Dipartimento di Scienze Agronomiche Agrochimiche e delle Produzioni Animali Sezione Scienze Agronomiche

Università degli Studi di Catania - ITALY

Scientific Responsible

Prof. Salvatore Foti

Biokenaf - Biomass Production Chain and Growth Simulation Model for Kenaf

Athens 23rd-24th October 2003

Research lines

WP2 Adaptability and Productivity Field Trials

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

Task 2.3 Effect of irrigation and nitrogen fertilization on biomass yields

WP3 Development of the growth simulation model

WP8 Dissemination

Athens, 23th-24th October 2003

WP2 Adaptability and Productivity Field Trials

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

Locality

Enna (450 m. s. l.) – 37°21' Lat. N, 14°16' Long. E

Studied factors

a) two sowing date
- 12/6/2003;
- 4/7/2003;

b) two varietes
- Tainung 2
- Everglades 41

c) two plant densities
- 200.000 plants ha^{-1}
- 400.000 plants ha^{-1}

Crop management

- Row distance: 50 cm;
- Fertilisation: 100 kg ha^{-1} of P_2O_5 and 100 kg ha^{-1} of N. Nitrogen fertilisation was distributed the first half part at sowing and the second one on the 25th July and on the 3rd September, respectively for the first and the second sowing
- Irrigation: 100% ETm

  * Water irrigation volume:

  - 416,67 mm for the 1st sowing (till September 1st)
  - 277,78 mm for the 2nd sowing (till September 4th)

Methodology

Experimental design	randomised block
No. of replicates	3
single plot dimension	6 m x 8 m (48 m^2)
irrigation system	drip irrigation

Athens, 23th-24th October 2003

Epoche di semina

12 file per parcella

1	**2**	**3**	**4**	
S1D1	**S2D2**	**S1D2**	**S1D1**	
TAINUNG	EVER.	TAINUNG	EVER.	
8	**7**	**6**	**5**	
S2D1	**S1D2**	**S2D1**	**S2D2**	**8 m**
TAINUNG	EVER.	EVER.	TAINUNG	
			6 m	
9	**10**	**11**	**12**	
S2D1	**S1D1**	**S2D2**	**S2D1**	
TAINUNG	EVER.	EVER.	EVER.	
16	**15**	**14**	**13**	
S1D2	**S1D1**	**S1D2**	**S2D2**	
EVER.	TAINUNG	TAINUNG	TAINUNG	

Nord

S1 = 1st sowing date

S2 = 2nd sowing date

D1 = 20 plants m^2

D2 = 40 plants m^2

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WP2 Adaptability and Productivity Field Trials

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

Locality

Enna (450 m. s. l.) – 37°21' Lat. N, 14°16' Long. E

Athens, 23th-24th October 2003

Studied factors

a) water supply

I_0 = no irrigation (191,26 mm);

I_1 = 25% of PET (231,26 mm);

I_2 = 50% of PET (271,26 mm);

I_3 = 100% of PET (351,26 mm);

b) nitrogen level

N_0 = 0 nitrogen fertilisation;

N_1 = 100 kg ha^{-1} of N

N_2 = 150 kg ha^{-1} of N

Nitrogen fertilisation was distributed the first half part at the sowing and second one on the 21st August; at the moment of the sowing was distributed 100 kg ha^{-1} of P_2O_5

Crop management

- Sowing: 24/6/2003;
- Row distance: 50 cm;
- Plant density: 200.000 plant ha^{-1};

Methodology

Experimental design:	split-split-plot
No. of replicates:	3
single plot dimension:	6 m x 8 m (48 m^2)
irrigation system:	drip irrigation

Measurements (*on both subtask 2.2 and 2.3*)

- *Meteorological*
- *Soil measurement (before sowing)*
- *Phenology*
- *Growth analysis*
  - *fresh and dry weight of each part of plant*
  - *leaf area of all green leaves*
- *Agronomic*
  - *at plant emergence, number of plant m^{-2}*

Prova kenaf 2003

varietà Tainung 2

Irrigazione e azoto

	I blocco				**II blocco**			
	N_1	**N_2**	**N_0**	**no irrigazione**	**N_0**	**N_2**	**N_1**	**100% dell'**
	36	35	34		33	32	31	
Nord	**N_2**	**N_0**	**N_1**	**5% dell'Etm**	**N_2**	**N_0**	**N_1**	**no irrigazi**
	25	26	27		28	29	30	
	N_0	**N_1**	**N_2**	**0% dell'Etm**	**N_1**	**N_2**	**N_0**	**50% dell'E**
	24	23	22		21	20	19	
	N_1	**N_2**	**N_0**	**0% dell'Etm**	**N_2**	**N_1**	**N_0**	**25% dell'E**
	13	14	15		16	17	18	

Measurements on subtask 2.3

Physiological

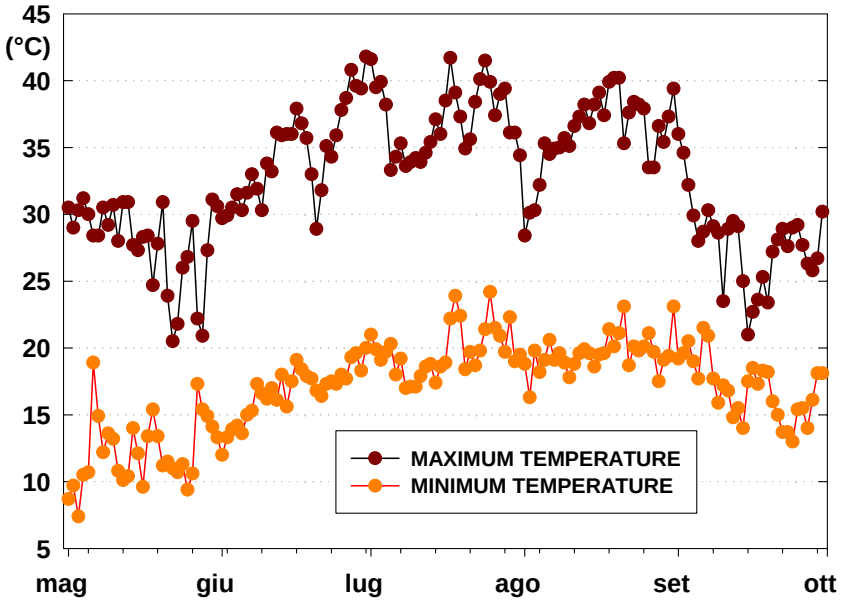
- **Leaf water potential (by means of a gas pressure chamber, Soil Moisture, USA)**

- **Leaf transpiration, Stomatal conductance, Photosyntesis by means of gas analyzer (by means of LCA4 from ADC, UK)**

Other measurements

- **ammonia volatilisation from soil**

(trapping the gas soil by means of hermetic cylinders inserted in the soil and provided of a polyfoam sorption pad satured with H_3PO_4 and glycerine)


(°C)
MAXIMUM TEMPERATURE
MINIMUM TEMPERATURE
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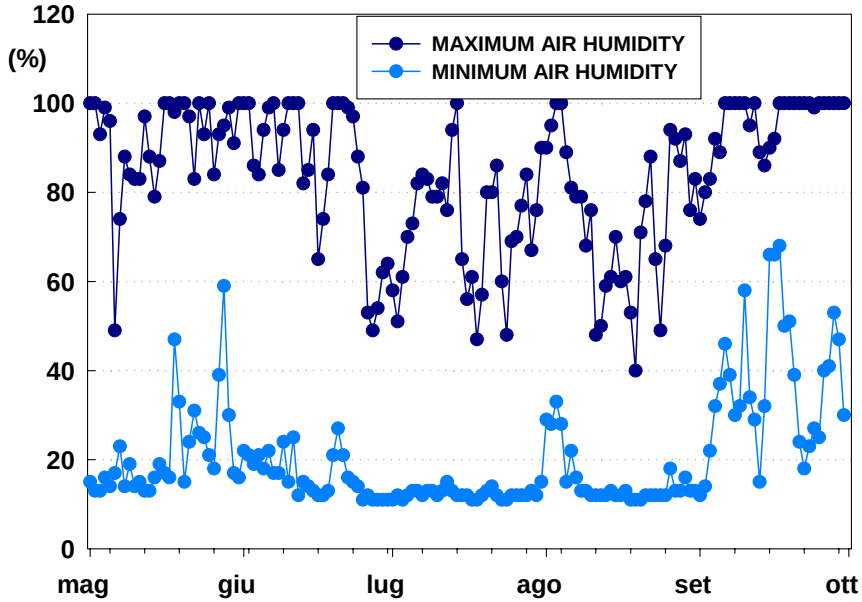
(%)
MAXIMUM AIR HUMIDITY
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mag
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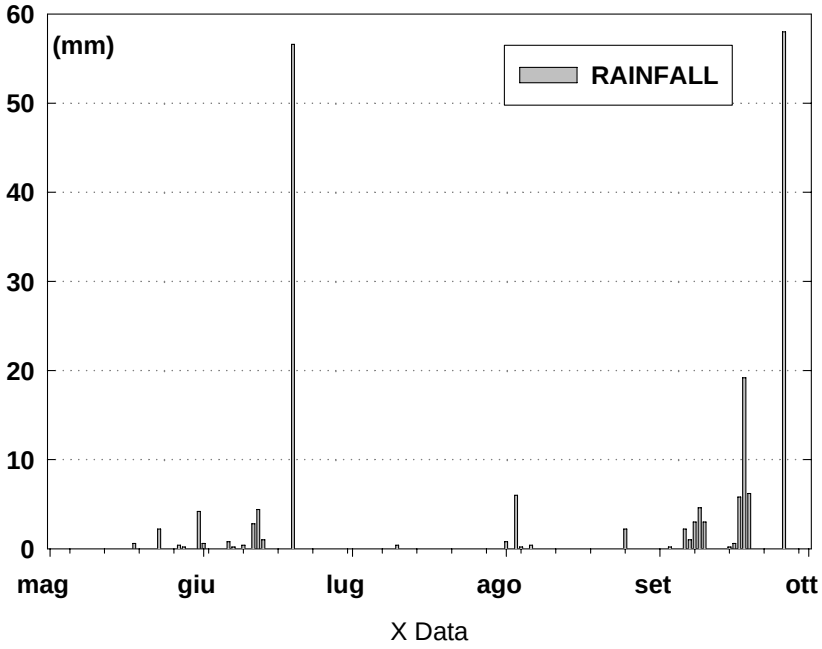
(mm)
RAINFALL
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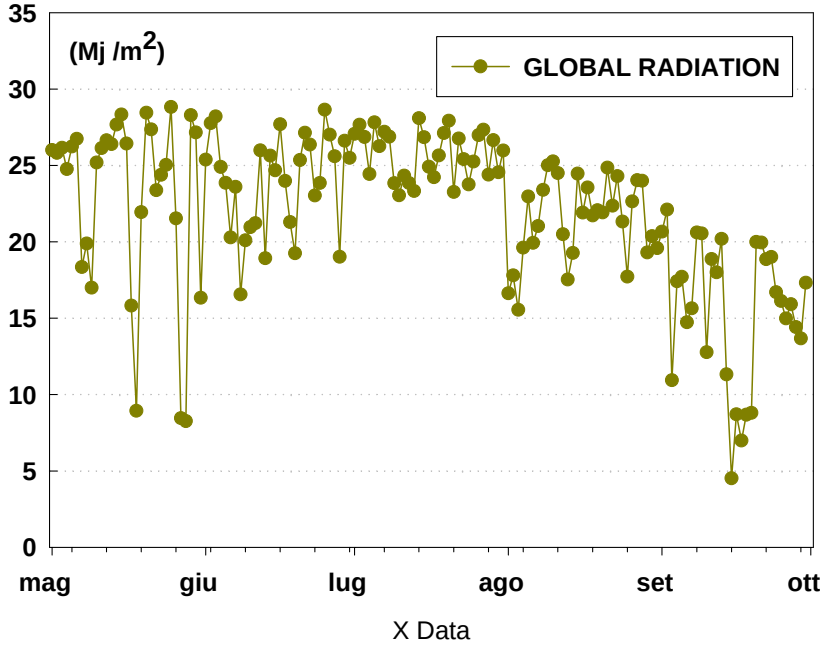
X Data


(Mj /m2)
GLOBAL RADIATION
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X Data

