

INSTITUUT VOOR BIOLOGISCH EN SCHEIKUNDIG ONDERZOEK  
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CO<sub>2</sub>-assimilation light response curves of leaves;  
some experimental data

by

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CO<sub>2</sub>-assimilation light response curves of leaves,

some experimental data

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Introduction

For a survey of the great number of CO<sub>2</sub>-assimilation light response curves measured at IBS between 1967 and 1972, it was decided to prepare a collection of these results in the form of an internal report.

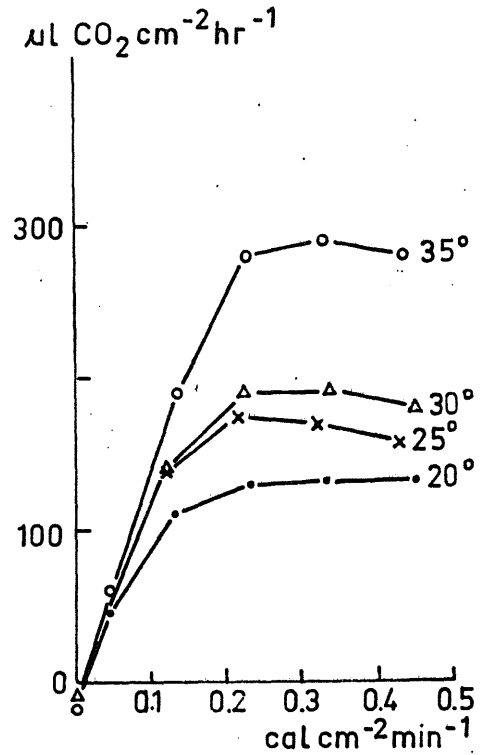
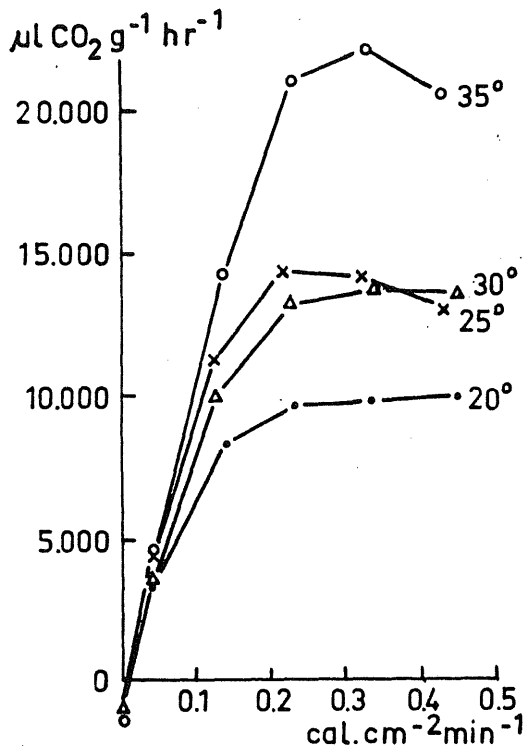
Presented are all the data we were able to collect of leaf photosynthesis experiments, the conditions of which during measurement and plant pretreatment were well described. Whole plant and "crop" (a pot with a great number of plants) measurements have been excluded, and most of the leaf, plant and "crop" transpiration data. Results of effects of application of chemicals on the CO<sub>2</sub>-assimilation have neither been included. The data were not selected for quality or any other subjective criterium.

All measurements were performed in the assembly at IBS, as described by Louwse and Van Oorschot, *Photosynthetica* 3(1969)305-315. The experiments were designed by IBS research workers and performed with technical assistance of W. Louwse and W. van der Zweerde. Some of the results included have been published or will be published. We

