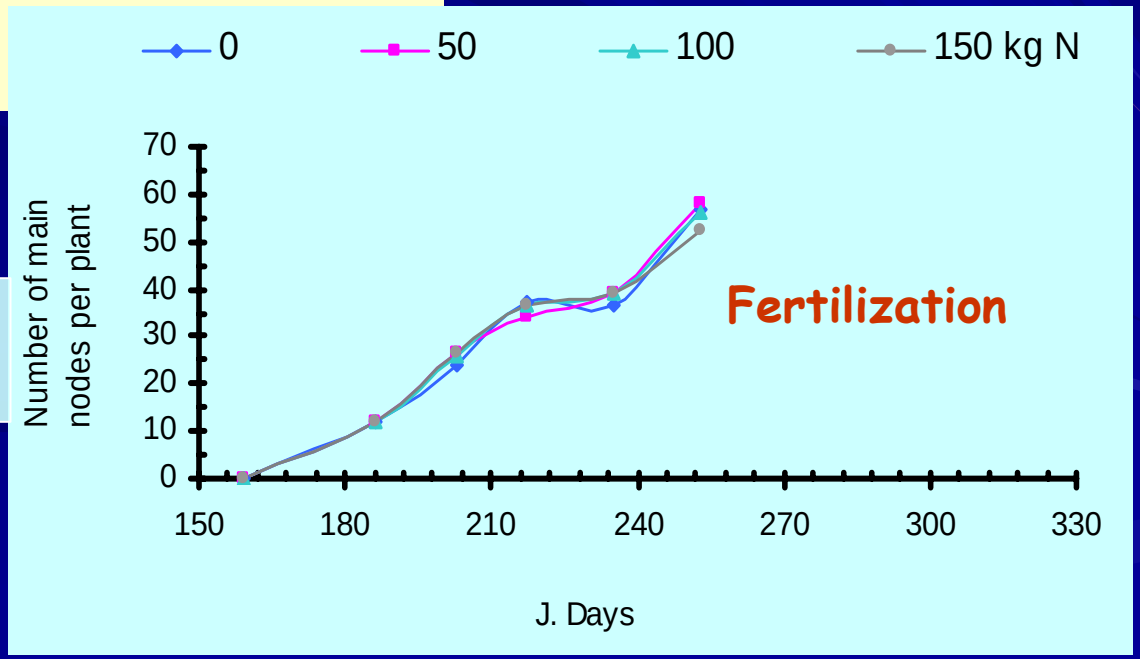
No effect of variety

Number of main nodes per plant



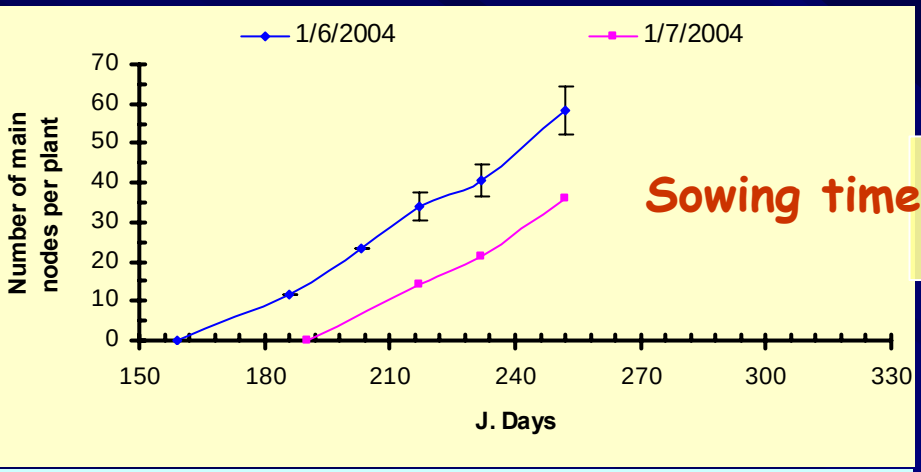
Irrigation

- No effect of irrigation
- 7 main nodes without leaf on 240 J. day
- 12.4 main nodes without leaf on 253 J. day

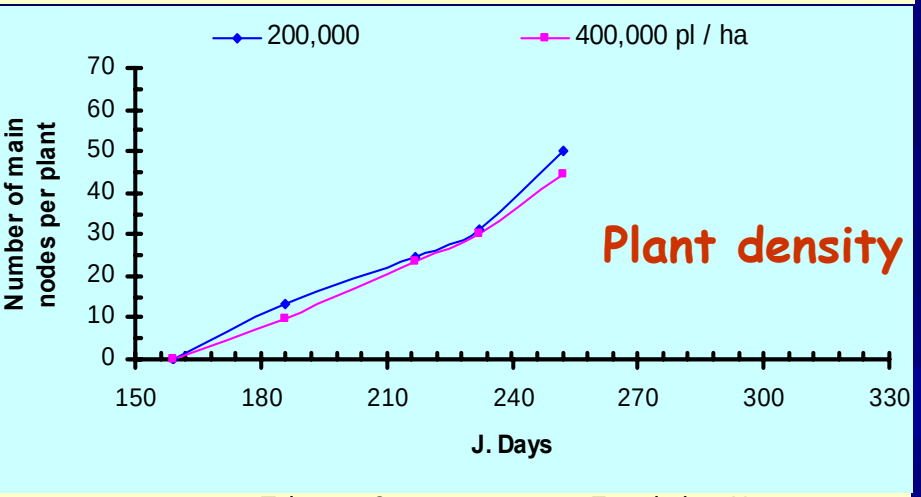


Fertilization

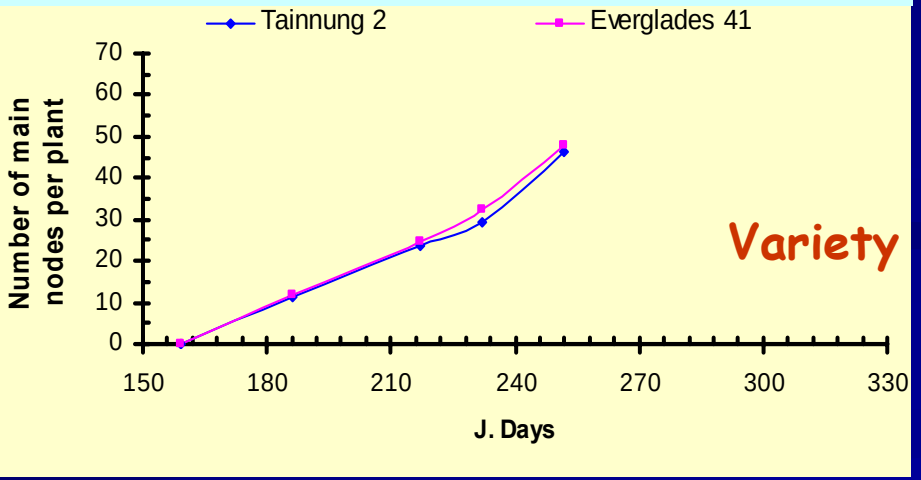
No effect of fertilization



Sowing time

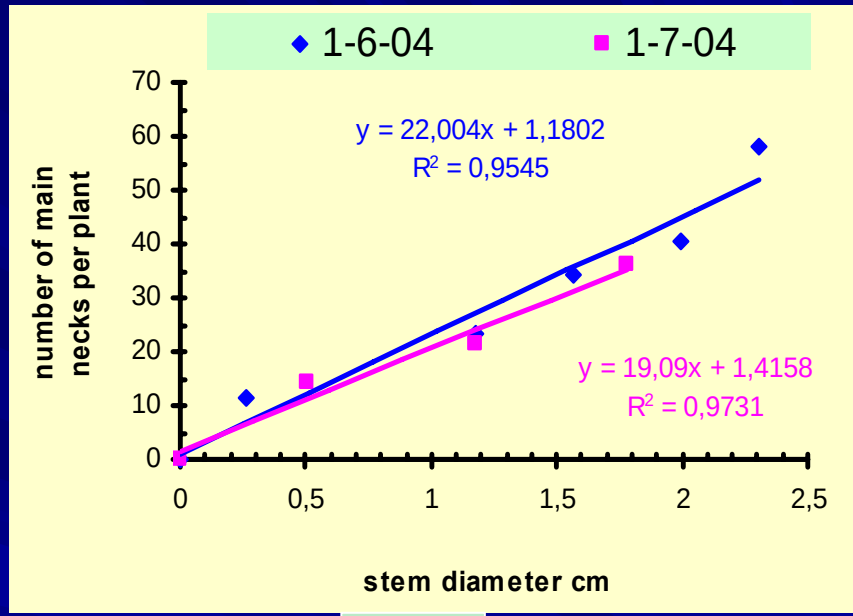


Plant density



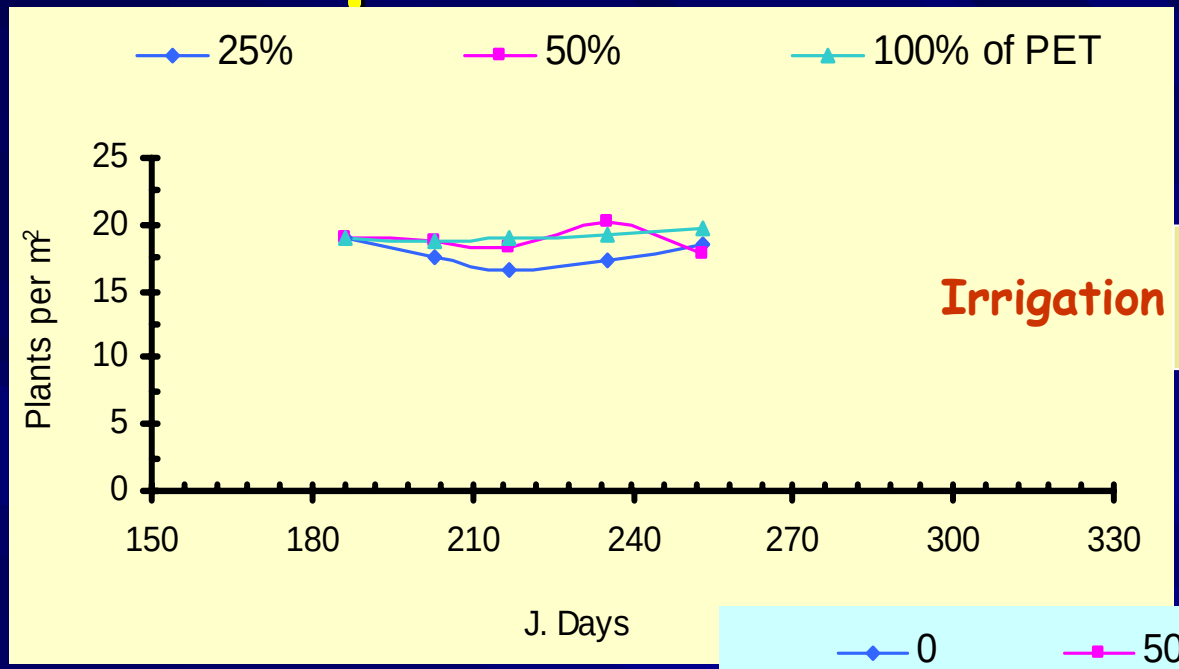
Variety

A high superiority ($LSD_{0.01}$) of S_1 sowing throughout the growing period until now