June 30th - 1st sowing date

Emergence of II sowing period plants - July 11th

July 29th -Tainung 2 S1 D2

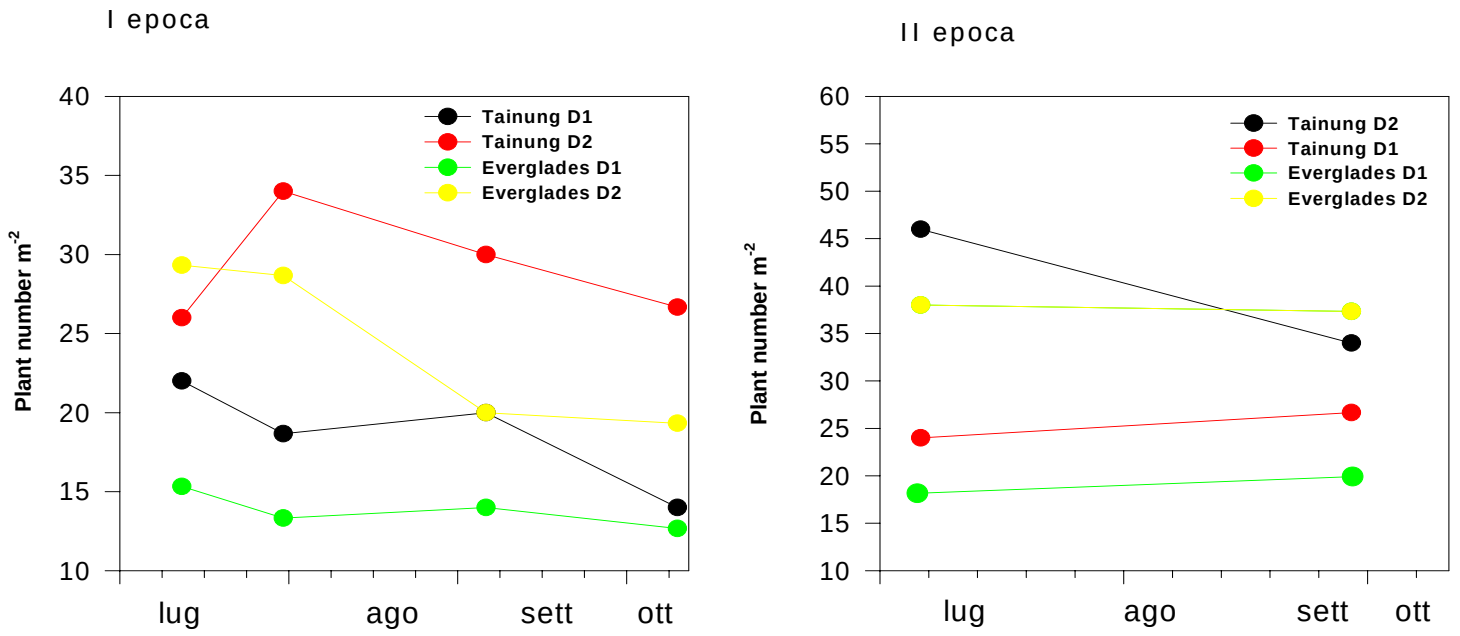
July 29th - Everglades 41 S1 D1

29th July - Everglades 41 S1 D2

July 29th – 1st and 2nd sowing date trial

July 29th - Everglades S2 D2

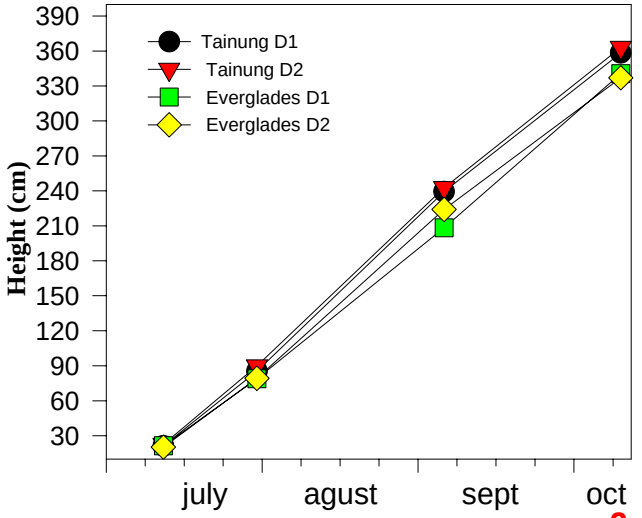
Plant density (n m²)

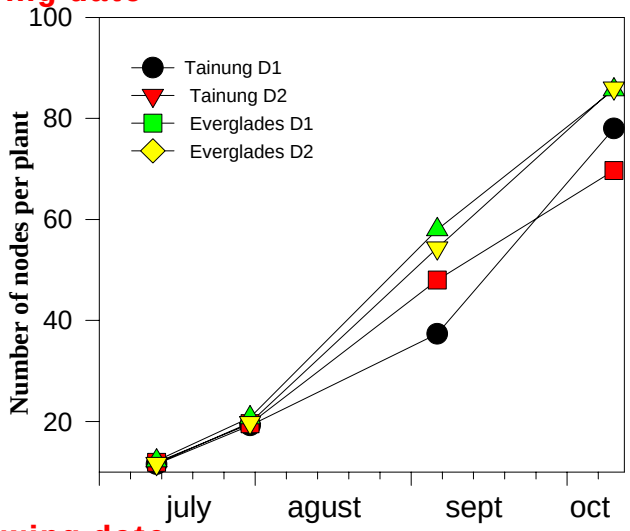


Plant height (cm)

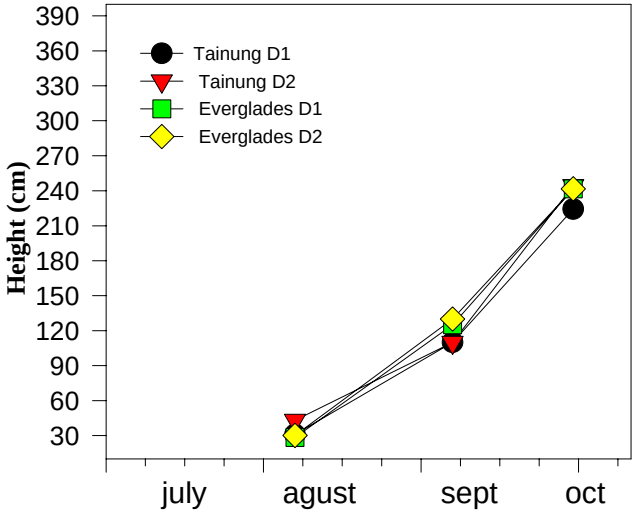
Number of nodes per plant

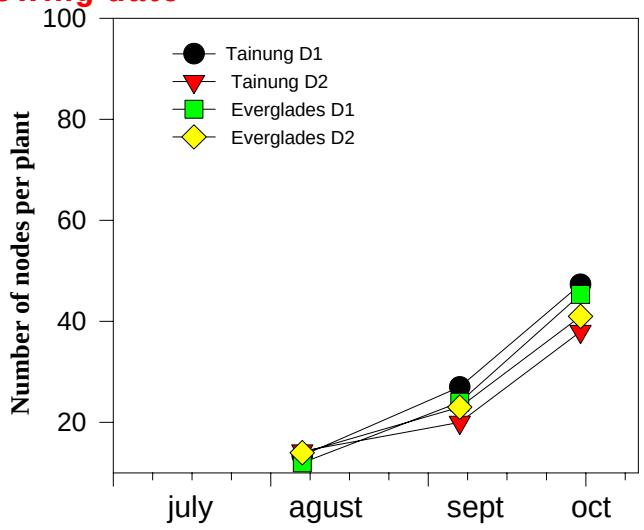
1st sowing date



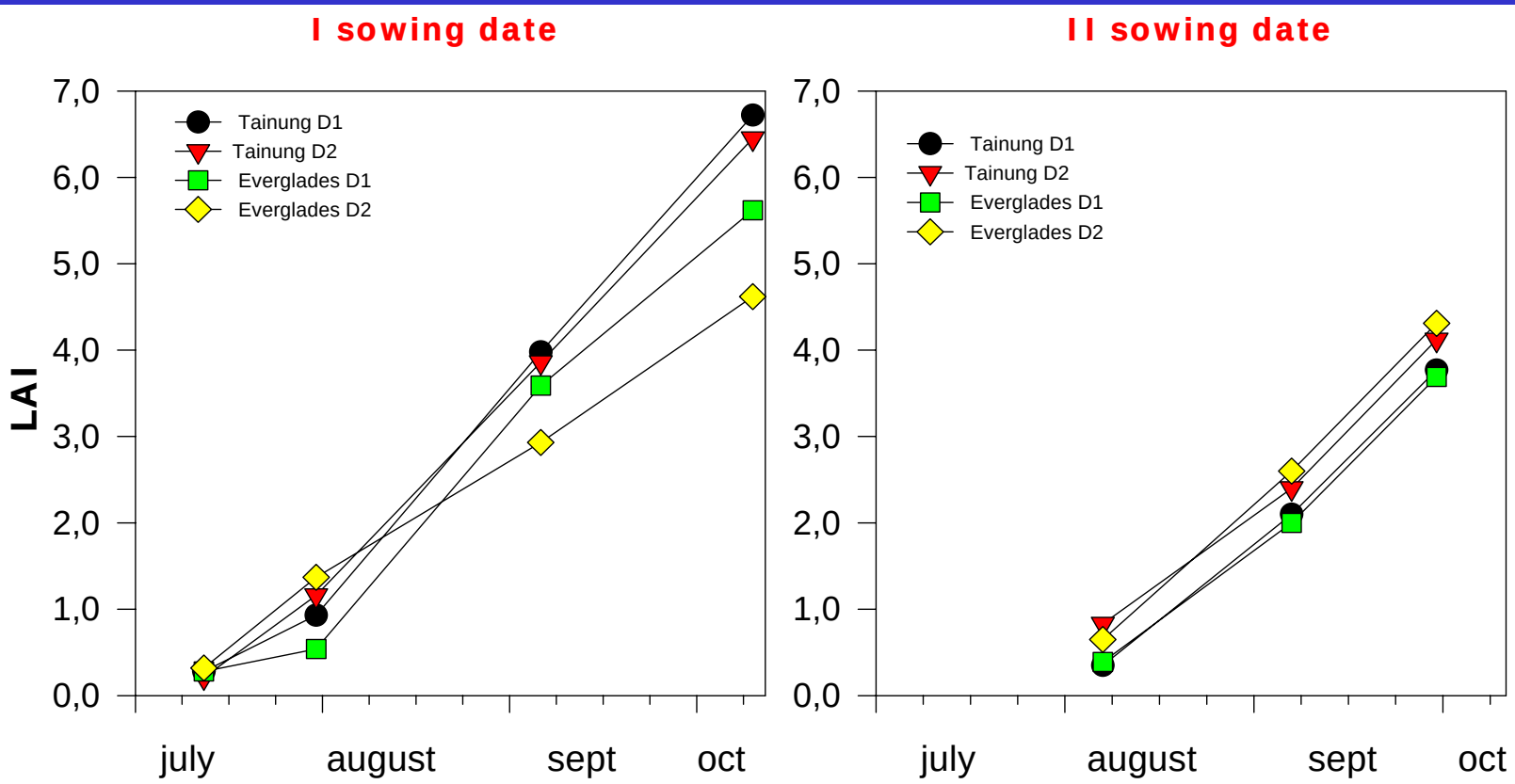


2nd sowing date



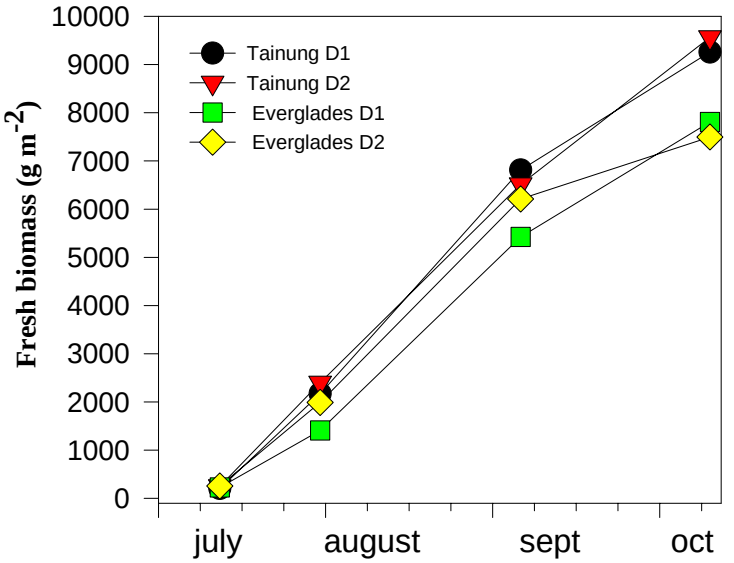


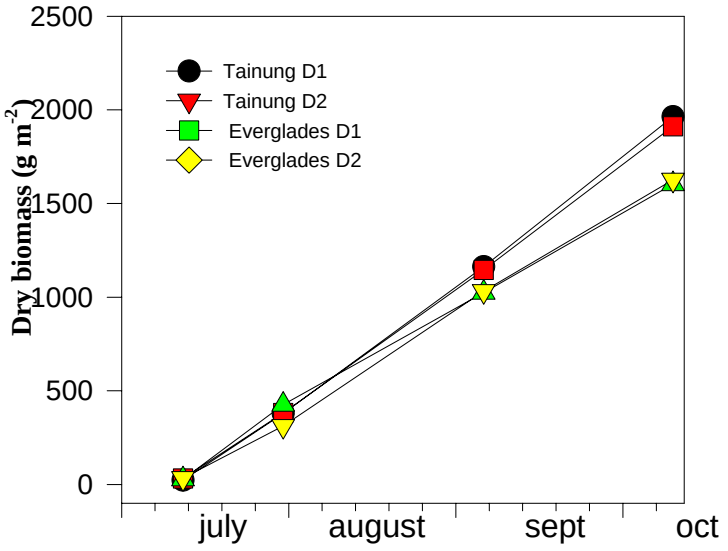
Leaf area index (LAI)



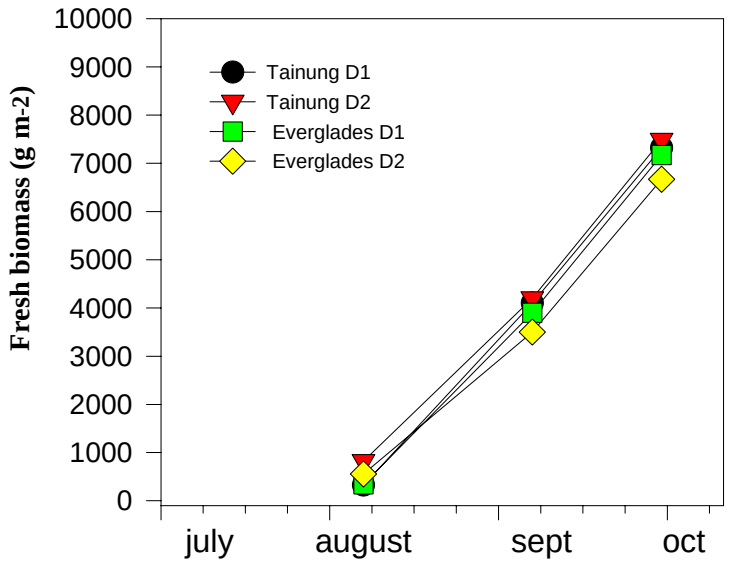
Fresh biomass (g m^{-2}) Dry biomass (g m^{-2})