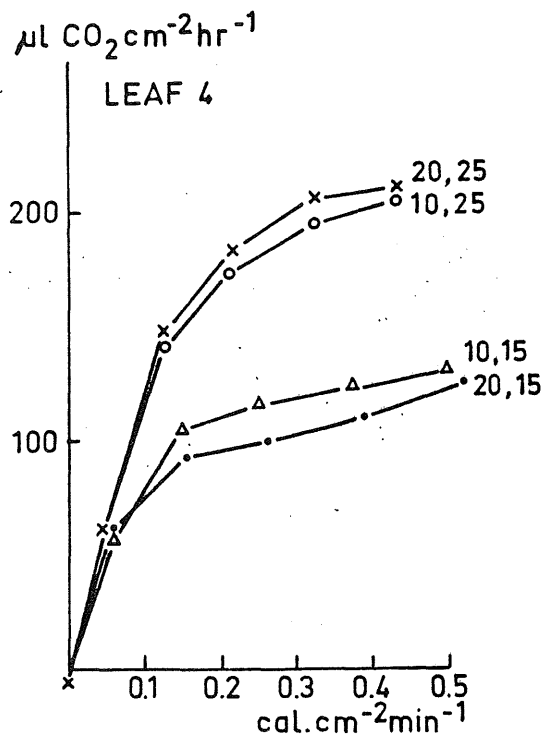
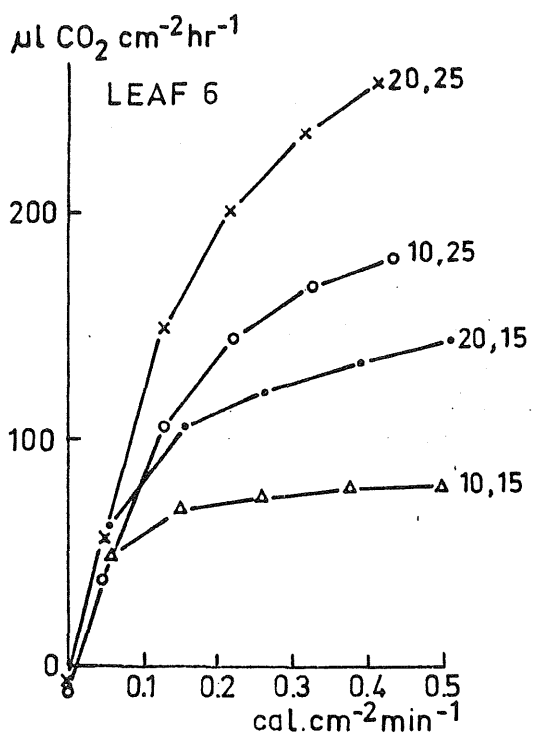
are grateful for the readiness of all in lending their results to this purpose.

Graphs are standardized as much as possible, and categorized. Many graphs concern two or more categories; these were placed in the category where its contribution seemed most illustrative. The section "miscellaneous data" contains examples of leaf versus plant and pot measurements and plant handling. Measuring conditions and pretreatment are given for each experiment. Numbering of leaves starts from the oldest leaf onwards.

Conversion tables of  $\text{CO}_2$ -assimilation rate units and light intensity units are added. It should be noted that in the graphs the incident light intensity is given. The intensity of the absorbed light is about 0.8 to 0.5 of the incident light, the exact value depending on leaf reflection and leaf transmission.



Species : Chloris gayana; Rhodes grass  
Scientist : Th. Alberda  
Experiment : Effect of temperature pretreatment on CO<sub>2</sub>-assimilation  
Pretreatment : climate room  
temperature see figures  
light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup>min<sup>-1</sup>  
nutrient solution  $\frac{1}{2}$  Hoagland  
Age : 5 weeks  
Measurement : leaf, 25°C