Strong linear increase of node number with basal stem diameter

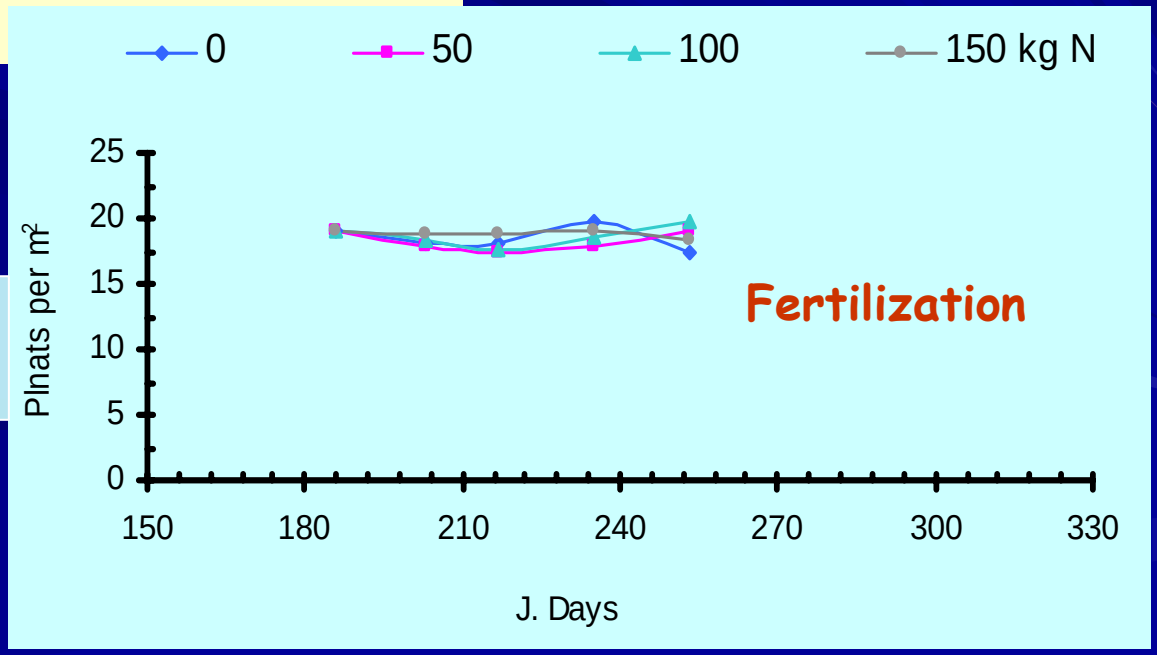
Plants per m²



Irrigation

No irrigation effect

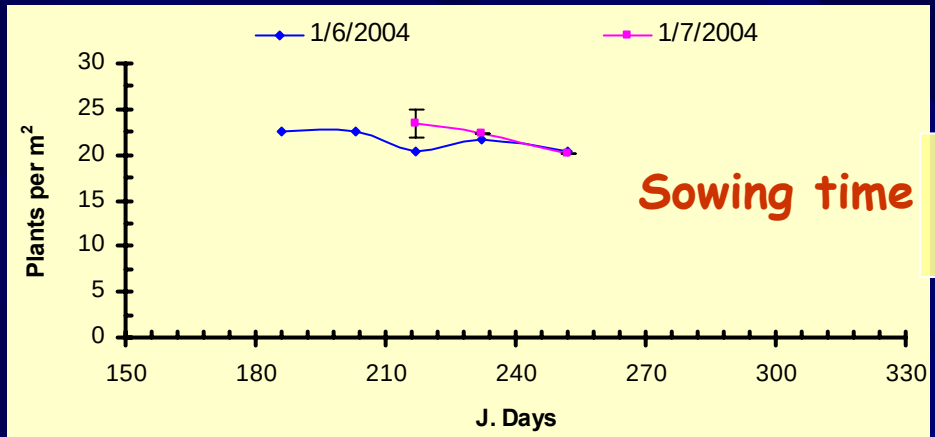
About 20 plants/ m²

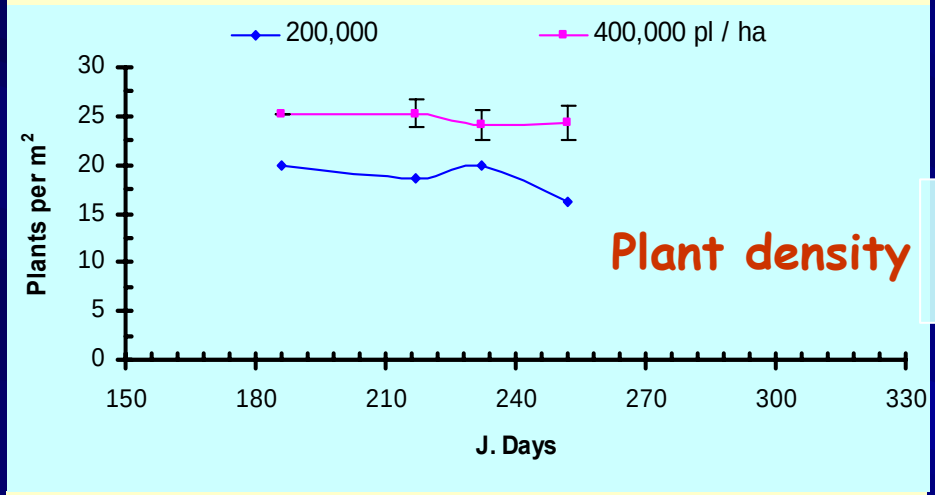


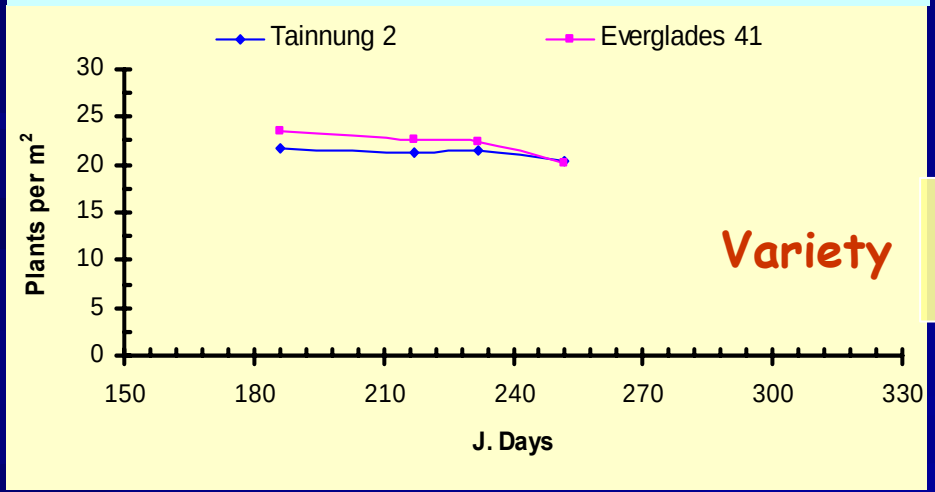
Fertilization

No fertilization effect

About 20 plants/ m²



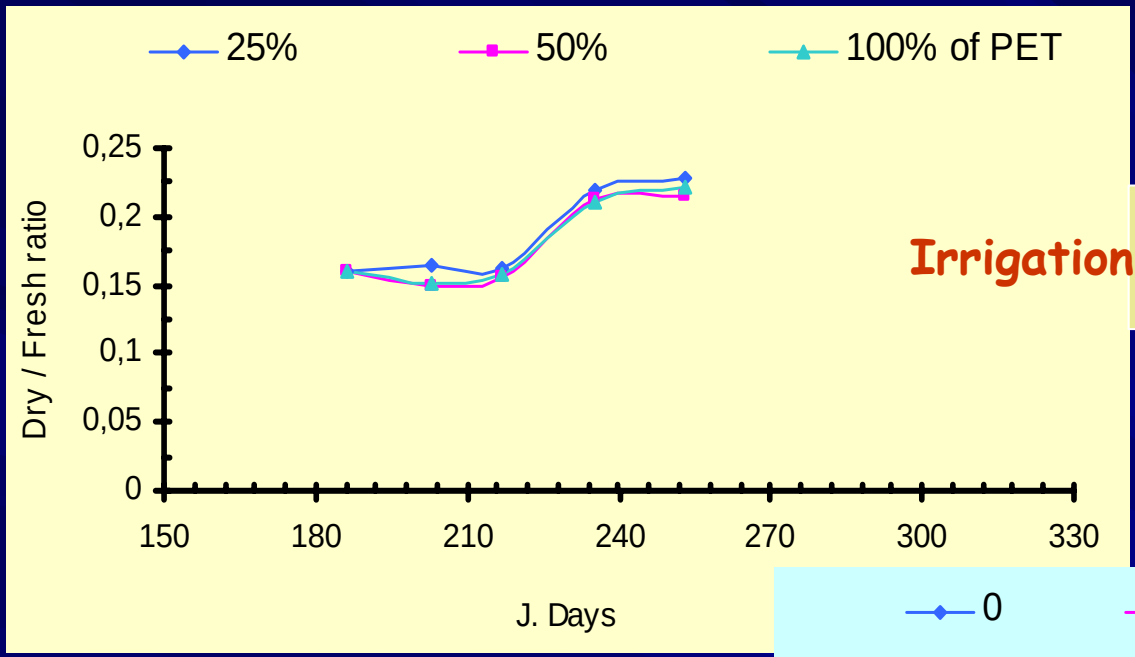




D_2 plantation fluctuated around 26 plants per m^2 as in the first experimental year, due to the sowing machine