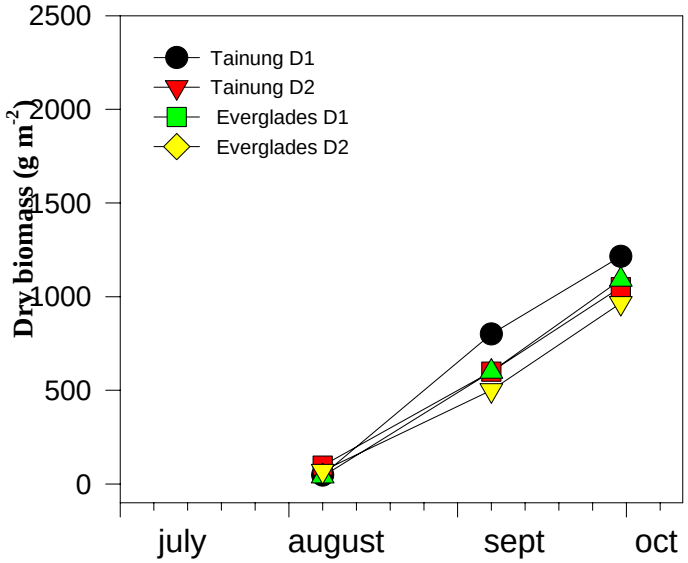
1st sowing date





2nd sowing date

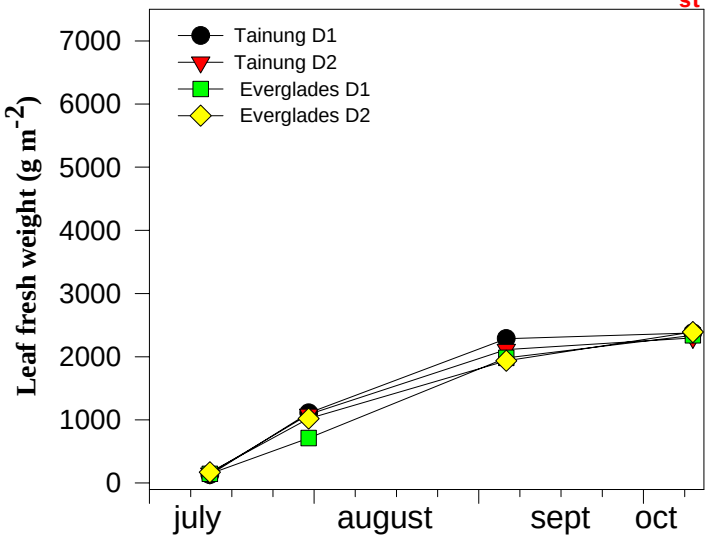


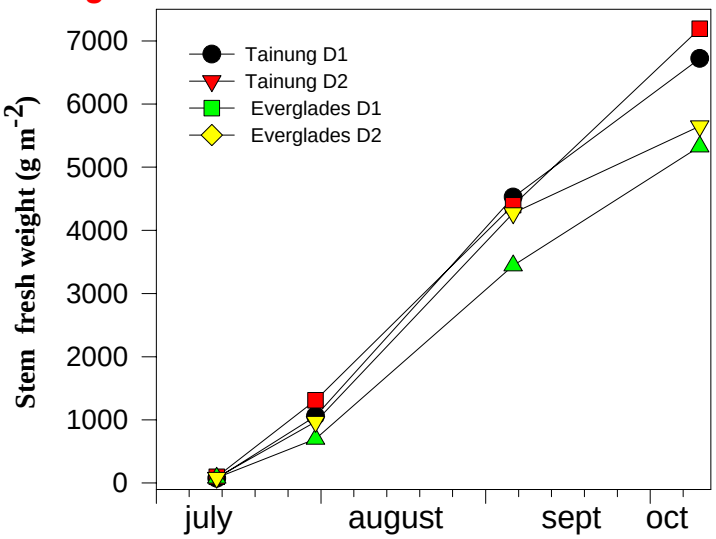


Leaf fresh weight (g m^{-2})

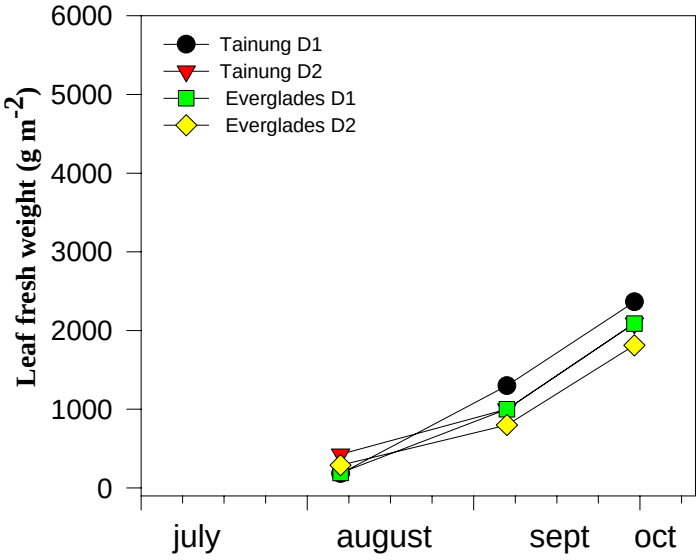
Stem fresh weight (g m^{-2})

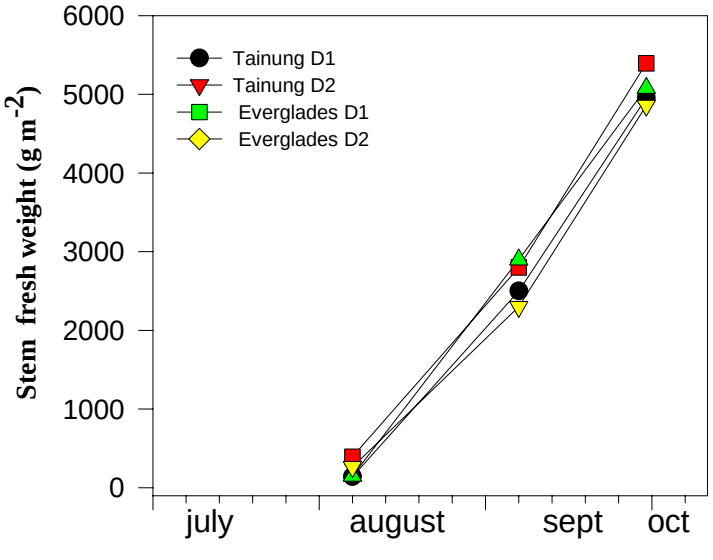
1$_{st}$ sowing date



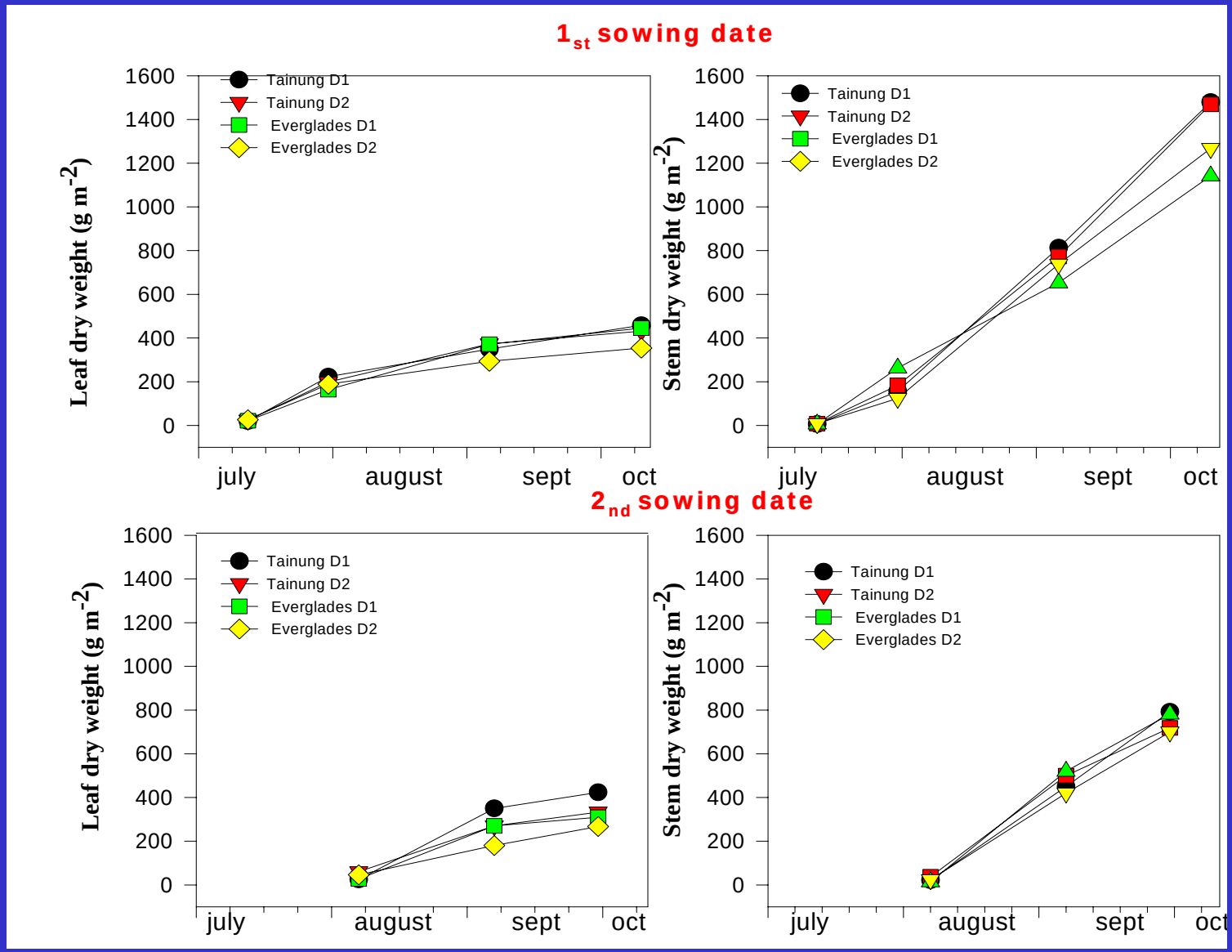


2$_{nd}$ sowing date





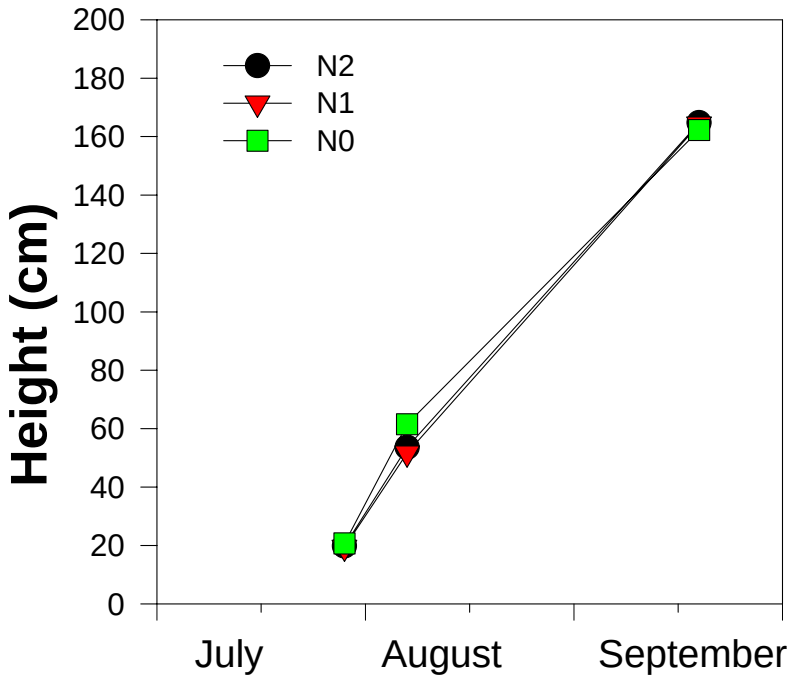
Leaf dry weight (g m^{-2}) Stem dry weight (g m^{-2})