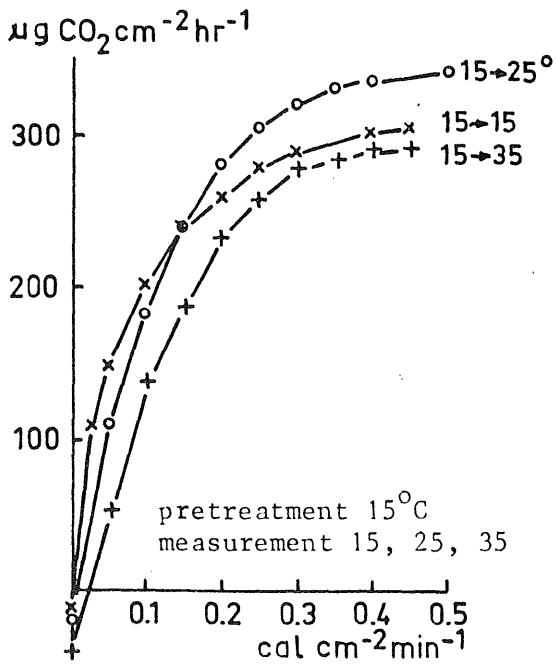
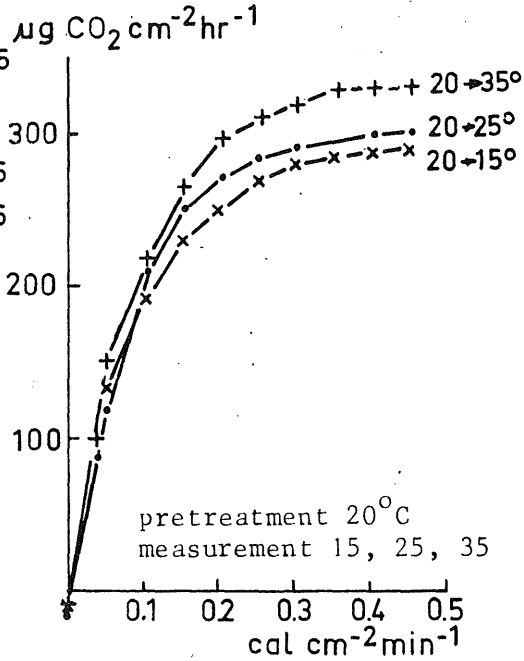
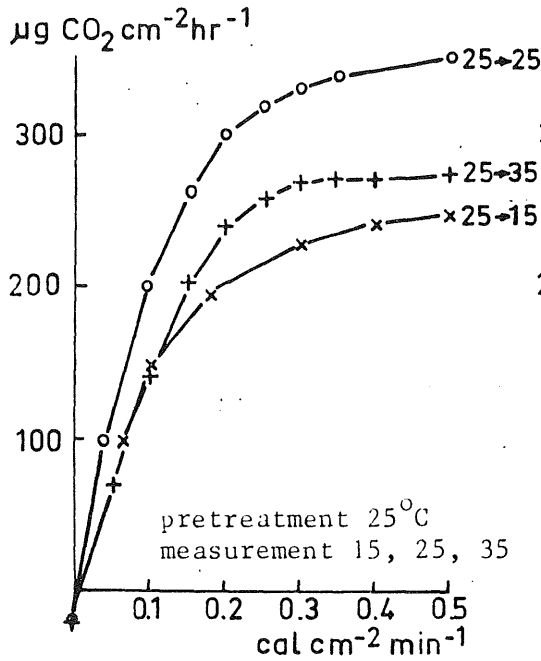
Species : Zea mays; maize

Scientist : Th. Alberda

Experiment : Effect of temperature pretreatment on  $\text{CO}_2$ -assimilation

Pretreatment and measurement } : climate room  
 : 20 - 25 pretreatment  $20^\circ\text{C}$  measurement  $25^\circ\text{C}$   
 : 20 - 15 " "  $15^\circ\text{C}$   
 : 10 - 25 day  $10^\circ$ /night  $20^\circ$  "  $25^\circ\text{C}$   
 : 10 - 15 " "  $15^\circ\text{C}$   
 light period 17 hrs, light intensity  $0.08 \text{ cal cm}^{-2} \text{ min}^{-1}$   
 nutrient solution  $\frac{1}{2}$  Hoagland