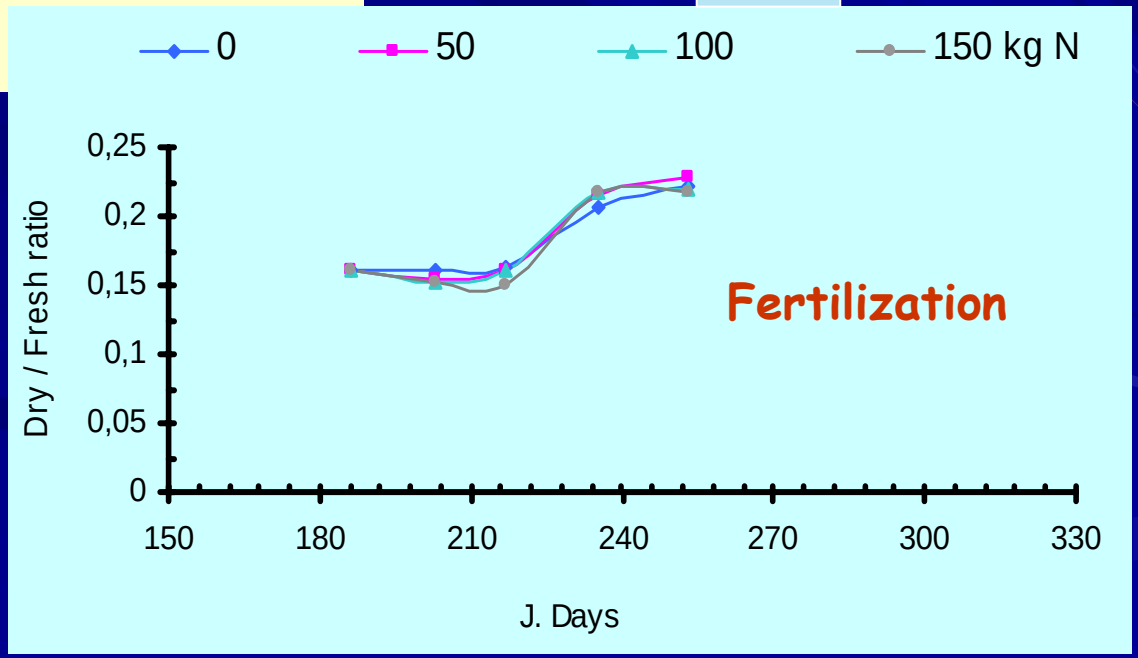
D_1 plantation fluctuated around 20 plants per m^2

Dry / Fresh ratio

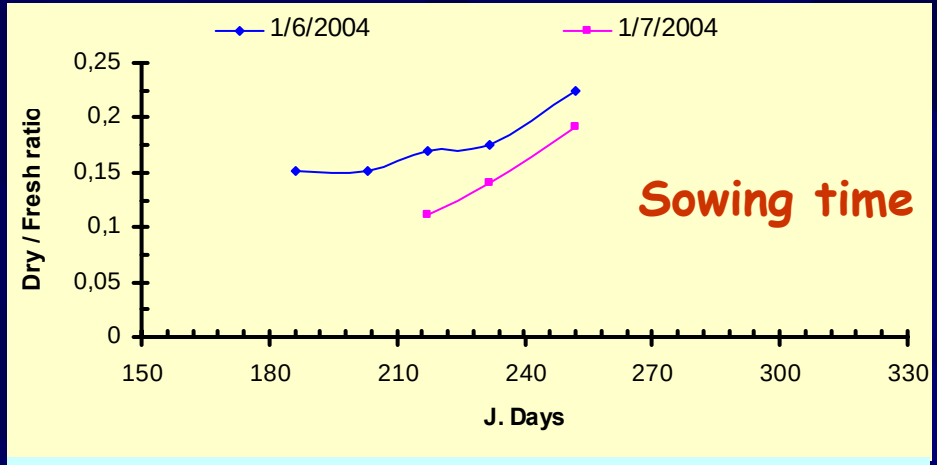


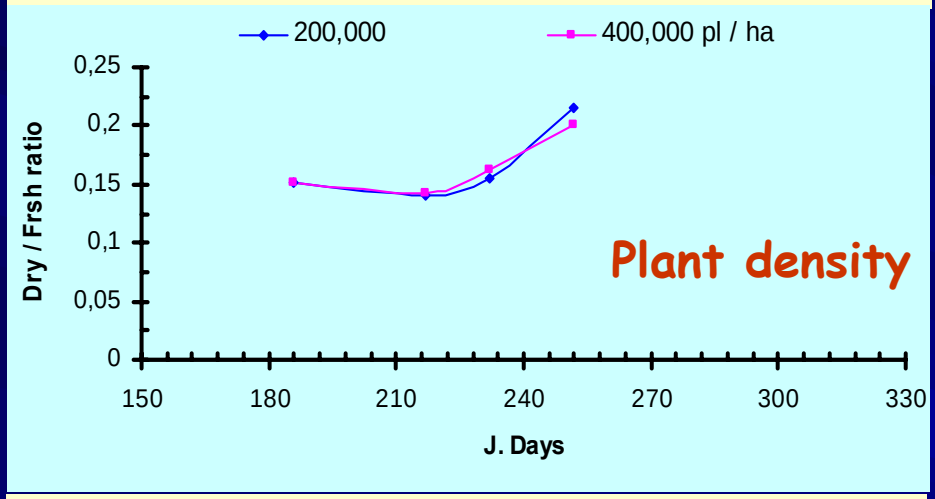
Irrigation

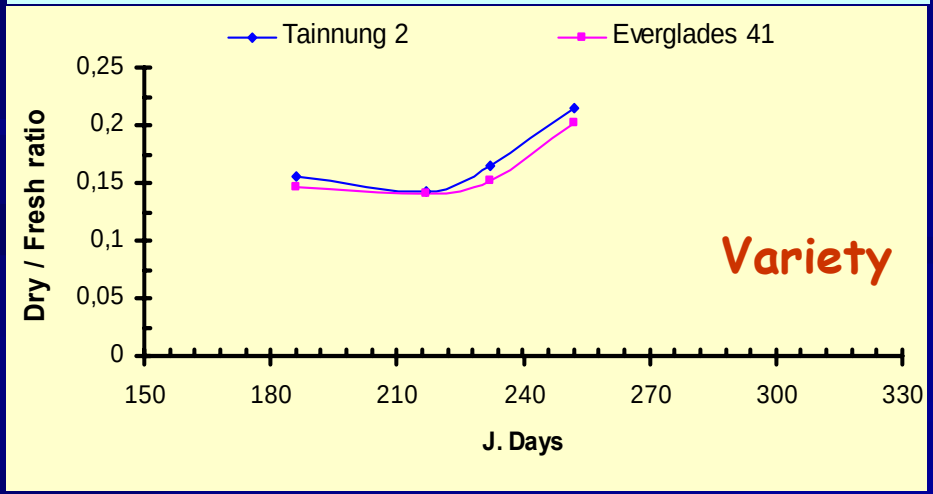
Dry / fresf ratio increased in August irrespective of irrigation and fertilization



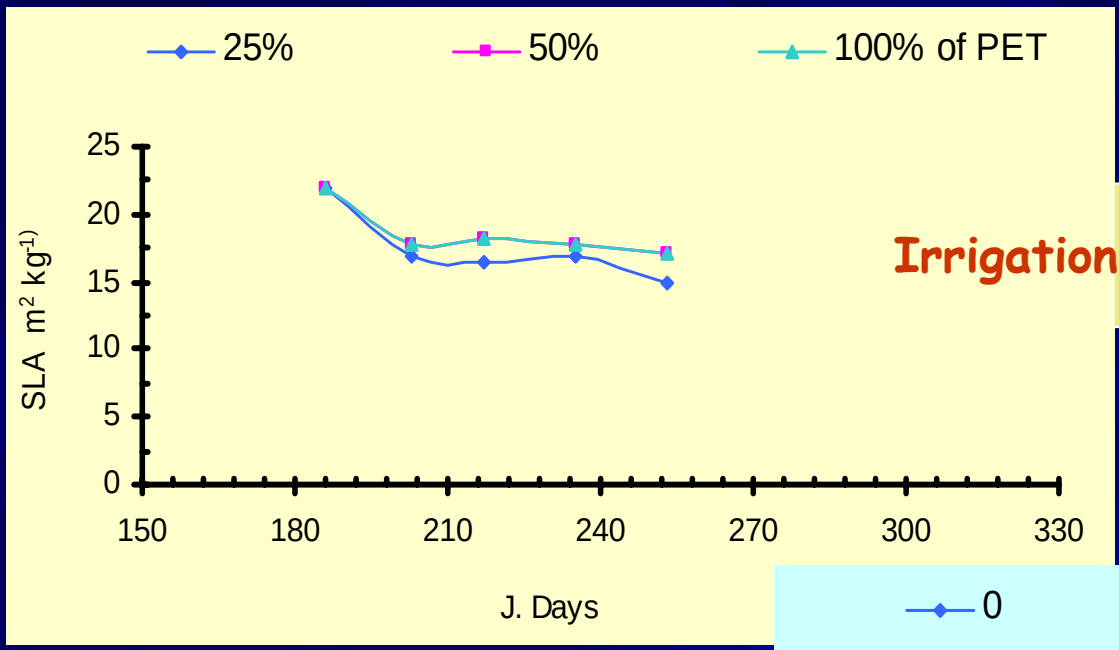
Fertilization


1/6/2004
1/7/2004
Dry / Fresh ratio
0,25
0,2
0,15
0,1
0,05
0
150
180
210
240
270
300
330
J. Days
Sowing time


200,000
400,000 pl / ha
Dry / Frsh ratio
0,25
0,2
0,15
0,1
0,05
0
150
180
210
240
270
300
330
J. Days
Plant density