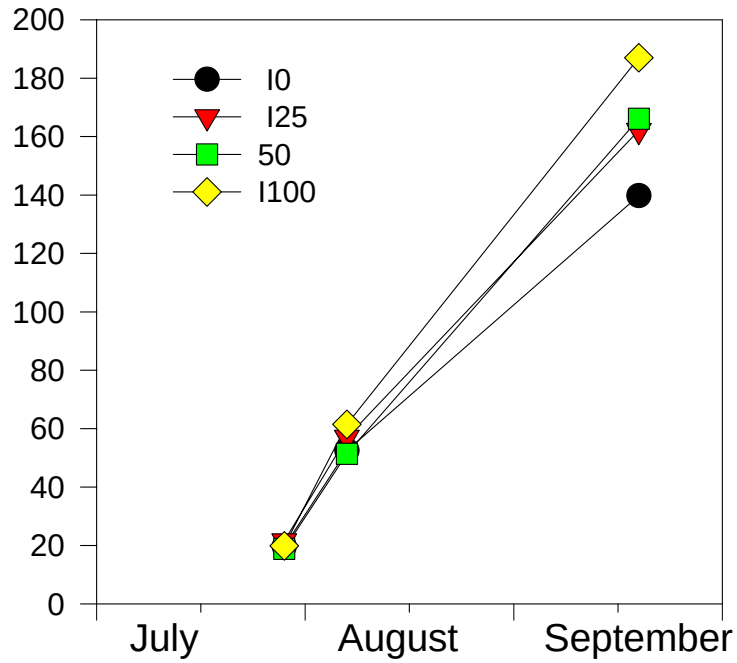


July 29th - Irrigation and nitrogen trial

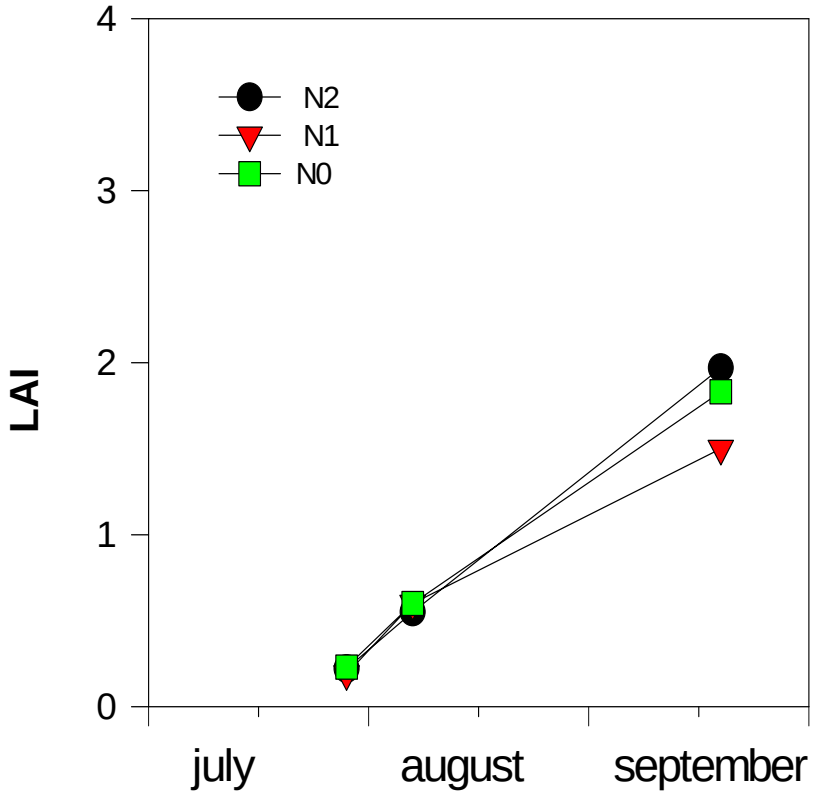
50% ETM - N0

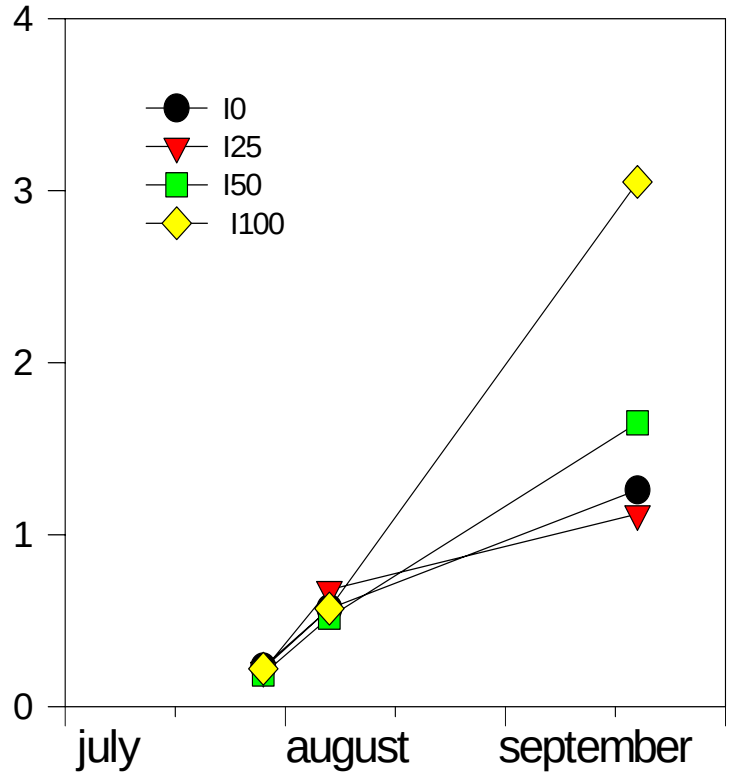
Plant height (cm)



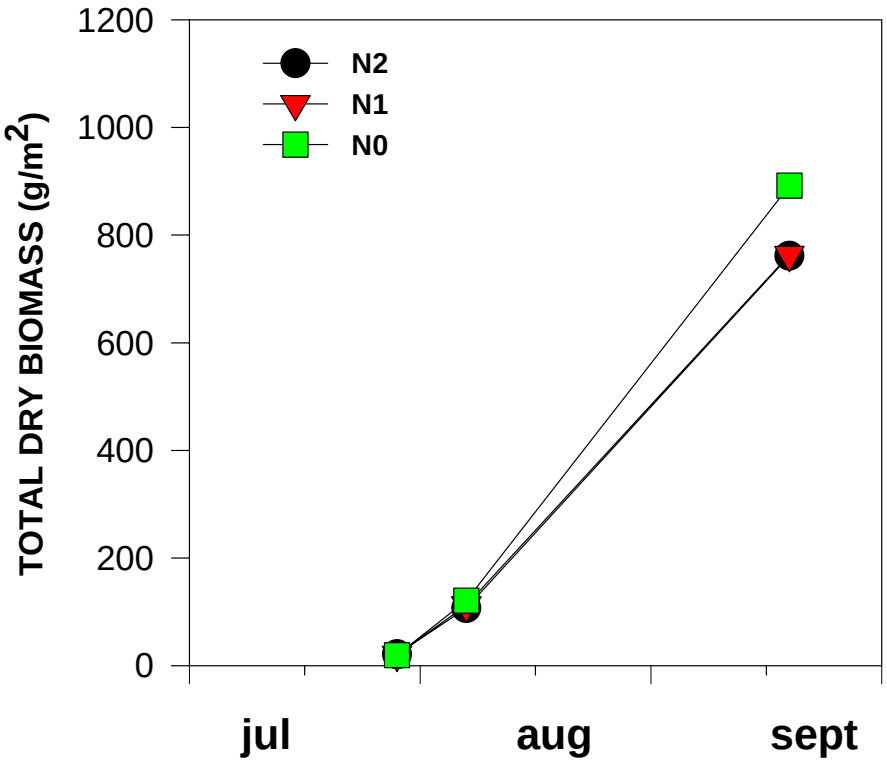


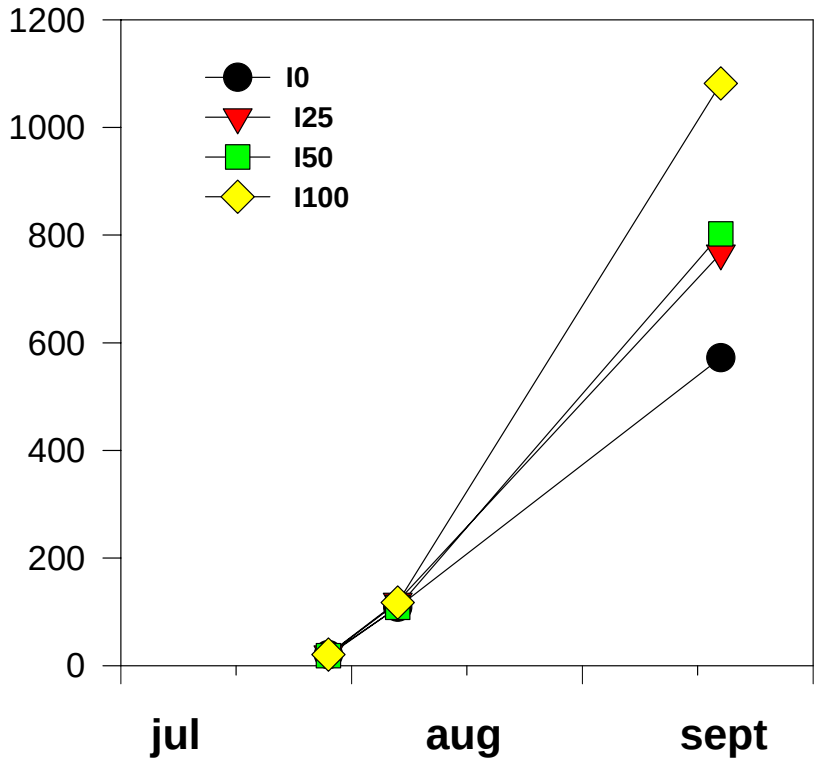
Leaf area index (LAI)



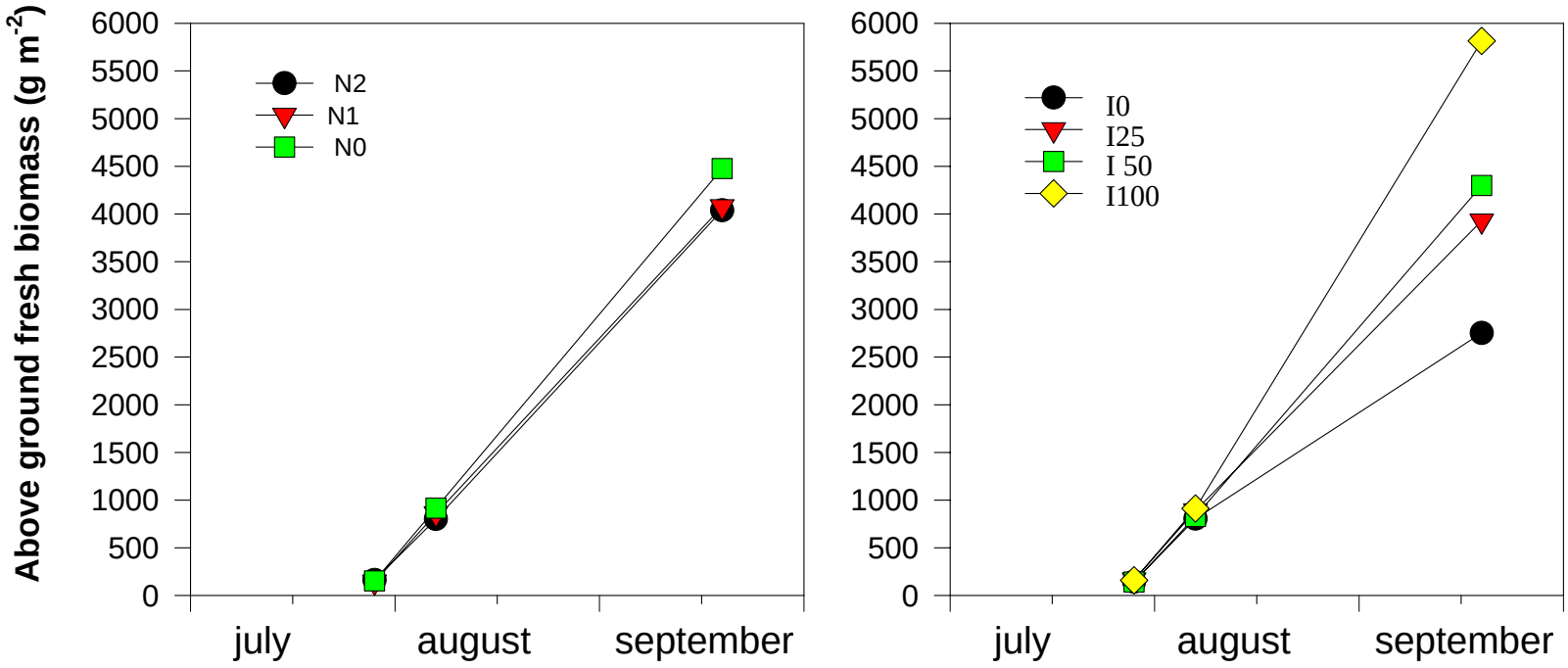


Total above ground dry biomass (g m^{-2})