Age : 4 weeks



Species : Carthamus tinctorius;  
safflower, safflower

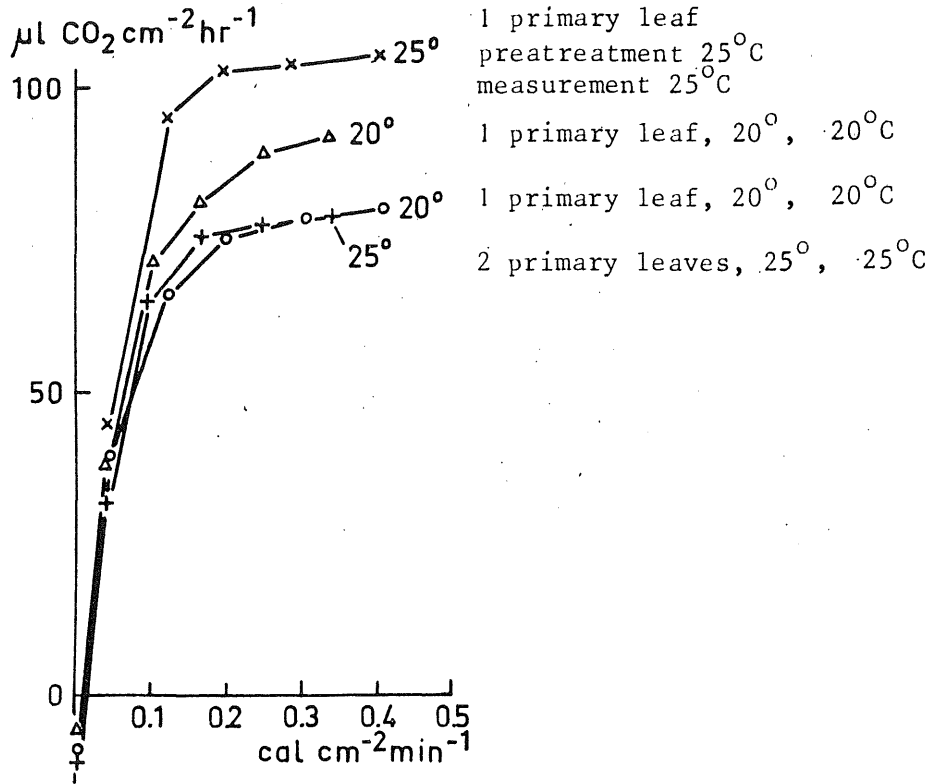
Scientist : D. Zoeb1

Experiment : Effect of temperature  
pretreatment on  $\text{CO}_2$ -  
assimilation

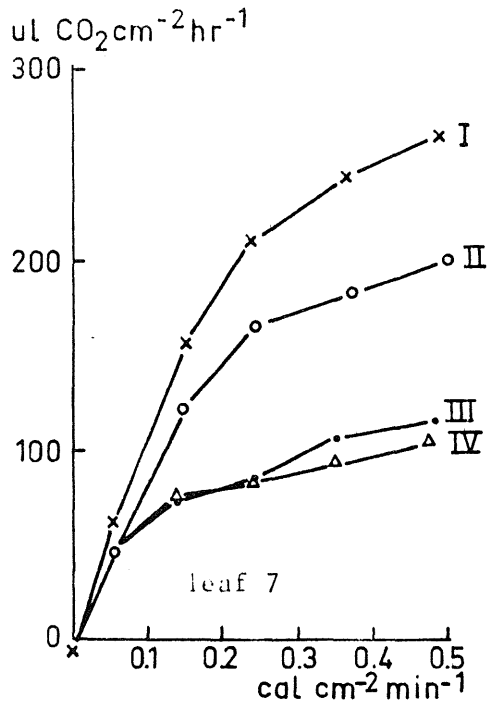
Pretreatment : climate room at  $15^\circ\text{C}$ ,  
 $20^\circ\text{C}$  and  $25^\circ\text{C}$   
nutrient solution:  
 $\frac{1}{2}$  Hoagland  
light period 17 hrs,  
light intensity:  $0.08 \text{ cal cm}^{-2} \text{ min}^{-1}$

Age : 40-44 days

Measurement : leaf



Species : Phaseolus vulgaris; brown bean  
Scientist : Th. Alberda  
Experiment : Effect of temperature on CO<sub>2</sub>-assimilation  
Pretreatment : climate room 20° (or 25°C)  
light period 17 hrs;  
light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
nutrient solution ½ Hoagland  
Age : 6 weeks  
Measurement : leaf, temperature as indicated in figure