Tainnung 2
Everglades 41
Dry / Fresh ratio
0,25
0,2
0,15
0,1
0,05
0
150
180
210
240
270
300
330
J. Days
Variety

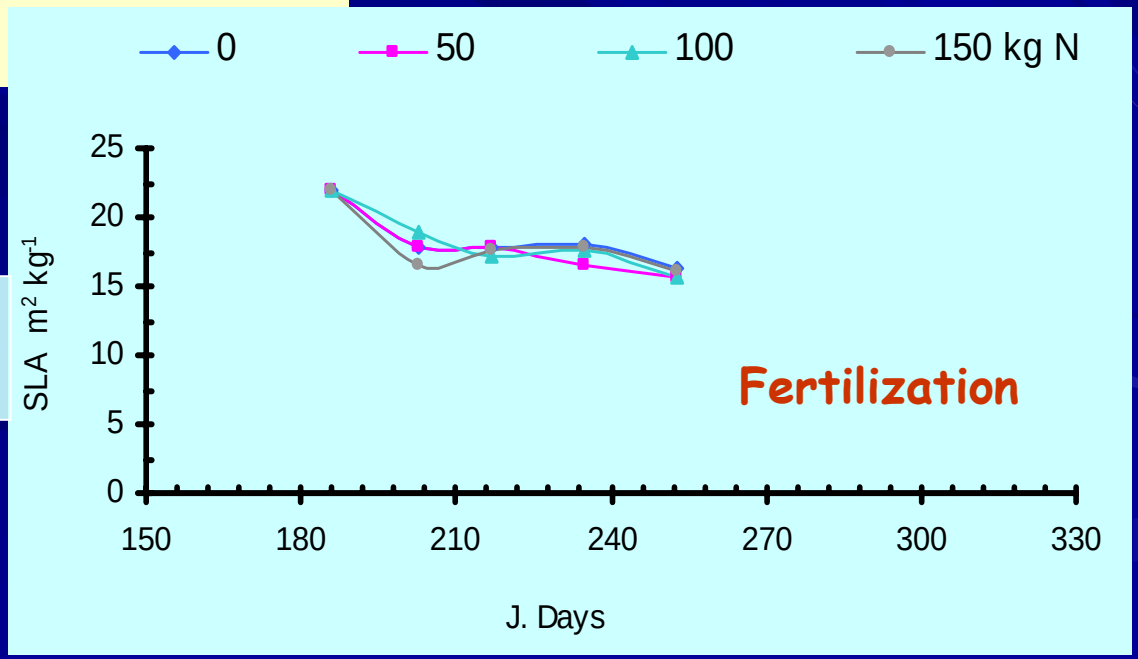
Specific Leaf Area (SLA, m^2kg^{-1})

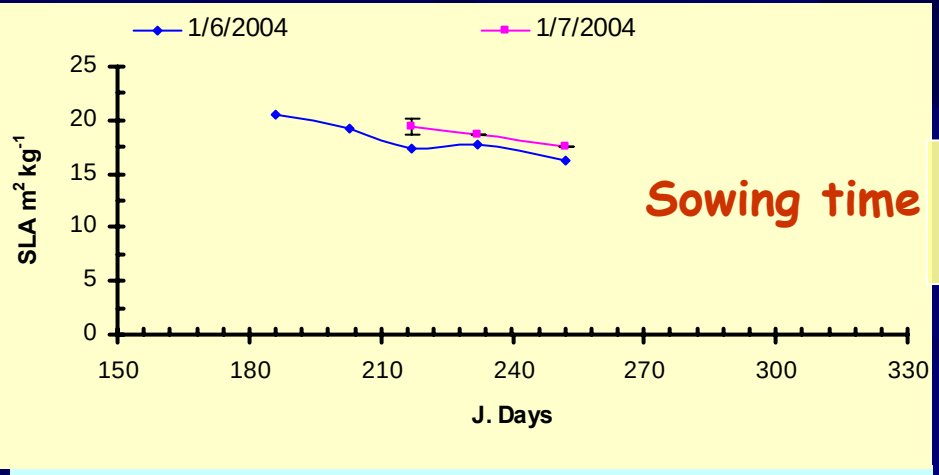


- No irrigation effect
- In the first development stage , SLA was higher than 2003 (2-3 values)
- After 200 J. Day SLA remained around 16-18, in similar levels with 2003

No fertilization effect

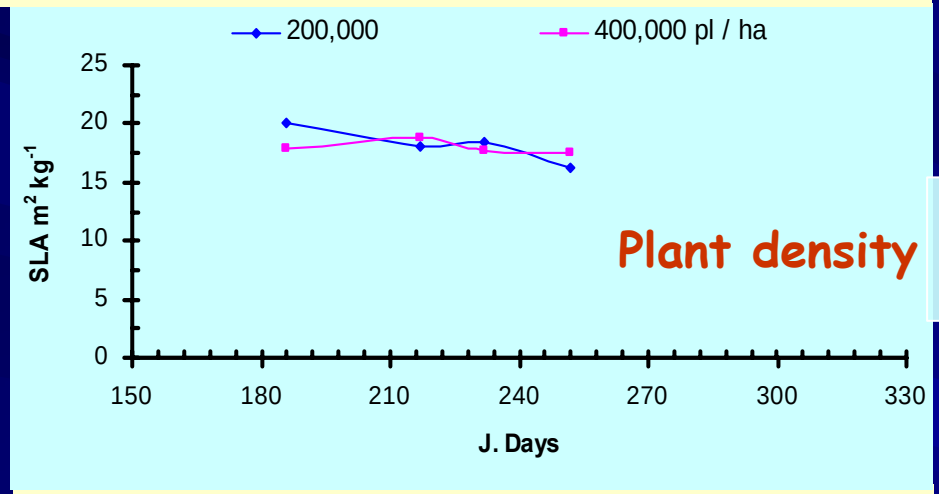
Sla decreased slightly during growing period





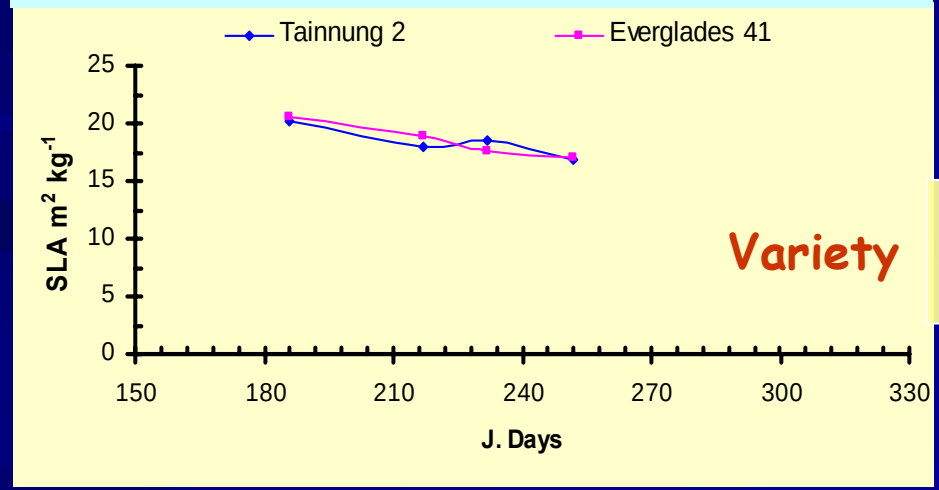
SLA took values around 22 at the early development stage

SLA remained in the range 16-19 until 9-9-2004 (same as 2003)



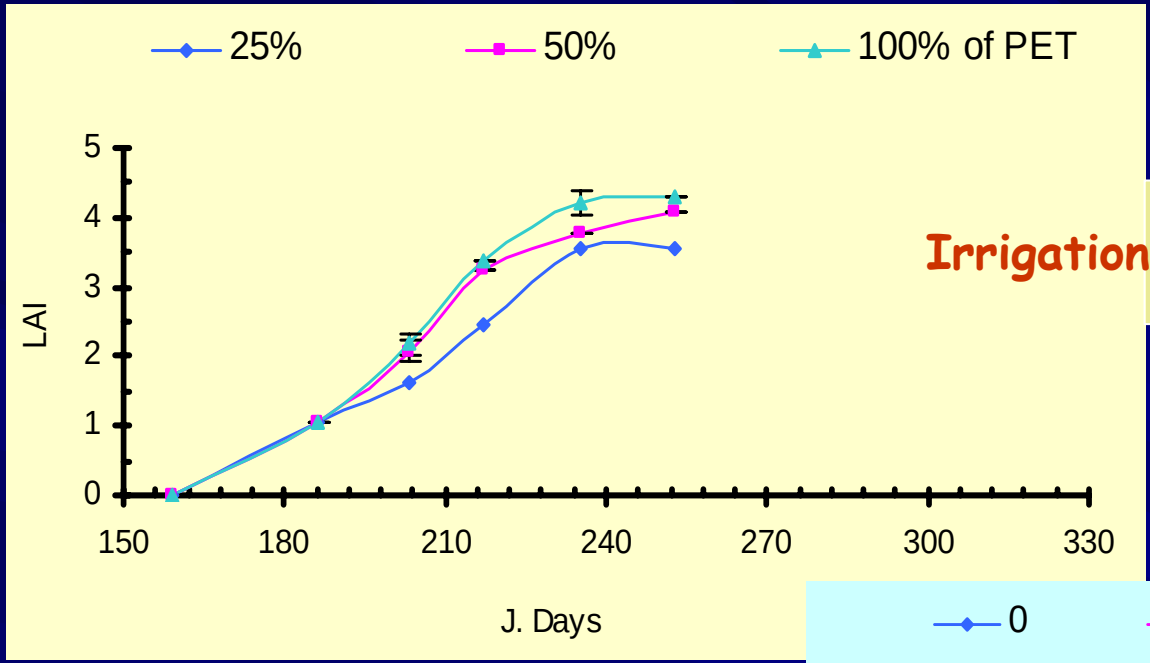
A slight but not significant superiority of S_2 sowing time was observed as in 2003