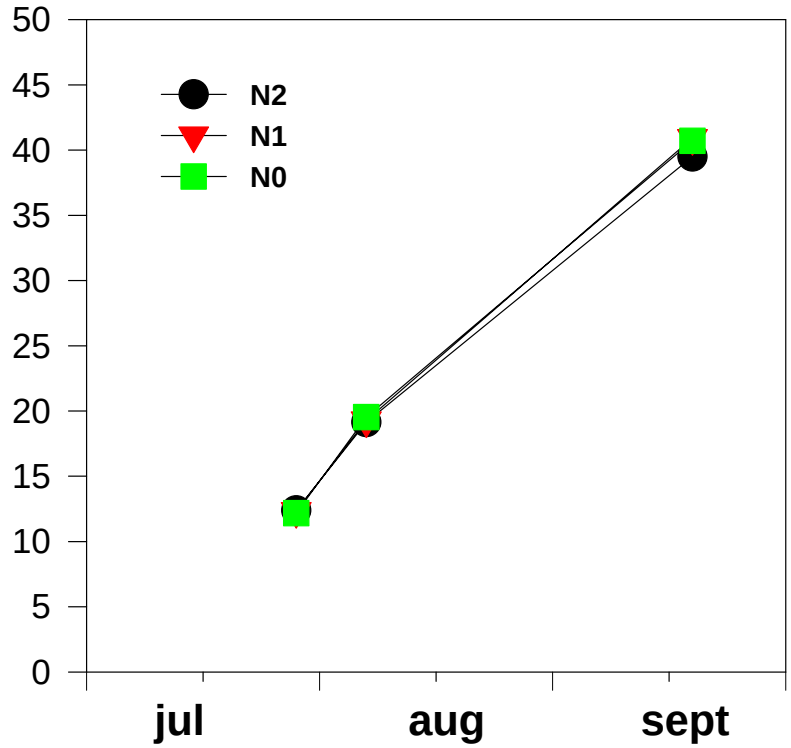


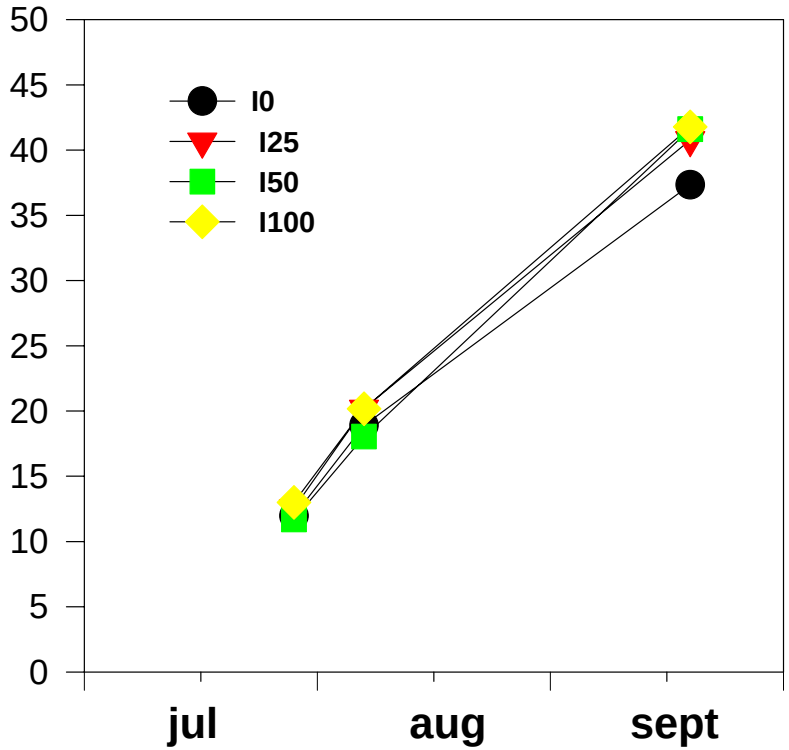


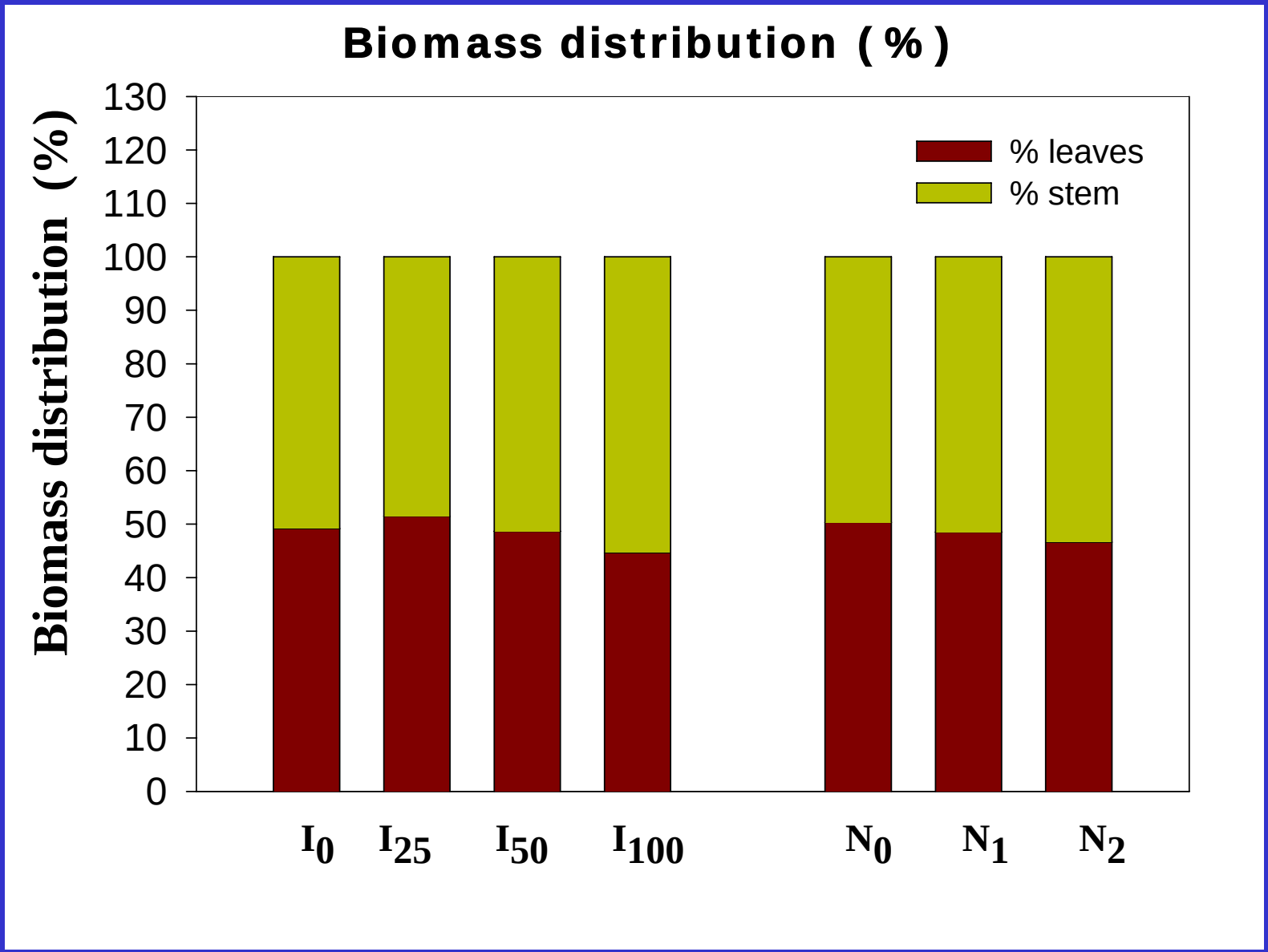
Above ground fresh biomass (g m^{-2})



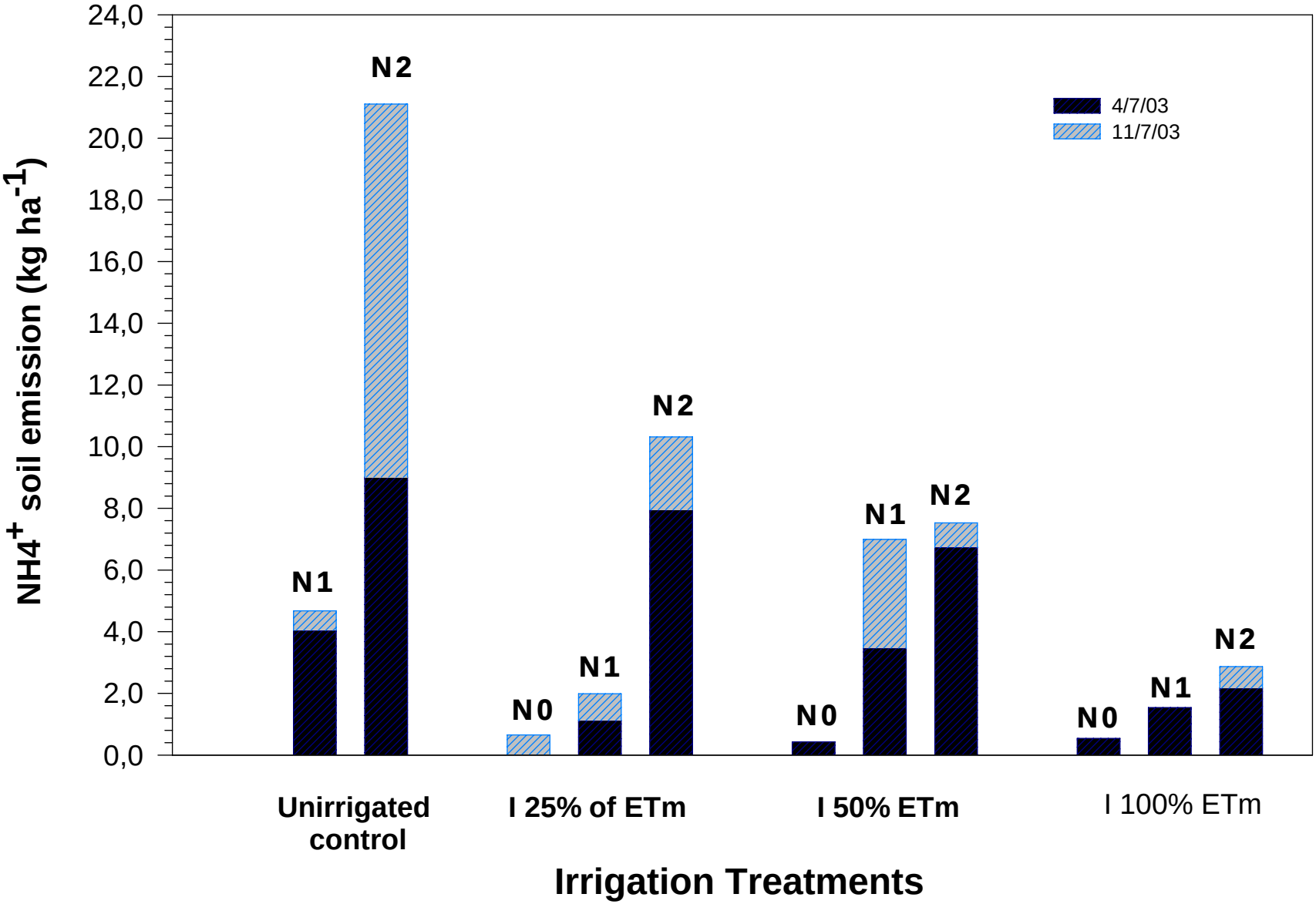
Number of nodes per plant






Biomass distribution (%)
Biomass distribution (%)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
% leaves
% stem
I0
I25
I50
I100
N0
N1
N2

Ammonia soil emission (Kg ha^{-1})