Species : Zea mays; maize

Scientist : Th. Alberda

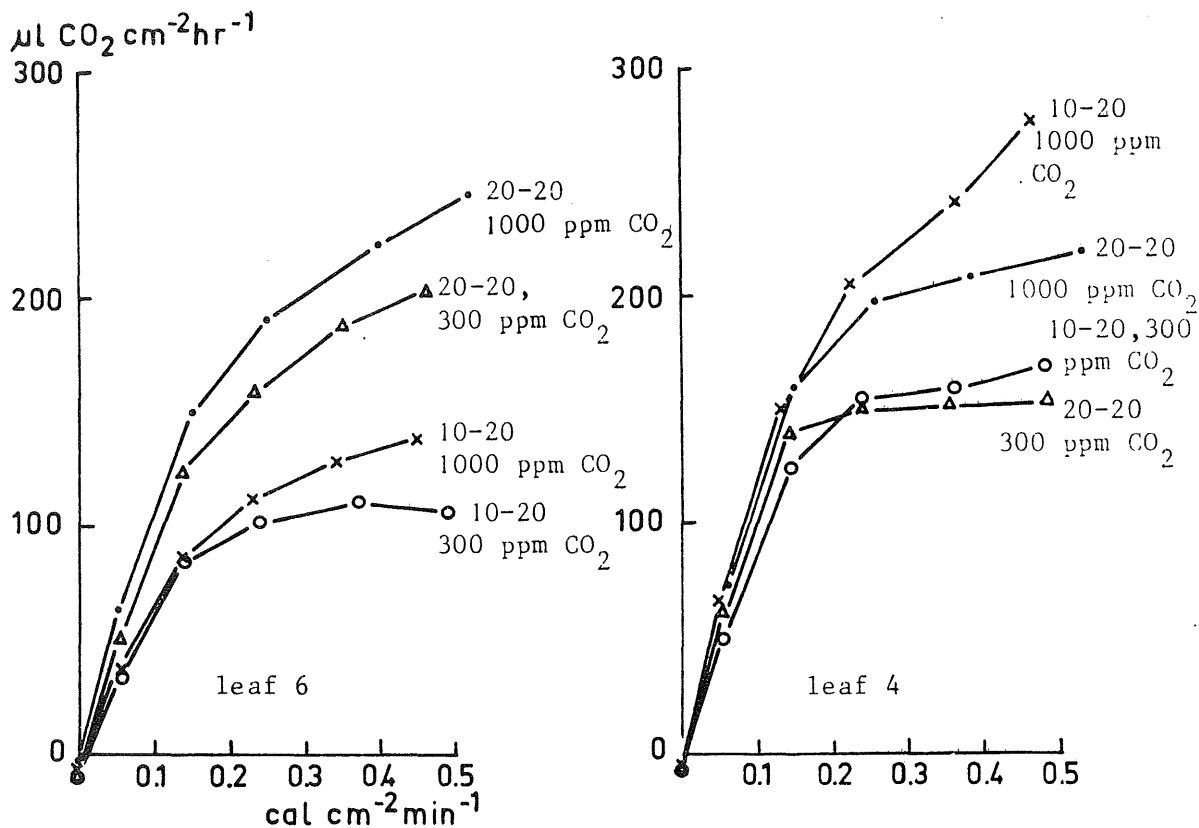
Experiment : Effect of temperature pretreatment on CO<sub>2</sub>-assimilation

Pretreatment : I climate room 25°C  
II 3 weeks 25°C, 1 week day 10°C, night 25°C  
III climate room 25°C  
IV 3 weeks 25°C, 1 week day 10°C, night 25°C  
light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>