No effect of plant density as in 2003



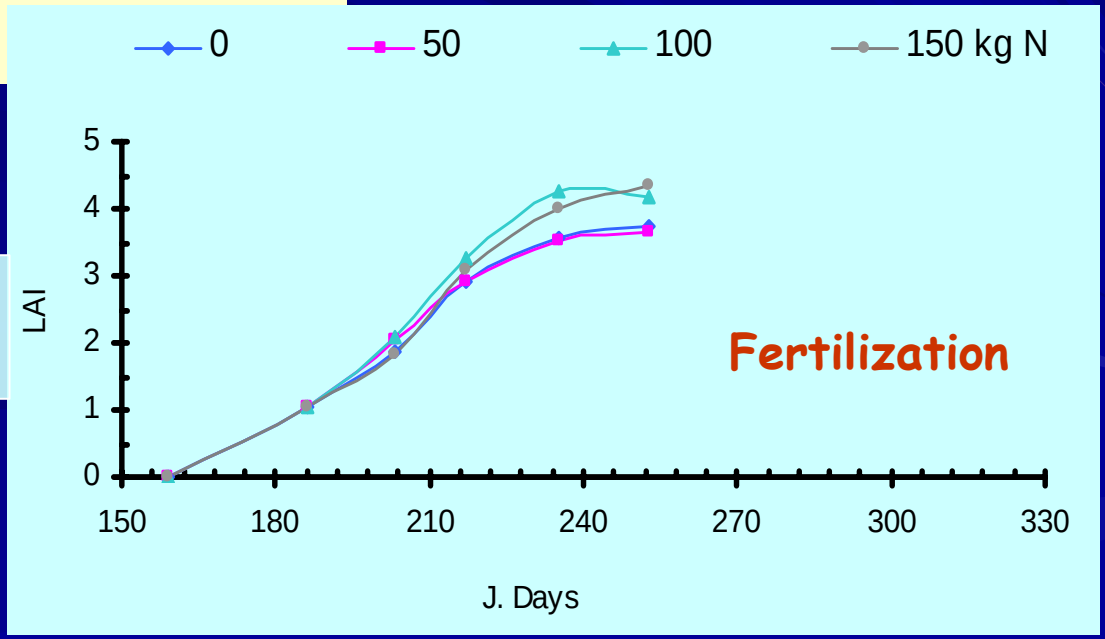
No effect of variety as in 2003

Leaf Area Index (LAI)



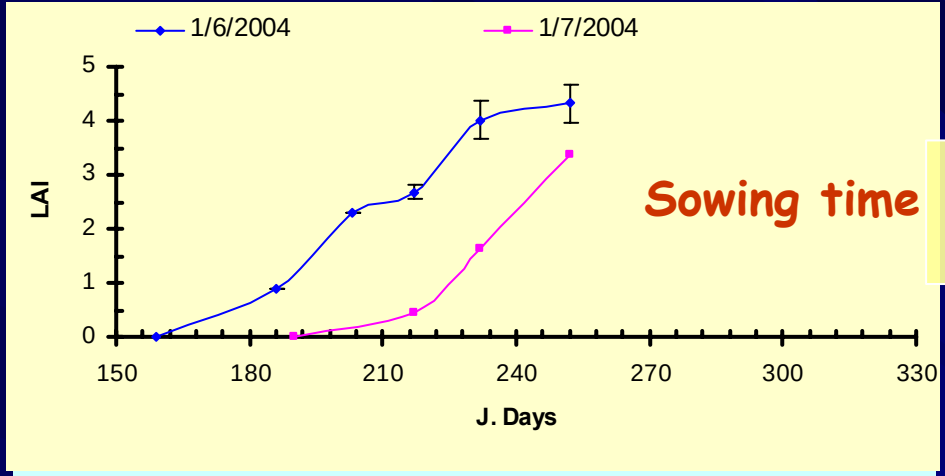
- A superiority of I_3 irrigated plants versus I_1 plants throughout the growing period

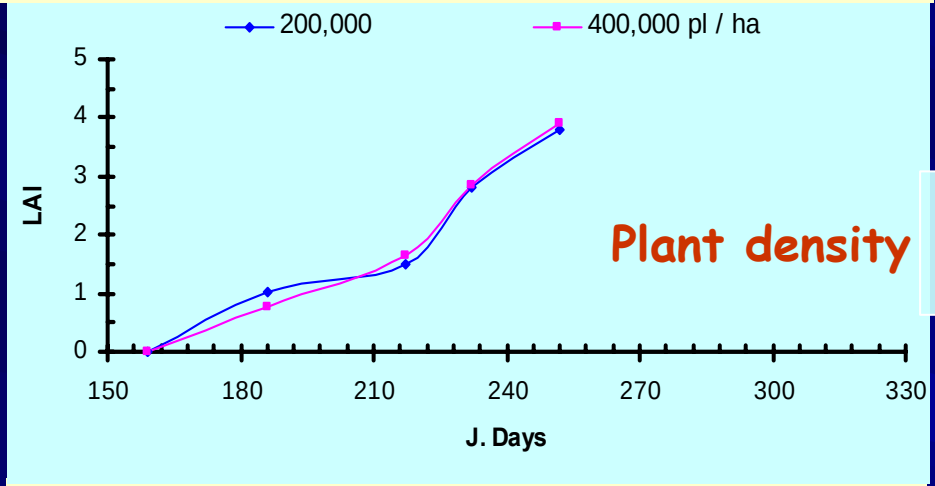
Lower LAI values than in 2003

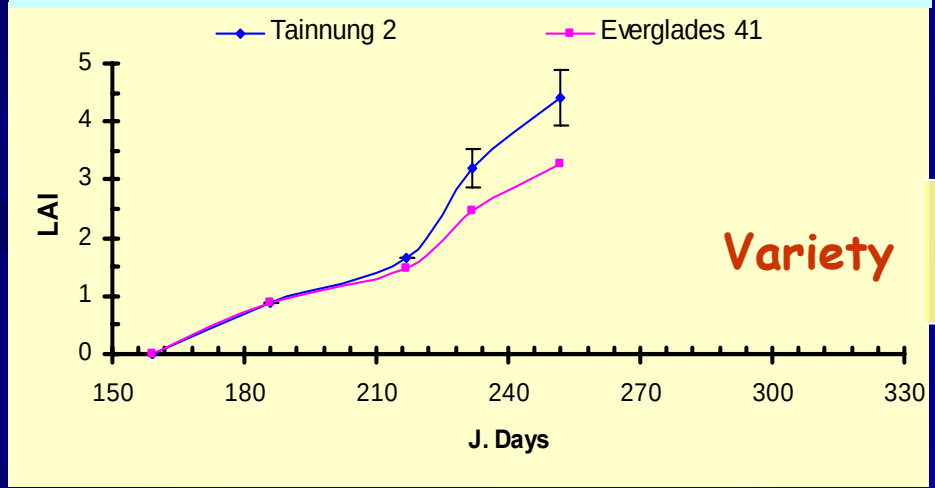


- No fertilization effect

- A slight but not significant superiority of 100 & 150 kg N were observed after 210 J. day







High superiority of S_1 versus S2 sowing time

Superiority of Tainnung 2 versus Everglades 41 after 15-8-04

No effect of plant density

LAI reached somewhat lower values than in 2003

Photosynthesis

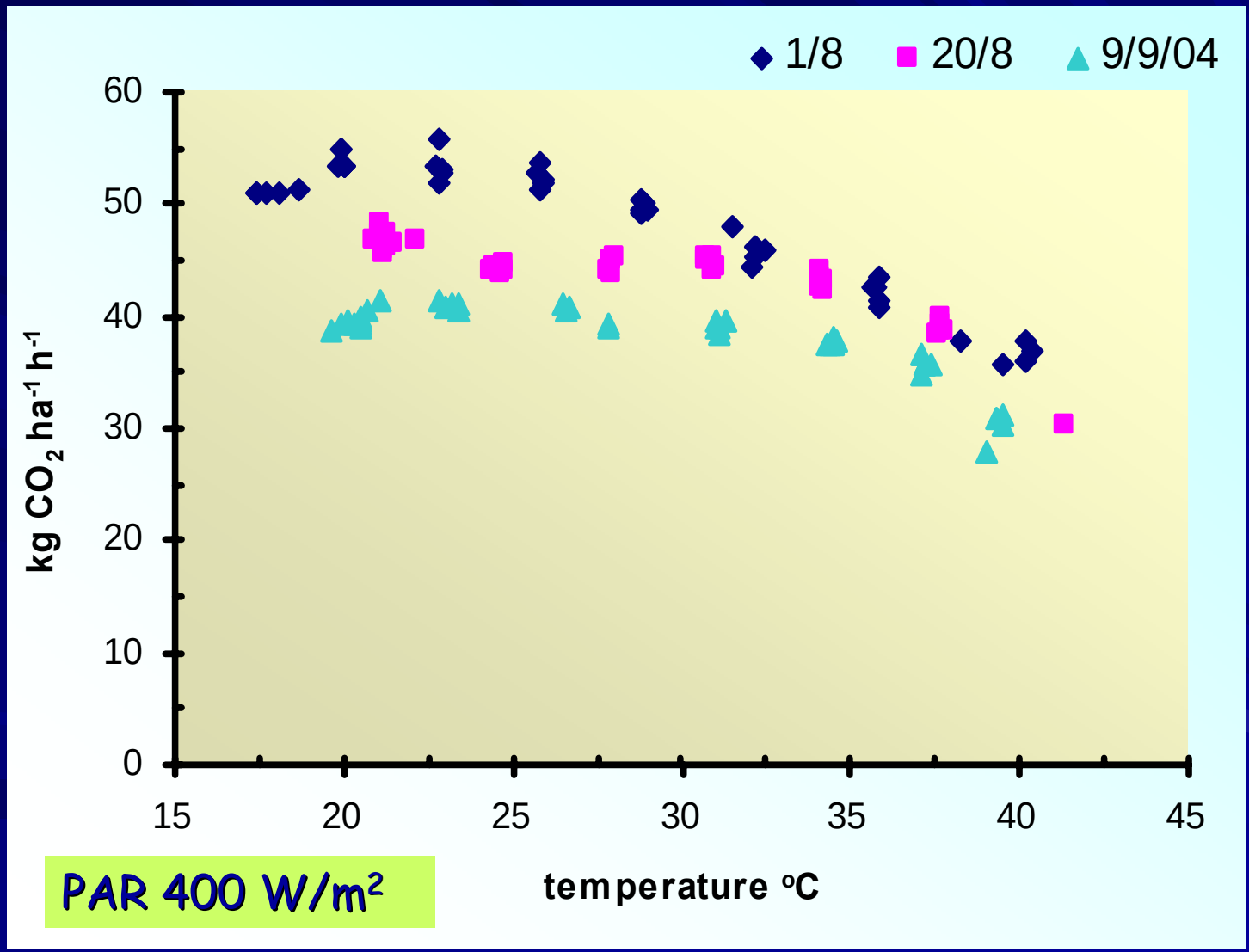
Data collected:

- Assimilation rate in temperature rage 0-40 ^{o}C
  in radiation rage 0-800 W/m^2
  at different development stages

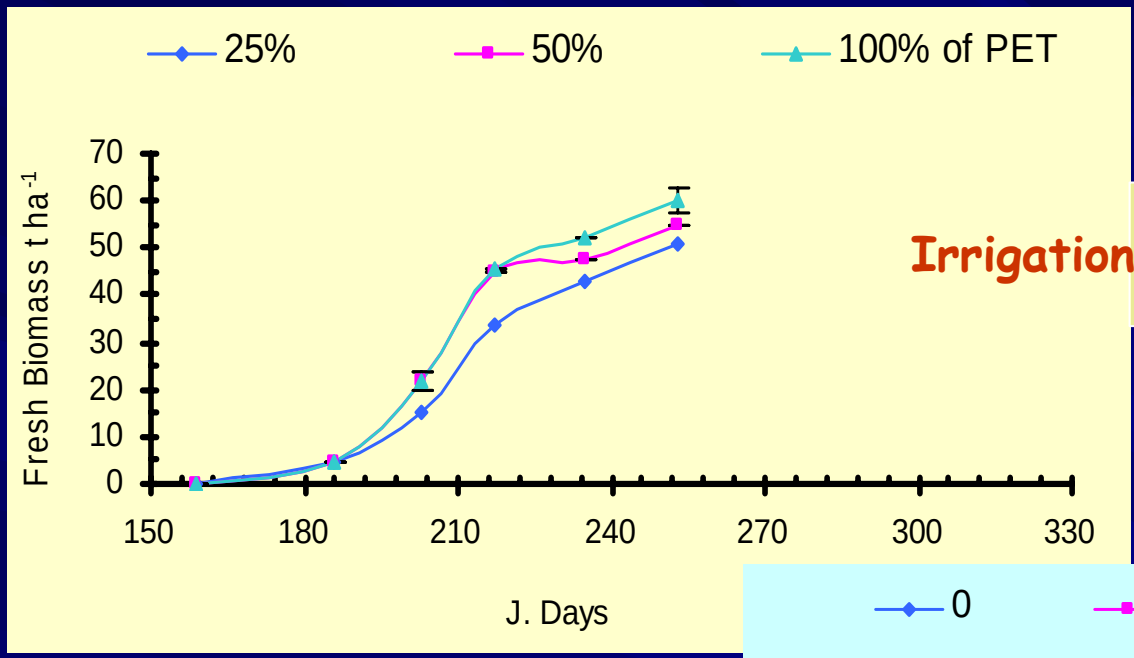
- Respiration rate in temperature range 0-25 ^{o}C

Data still under processing

Tainnung 2, maximum assimilation rate



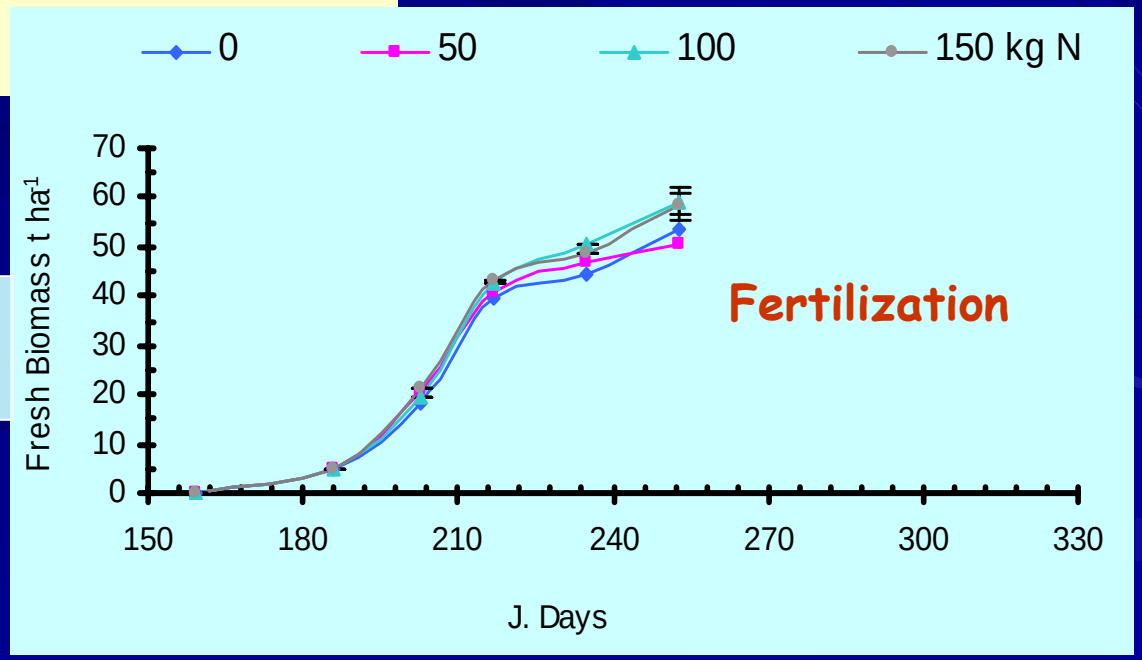
Fresh Biomass (t ha^{-1})



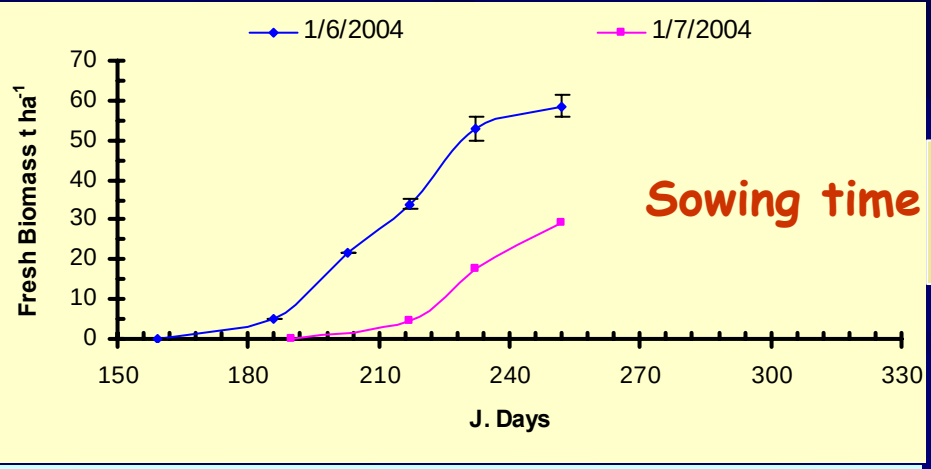
Irrigation

- A superiority of I_3 plants
- Reduced fresh biomass production than in 2003 (60 vs 76 t ha^{-1} at 250 J. Day)

- A slight effect of fertilization in September

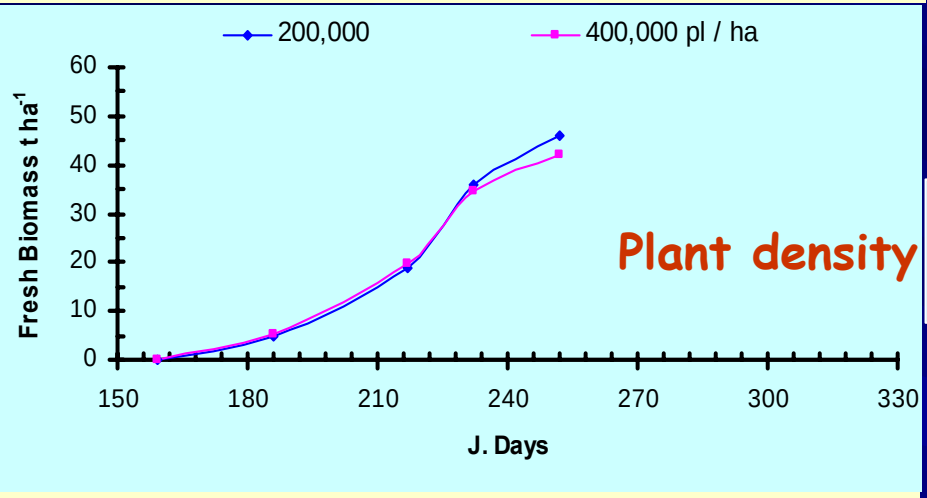


Fertilization

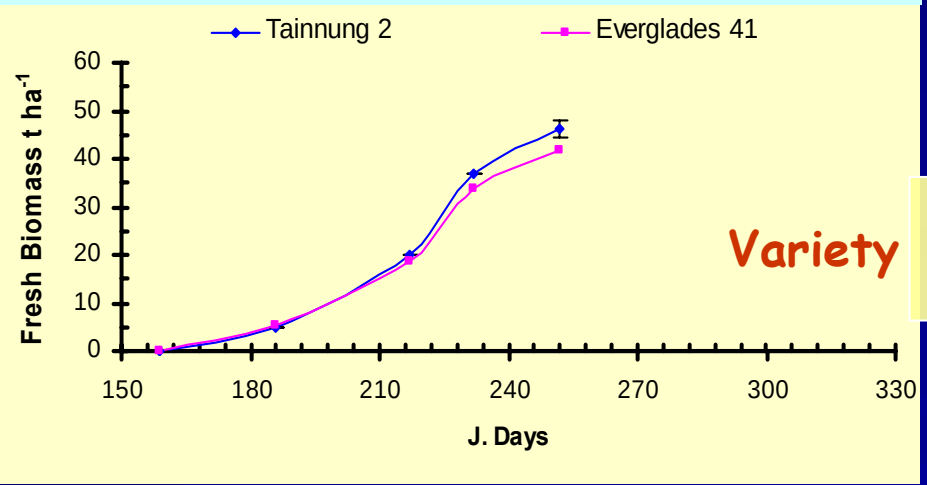


A high superiority ($LSD_{0.01}$) of S_1 sowing

Reduced fresh biomass production than in 2003 (30% for S_1 and 40% for S_2)