100%
25%
0
50%

I_0 $I_{50\%}$

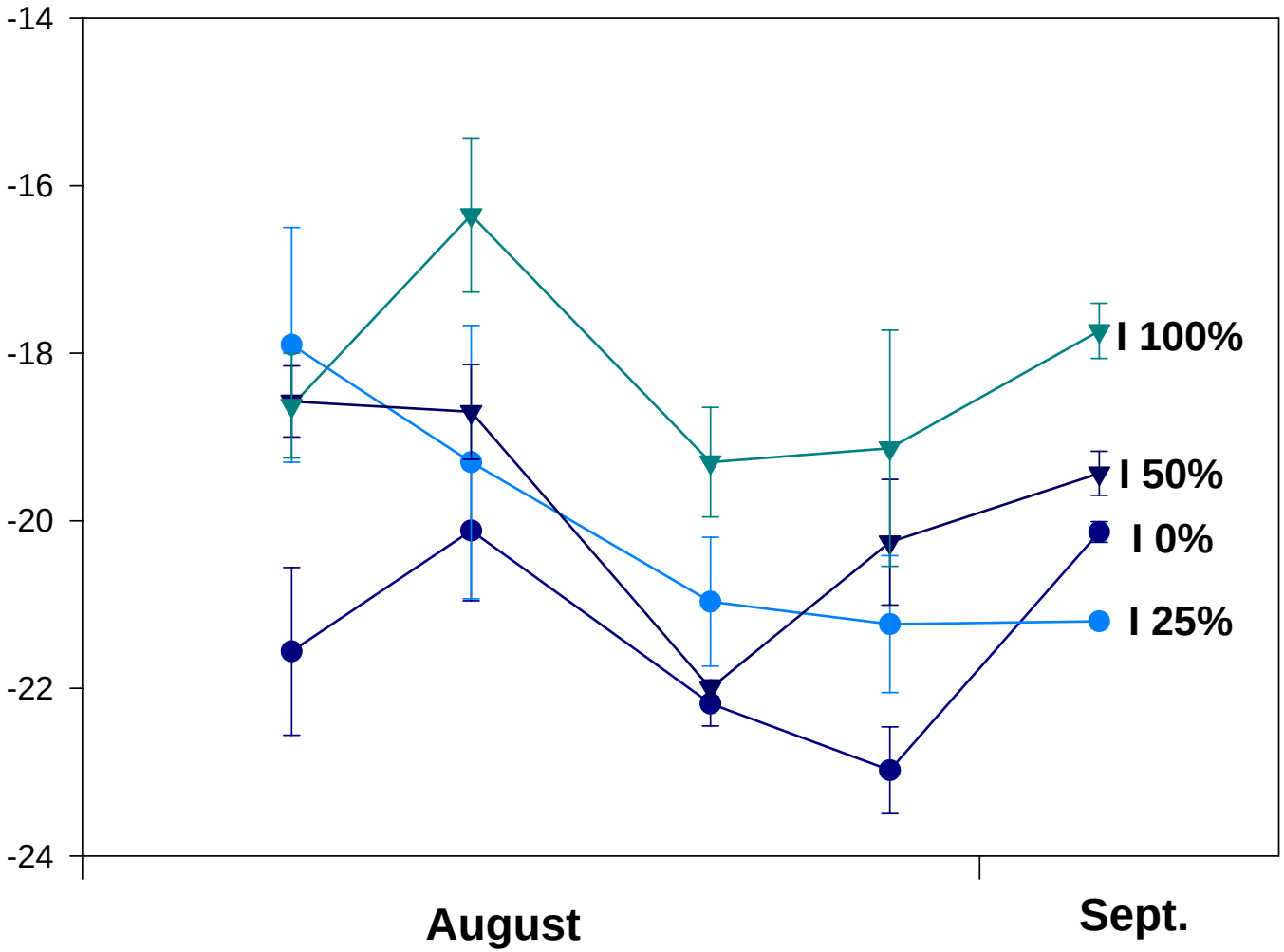
100%

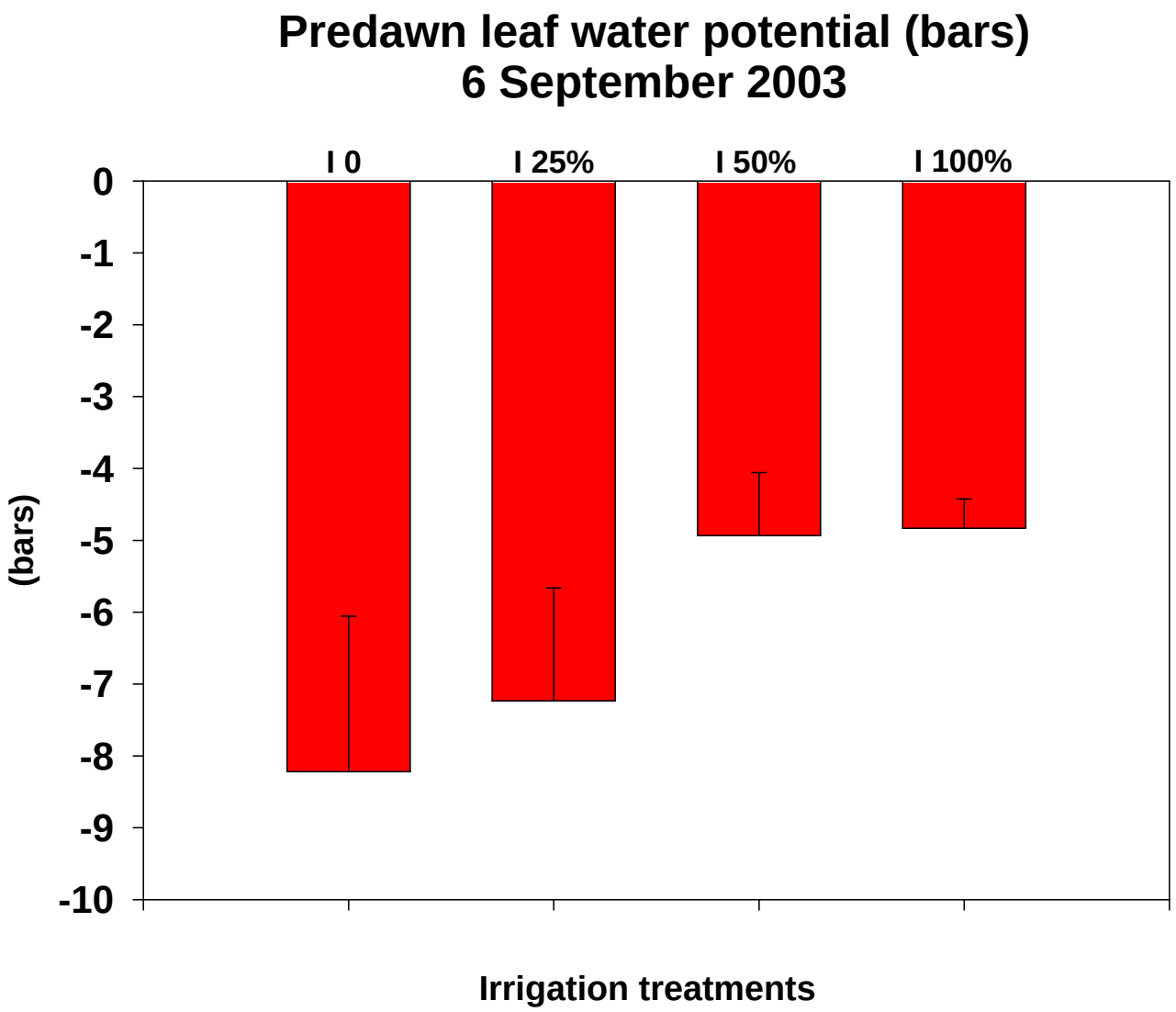
25%

I 25% I 50% I 0 I100%

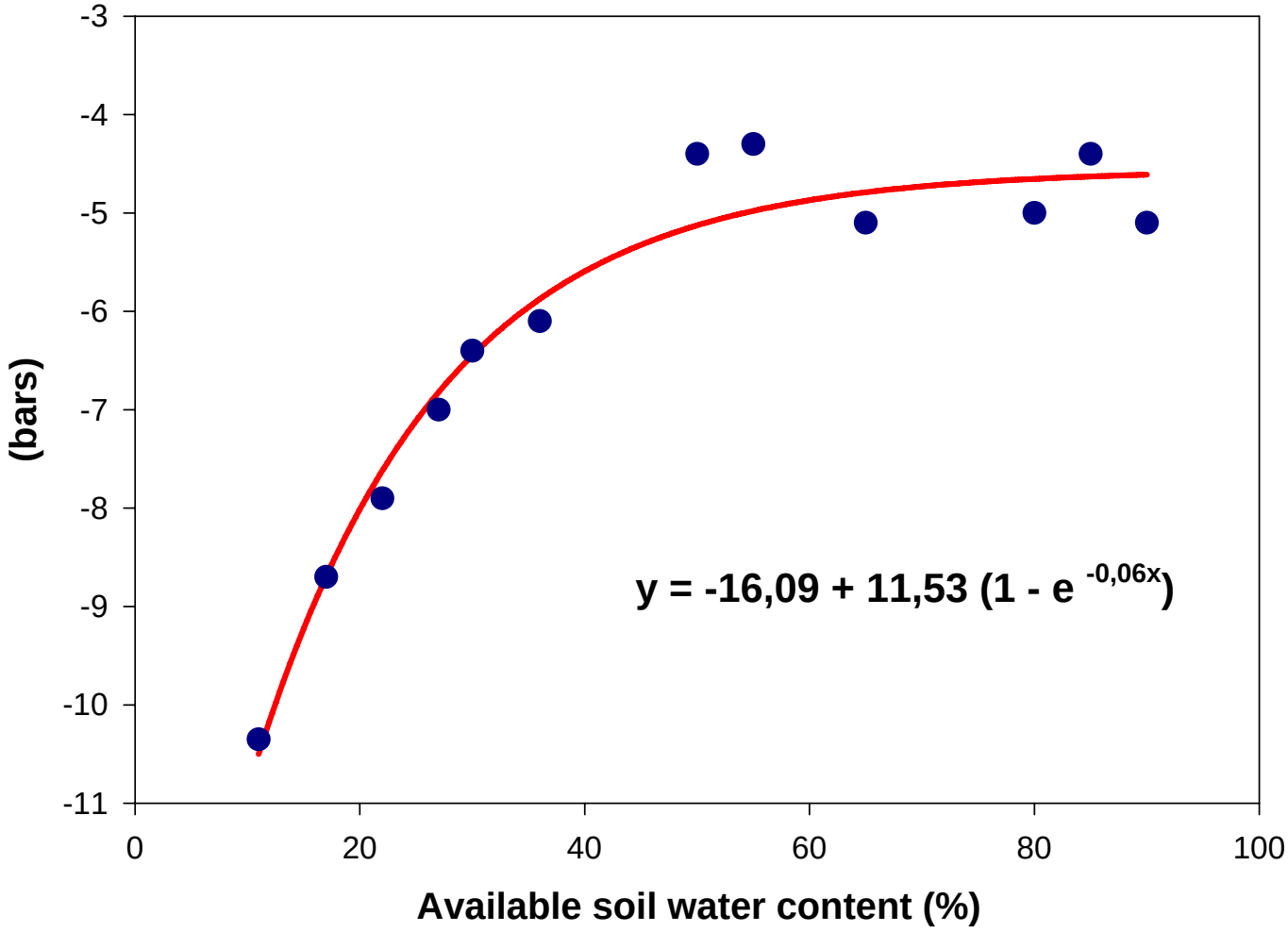
I 0 I 100%

Midday leaf water potential (bars)

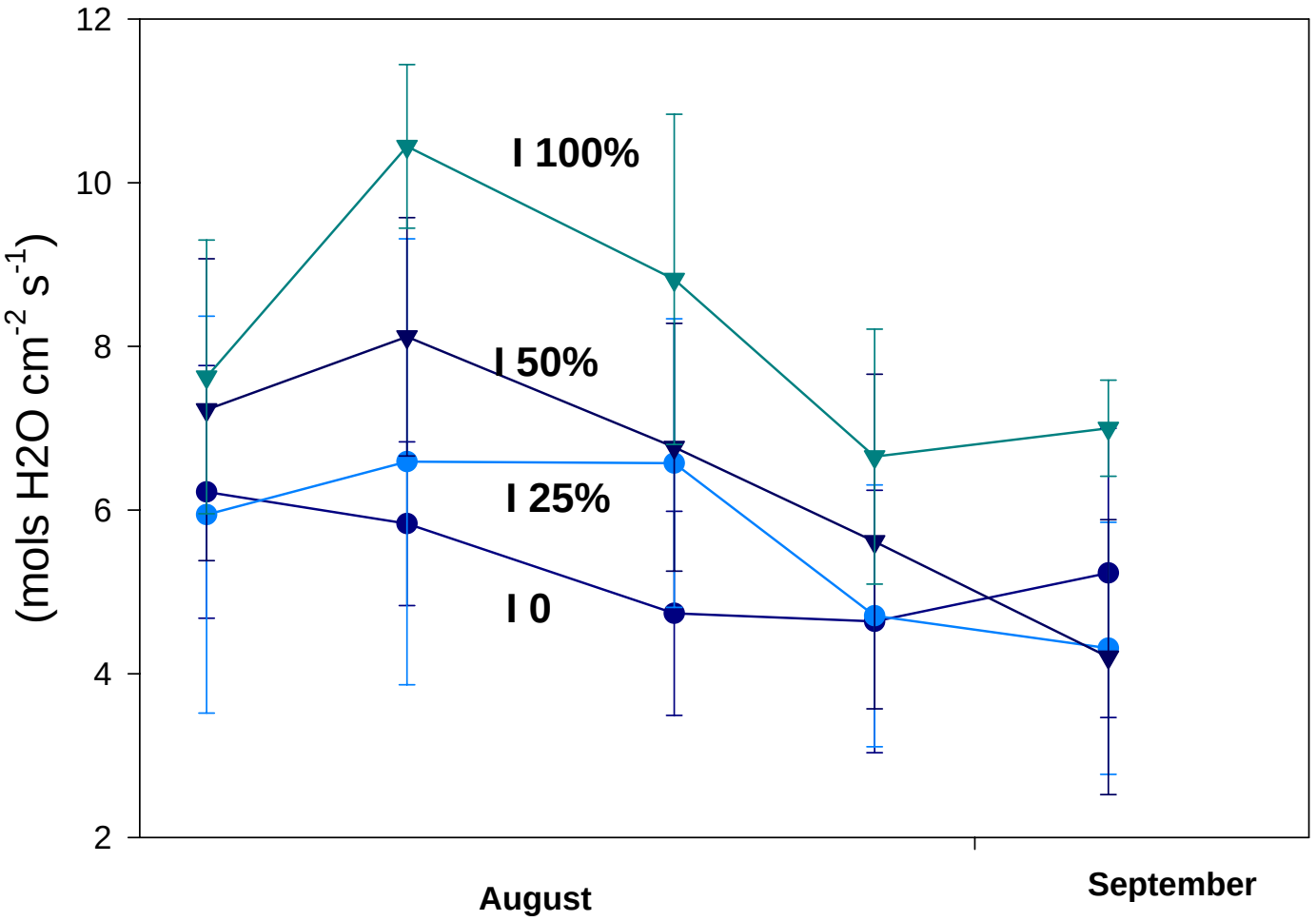



Predawn leaf water potential (bars)
6 September 2003
I 0
I 25%
I 50%
I 100%
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
(bars)
Irrigation treatments