Age : 4 weeks

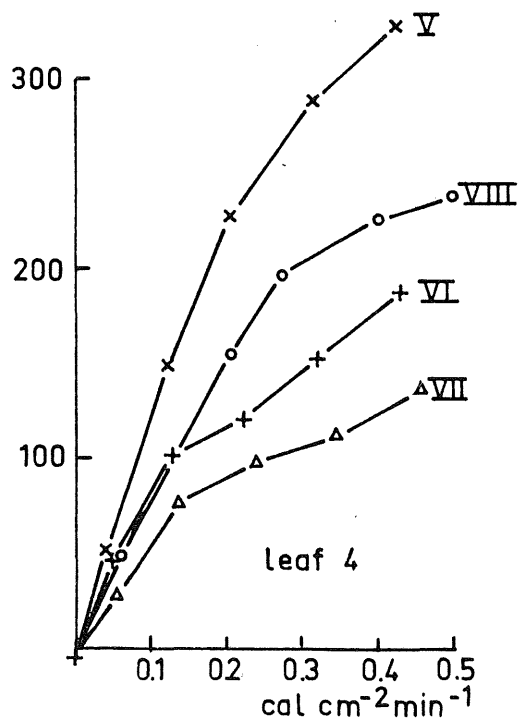
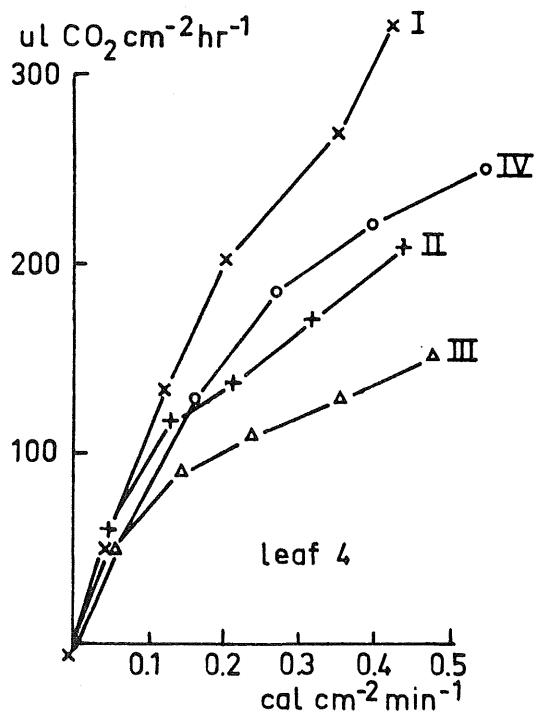
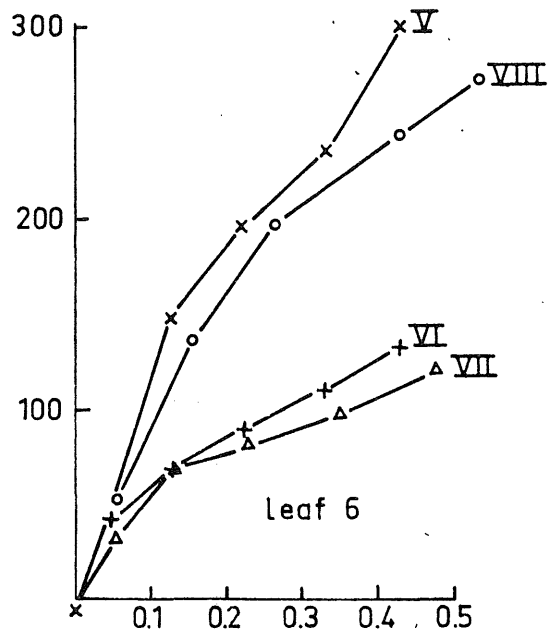
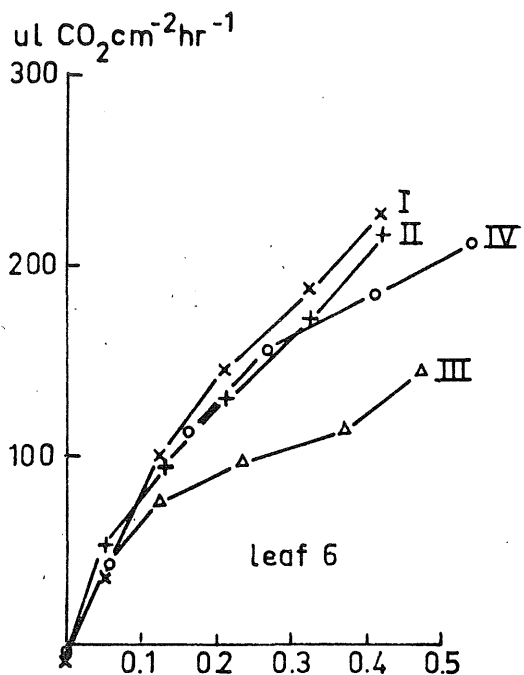
Measurement : I + II: 25°C  
III + IV: 15°C