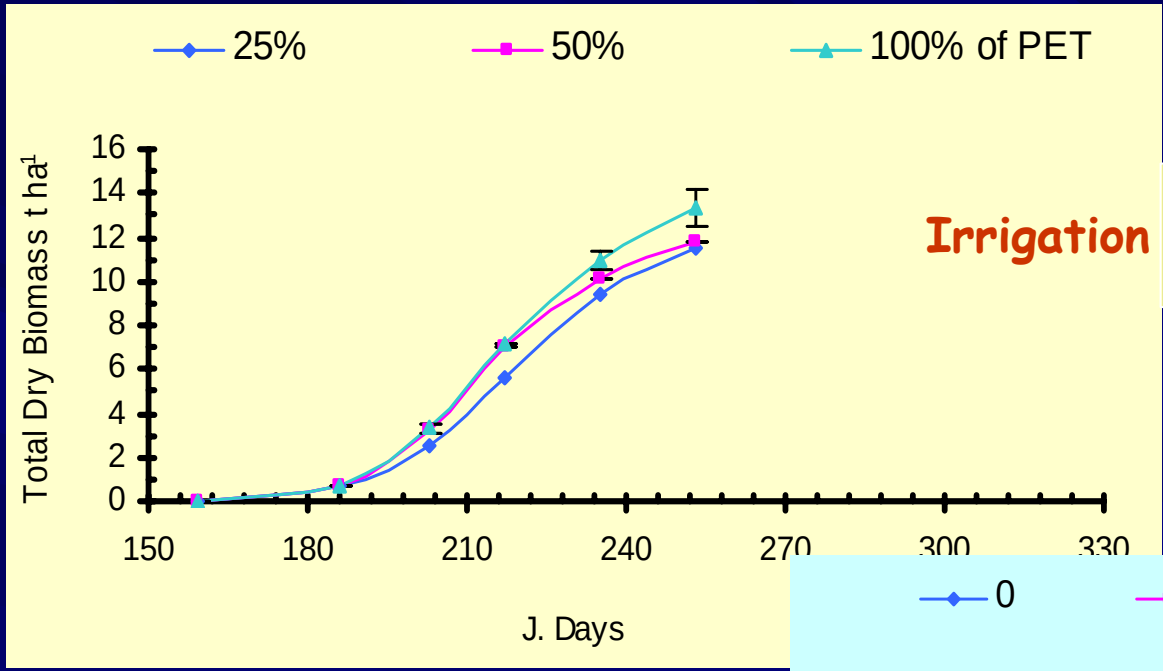


No effect of plant density



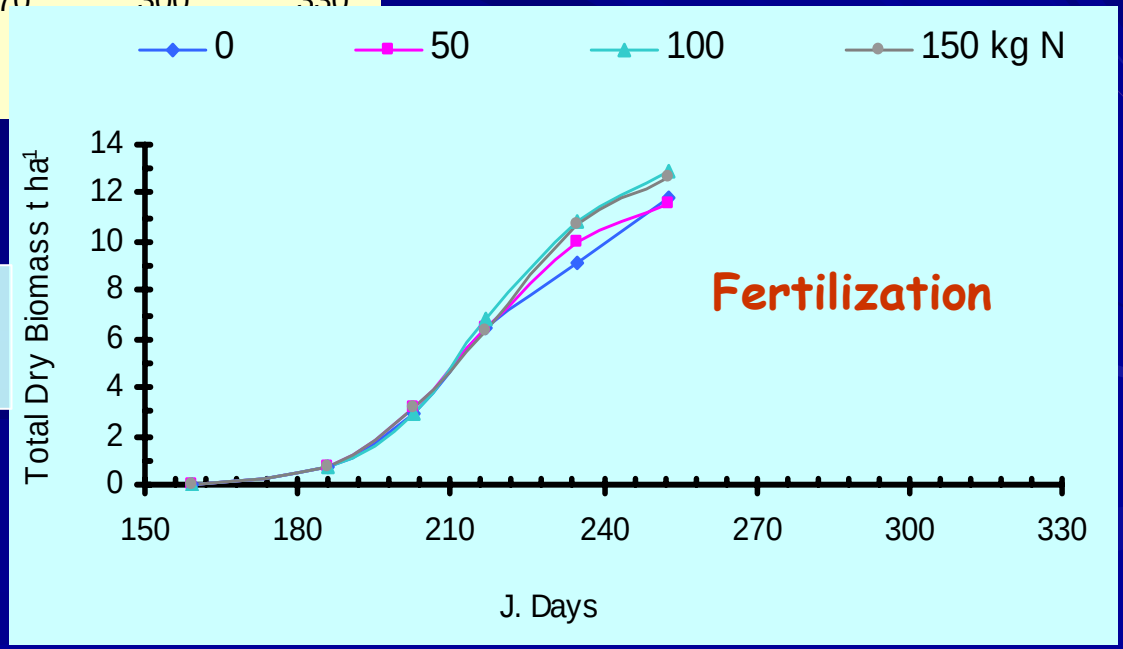
A slight superiority of Tainnung 2 vs. E-41

Total Dry Biomass (t ha^{-1})



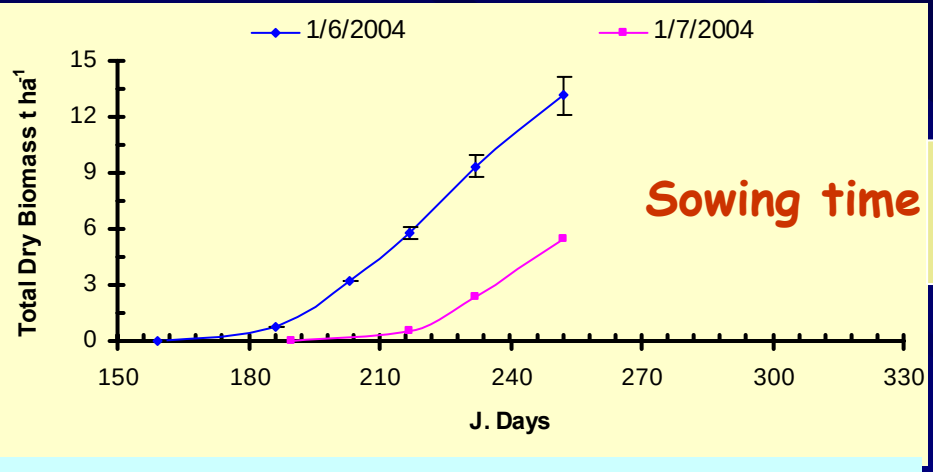
Irrigation

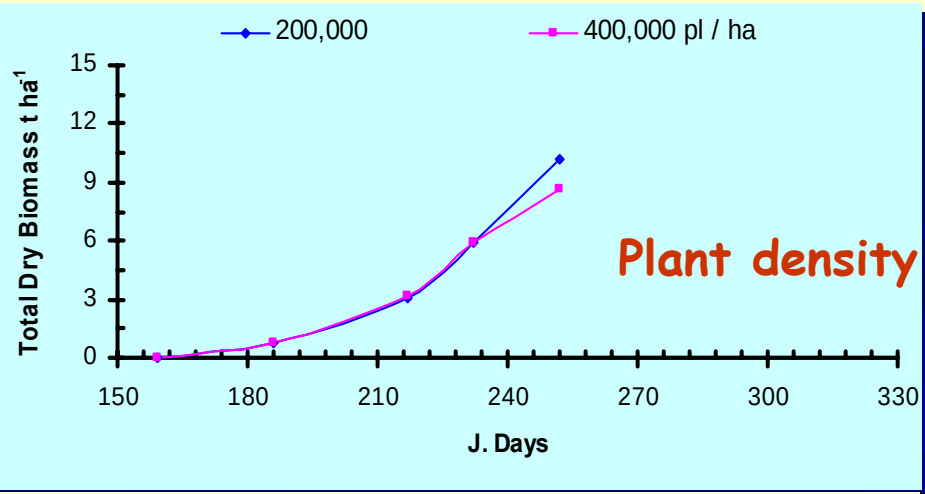
- A slight superiority of I_3 plants
- Maximum growth rate of about 280 kg ha^{-1} (I_3 plants)
- Total dry biomass (2004) fluctuated at similar level with the previous year until 250 J. Day