Predawn leaf water potential vs. available soil water content



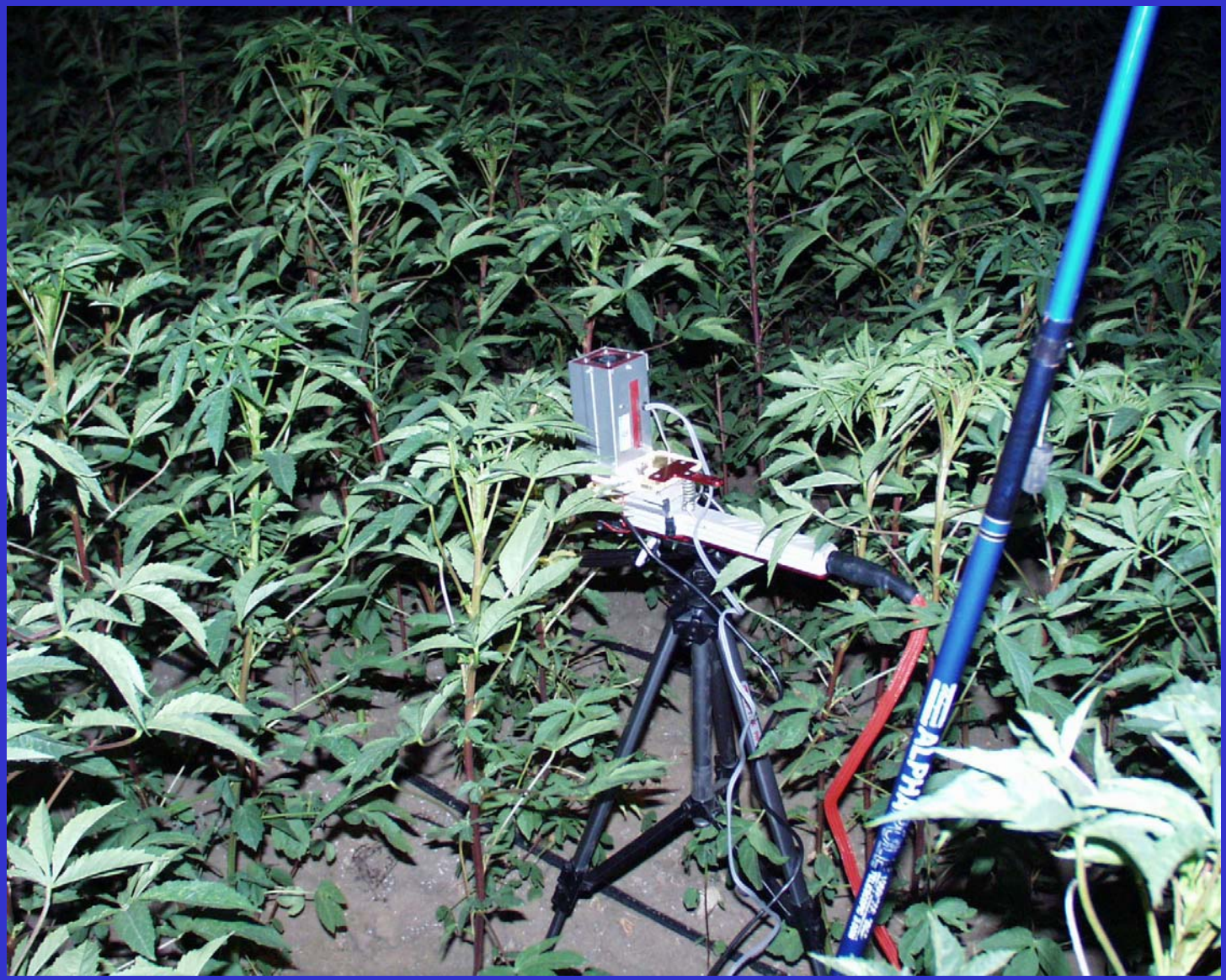
Leaf transpiration



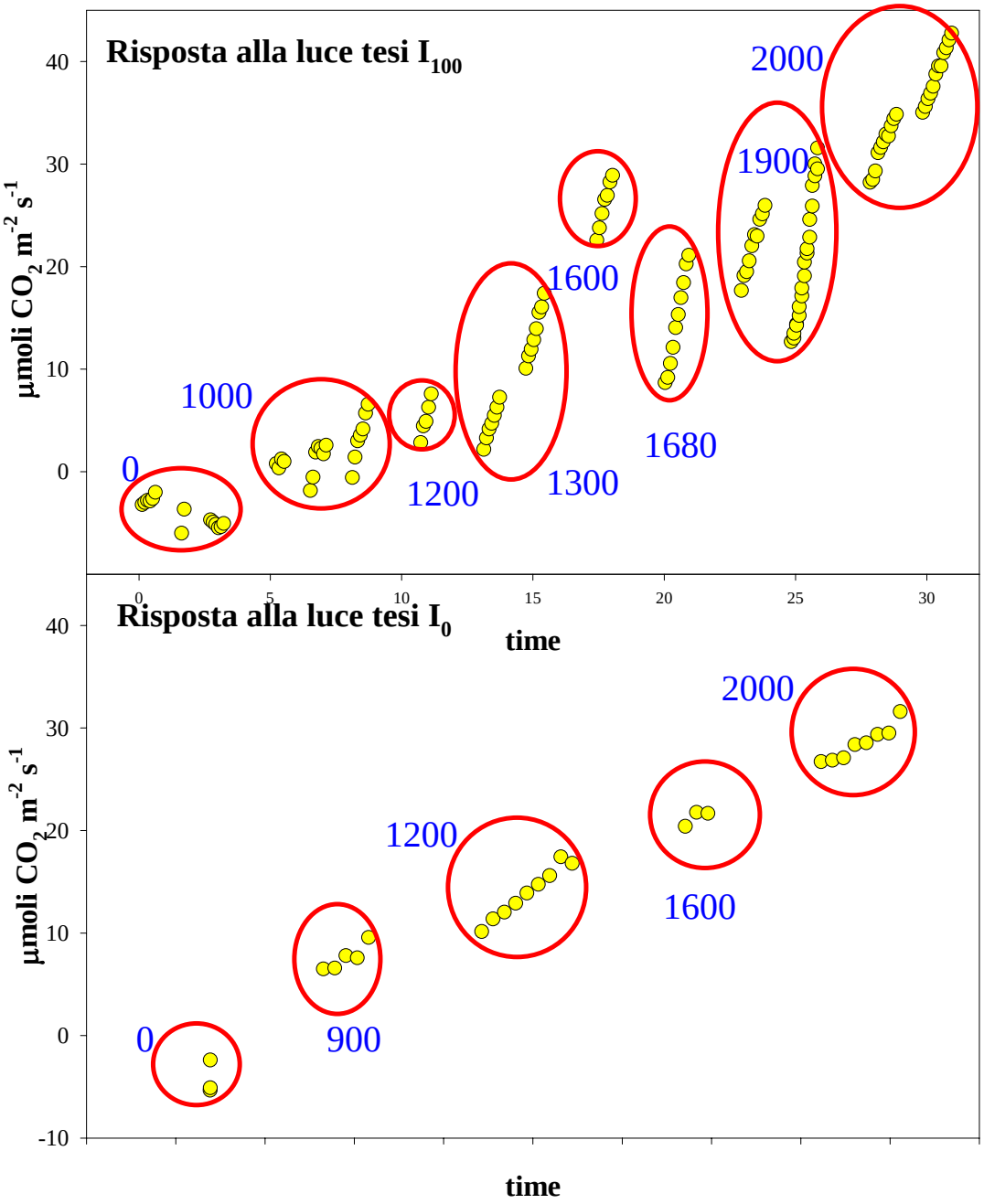
Effect of Temperature on Dark Respiration

$$R_t = R_{20}\, 2^{(t - 20)/10}$$

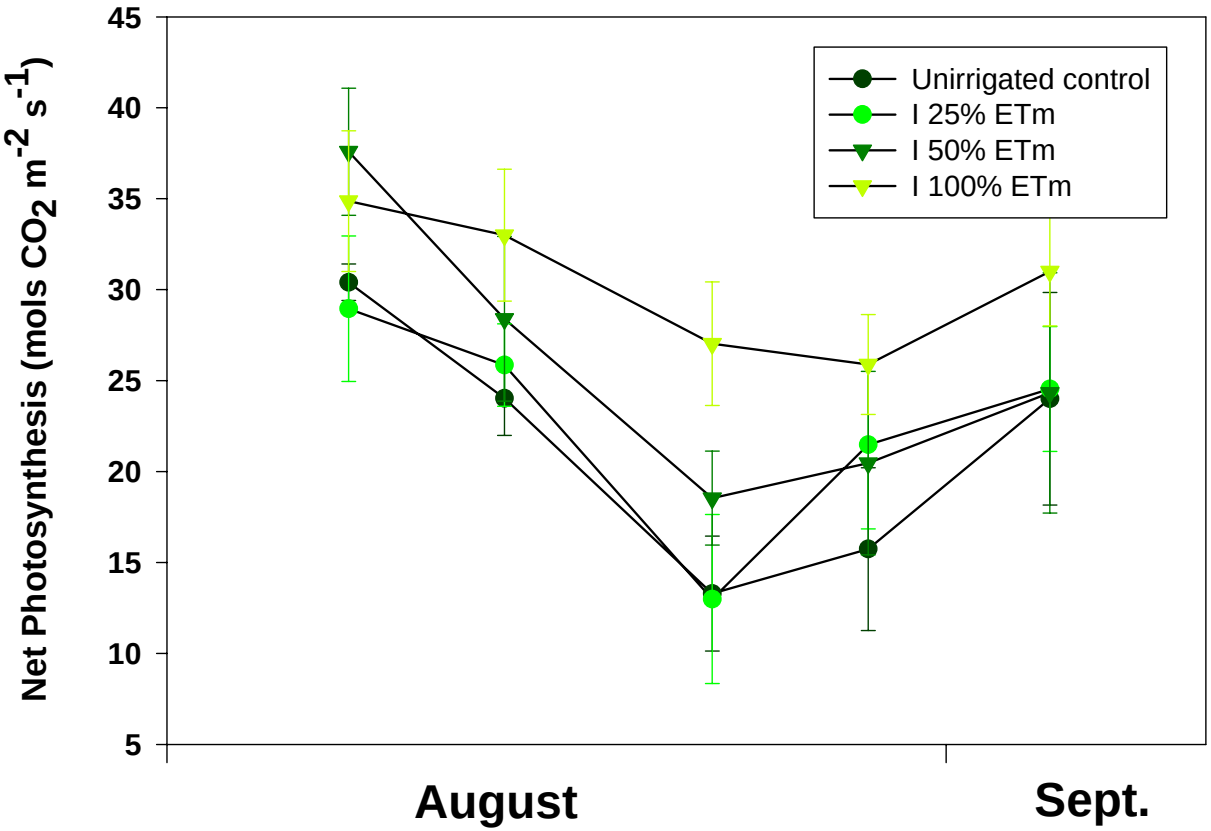
Respiration doubles each 10^{o}C. It has a $Q_{10} = 2$

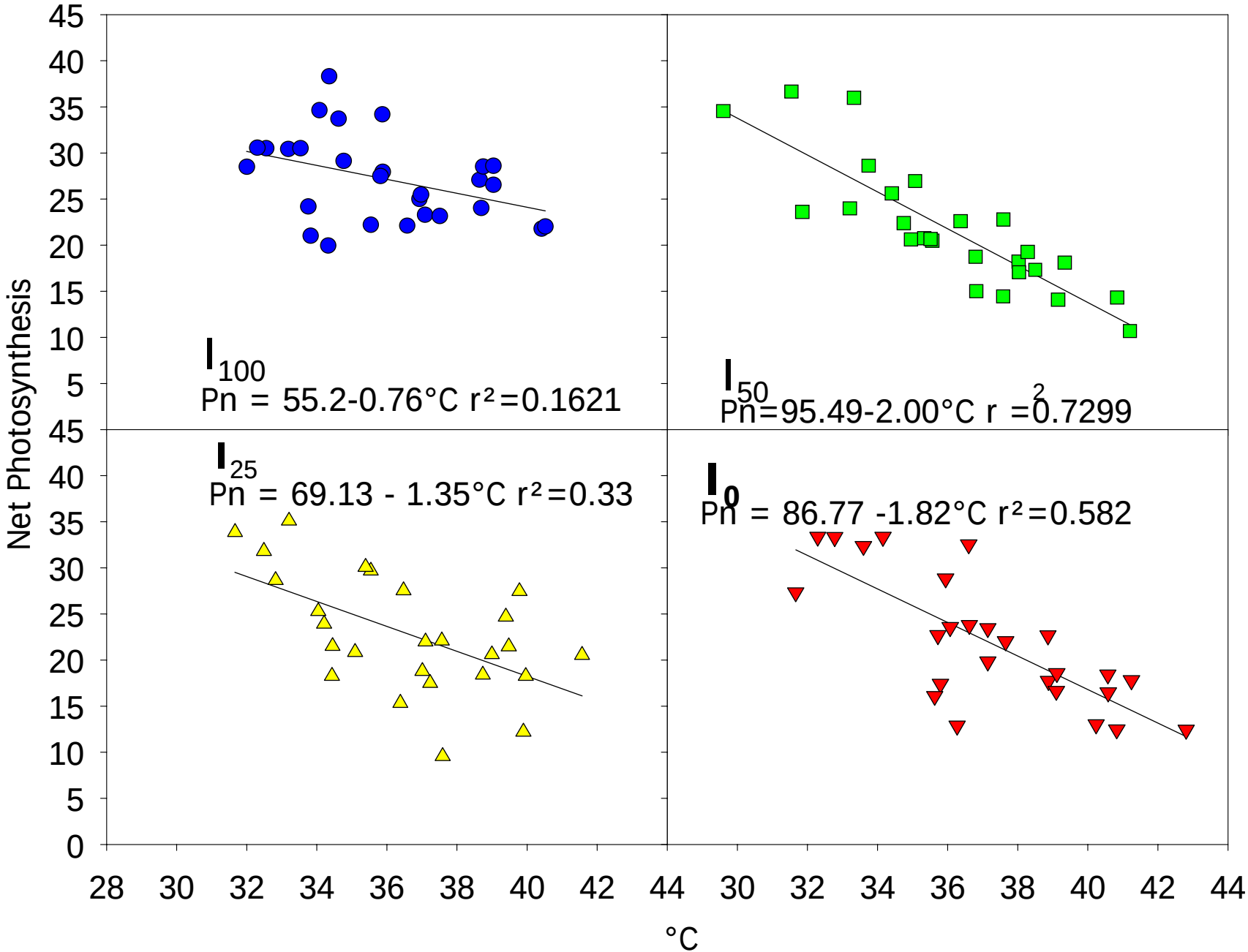

ALPHA

Attività fotosintetica risposta alla luce

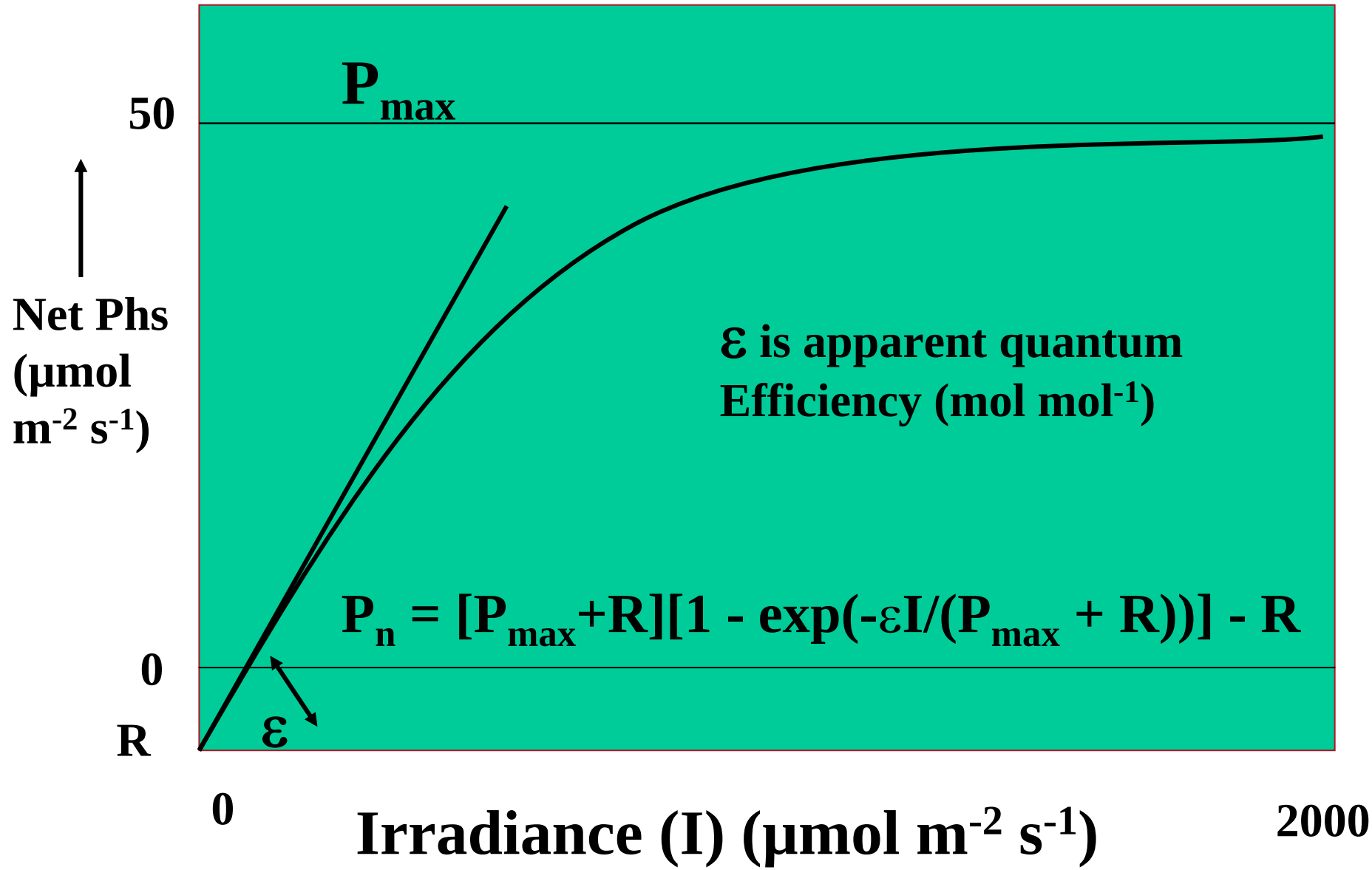


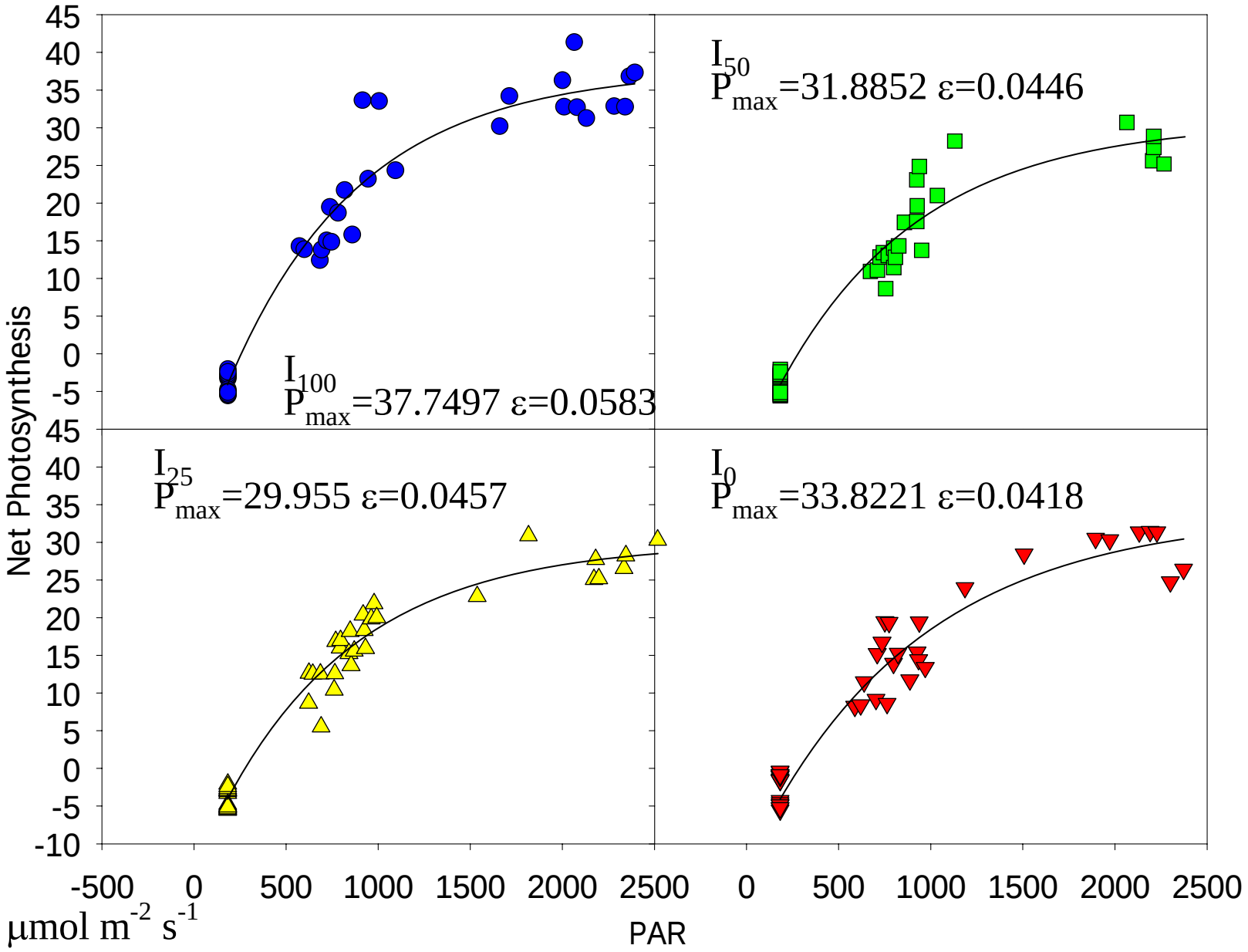
Net Photosynthesis (mols CO_2 m^{-2} s^{-1})

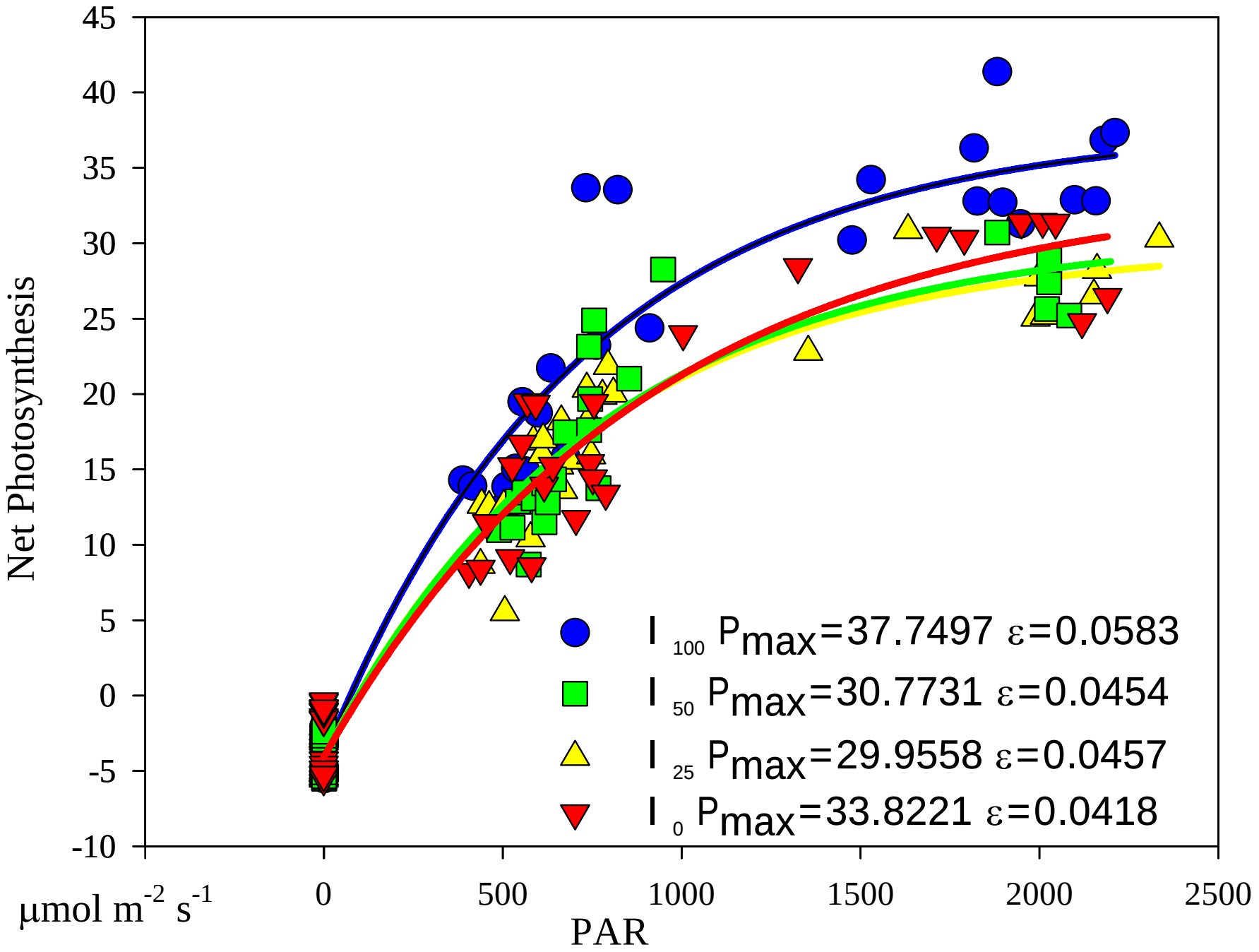


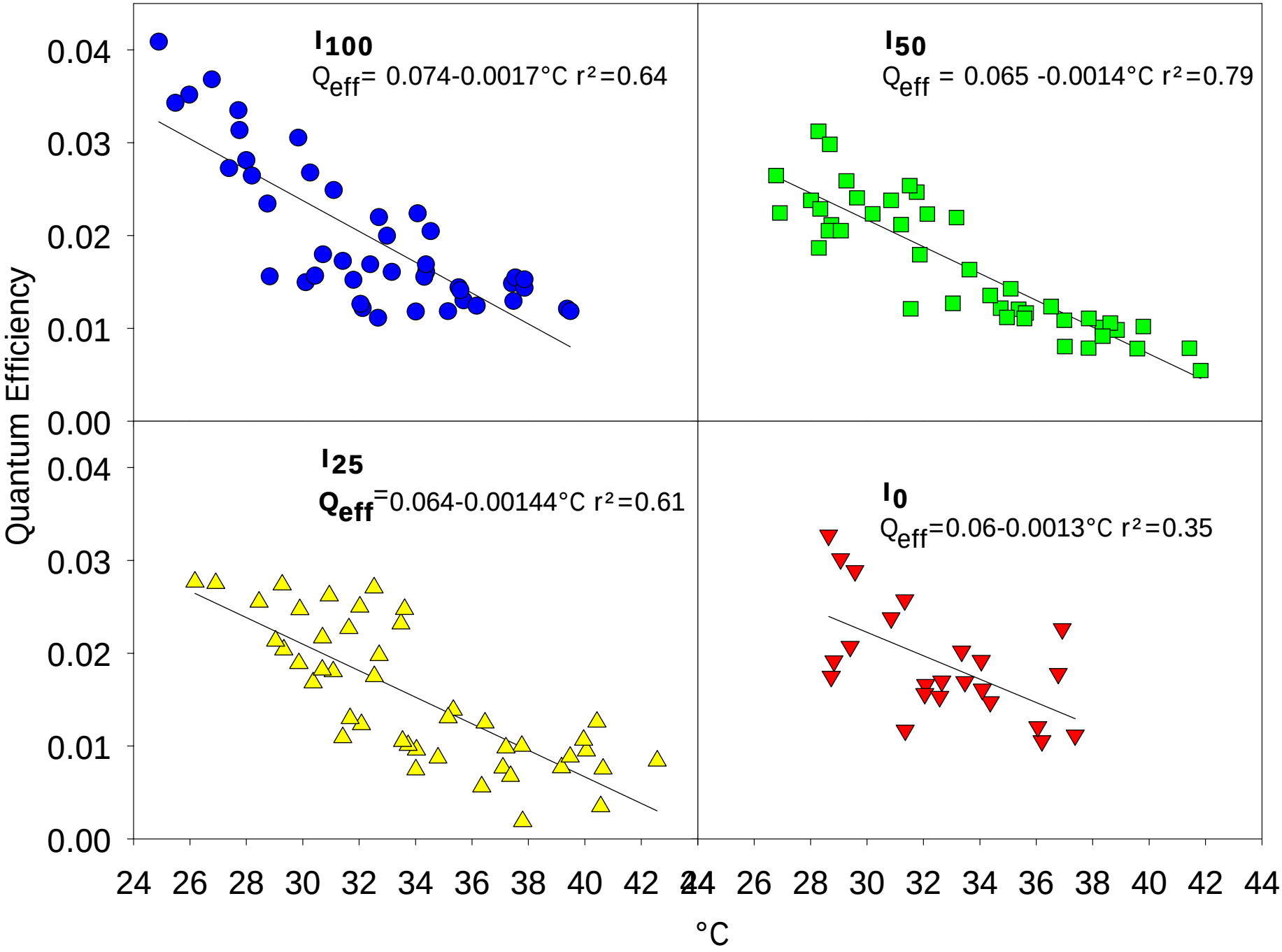

Net Photosynthesis
°C
I100
Pn = 55.2-0.76°C r²=0.1621
I50
Pn=95.49-2.00°C r²=0.7299
I25
Pn = 69.13 - 1.35°C r²=0.33
I0
Pn = 86.77 -1.82°C r²=0.582

Leaf Photosynthesis Response to Irradiance




Net Photosynthesis
45
40
35
30
25
20
15
10
5
0
-5
-10
I_{100}
P_{max}=37.7497 ε=0.0583
I_{50}
P_{max}=31.8852 ε=0.0446
I_{25}
P_{max}=29.955 ε=0.0457
I_0
P_{max}=33.8221 ε=0.0418
-500
0
500
1000
1500
2000
2500
µmol m^{-2} s^{-1}
PAR


45
40
35
30
25
20
15
10
5
0
-5
-10
Net Photosynthesis
μmol m-2 s-1
0
500
1000
1500
2000
2500
PAR
I 100 Pmax=37.7497 ε=0.0583
I 50 Pmax=30.7731 ε=0.0454
I 25 Pmax=29.9558 ε=0.0457
I 0 Pmax=33.8221 ε=0.0418


I100
Qeff= 0.074-0.0017°C r²=0.64
I50
Qeff = 0.065 -0.0014°C r²=0.79
I25
Qeff=0.064-0.00144°C r²=0.61
I0
Qeff=0.06-0.0013°C r²=0.35
Quantum Efficiency
0.04
0.03
0.02
0.01
0.00
24 26 28 30 32 34 36 38 40 42 44
°C