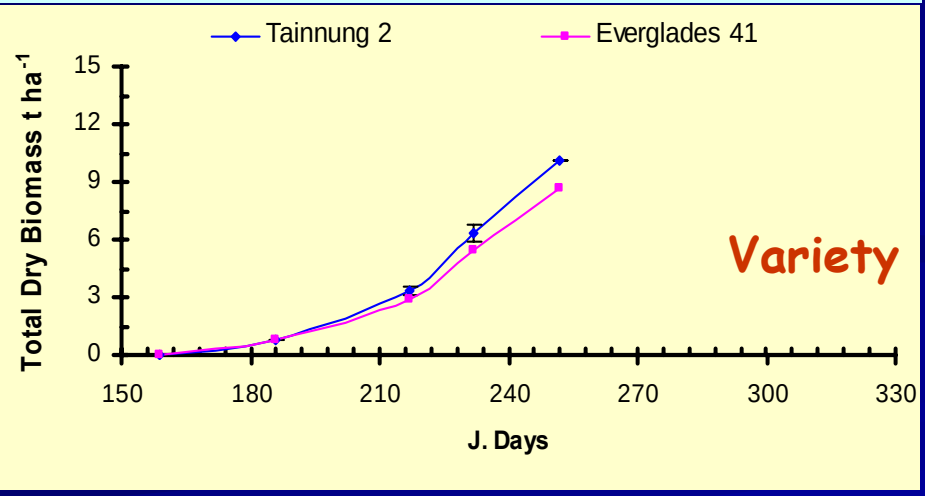


Fertilization

- No fertilization effect for second year on total dry biomass







A high superiority ($LSD_{0.01}$) of S_1 sowing

Maximum growth rates

S_1: 240 kg ha^{-1}

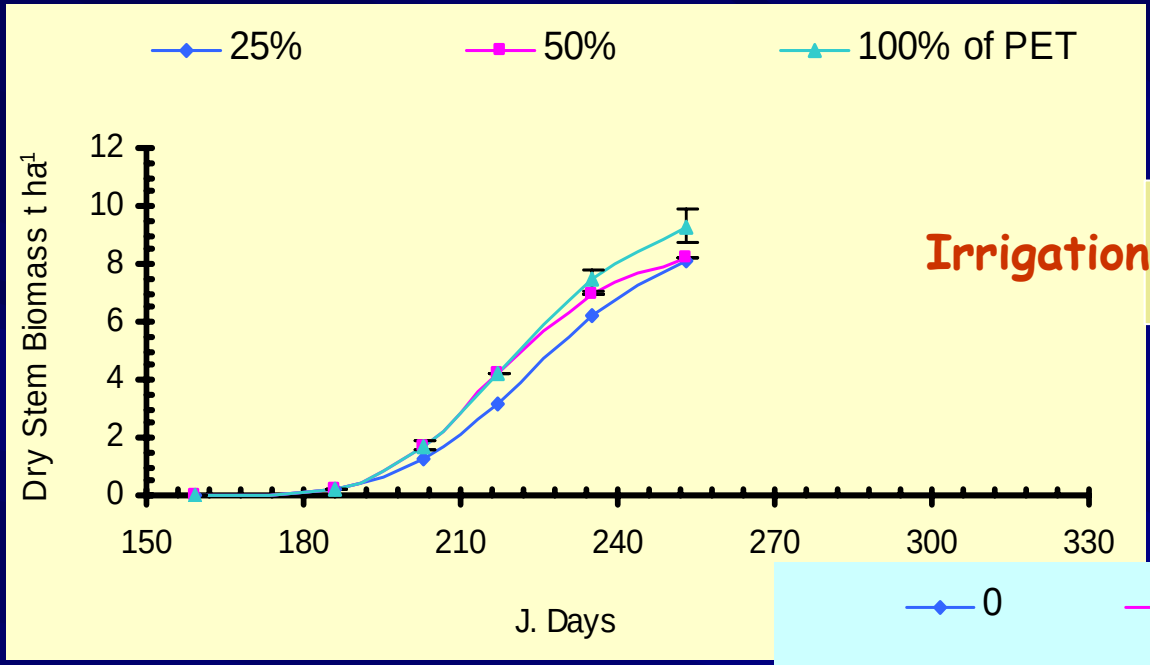
S_2: 150 kg ha^{-1}

S_1 sowing time (2004) reached similar level with (2003) until now

S_2 sowing time (2004) reached 2.3 t under (2003) until now

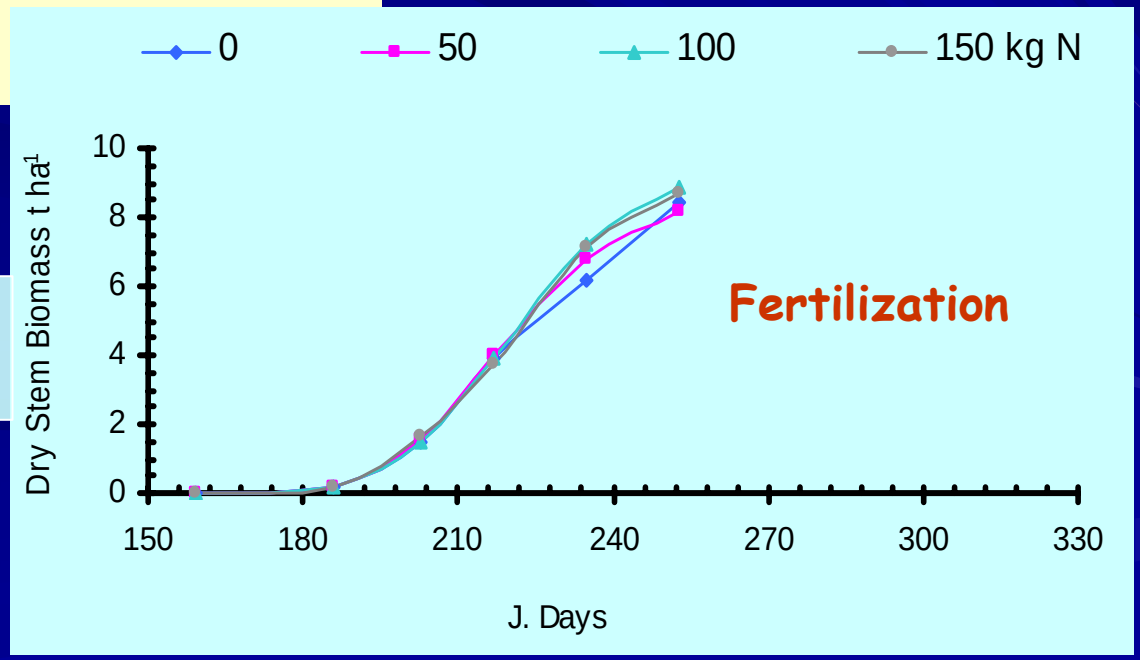
No effects of plant density and variety

Dry Stem Biomass (t ha^{-1})



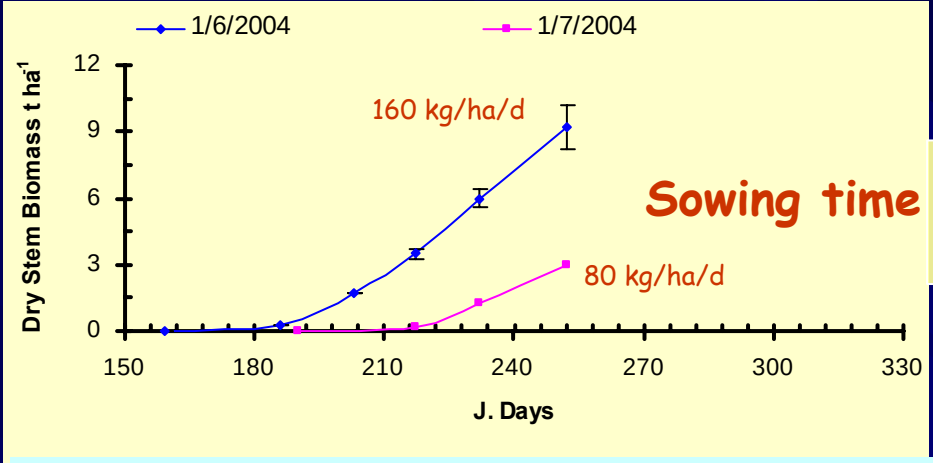
Irrigation

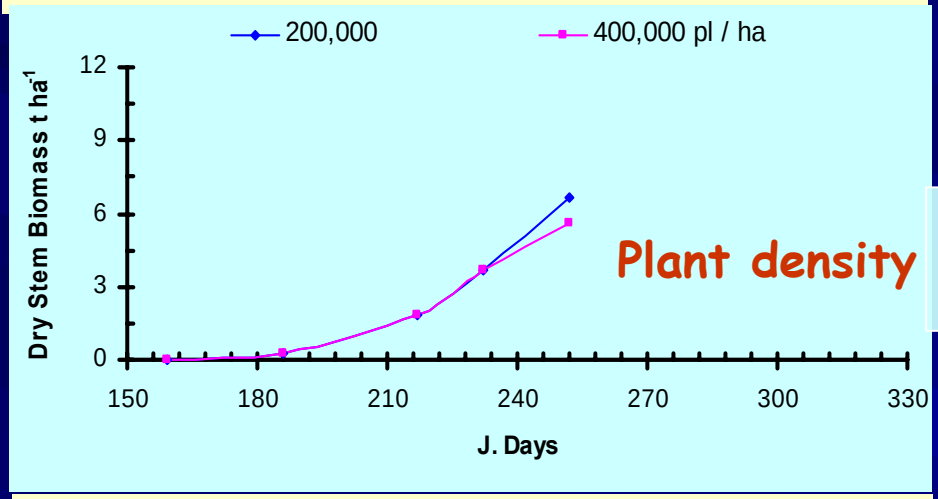
- 35% of dry stem is bark core (95 DAE)
- Dry stem comprises 70% of total biomass (95 DAE)
- 1 t less stem biomass than in 2003
- Significant irrigation effect

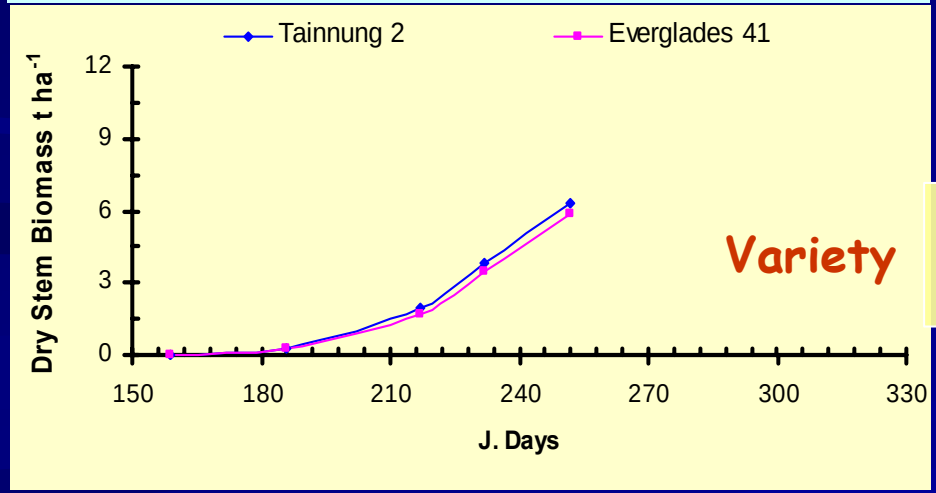


Fertilization

- No fertilization effect







1 and 2.5 t less biomass than in 2003 respectively for S_1 and S_2 sowing times

S_1 sowing time combines the 70% of total dry biomass (252 J. Day)

S_2 sowing time combines the 55% of total dry biomass (252 J. Day)

A high superiority ($LSD_{0.01}$) of S_1 sowing

No effect of other treatments

Dry Matter Distribution

Not yet ready

The field experiments are being continued...