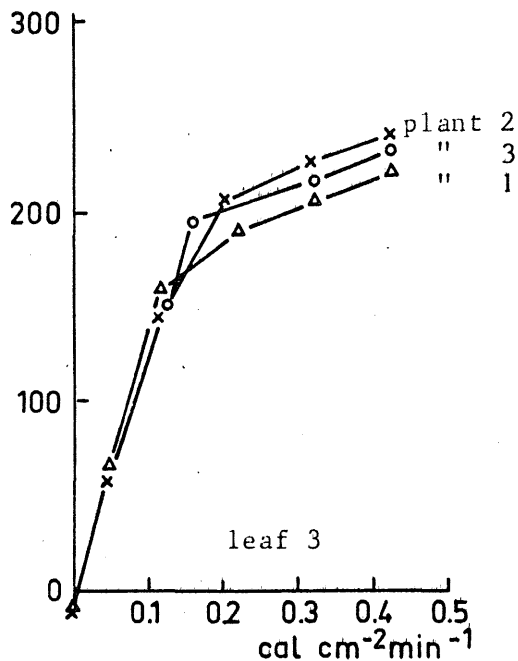
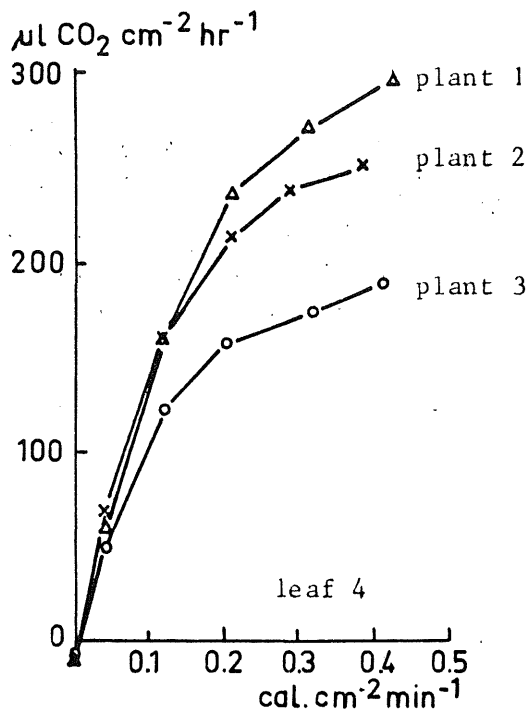
Species : Zea mays; maize  
 Scientist : Th. Alberda  
 Experiment : Effect of temperature pretreatment on CO<sub>2</sub>-assimilation at various CO<sub>2</sub>-concentrations  
 Pretreatment : climate room:  
                   20-20 = 4 weeks: day 20°C, night 20°C  
                   10-20 = 3 weeks: day 20°C, night 20°C  
                   1 week : day 10°C, night 20°C  
                   light period 17 hrs; light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
                   nutrient solution  $\frac{1}{2}$  Hoagland  
 Age : 4 weeks  
 Measurement : leaf, 25°C; 300 and 1000 ppm CO<sub>2</sub>

MAIZE

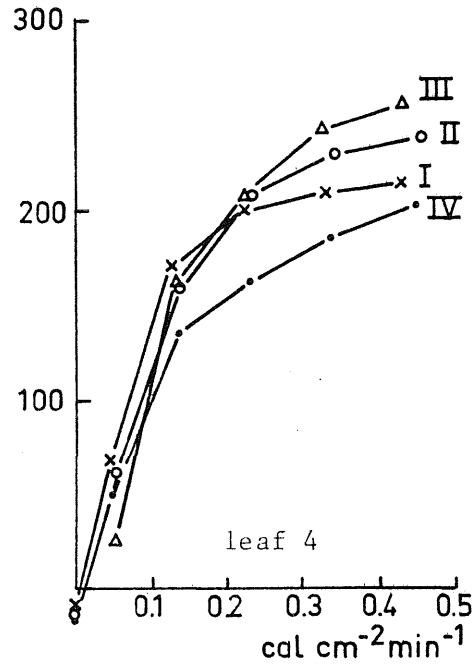
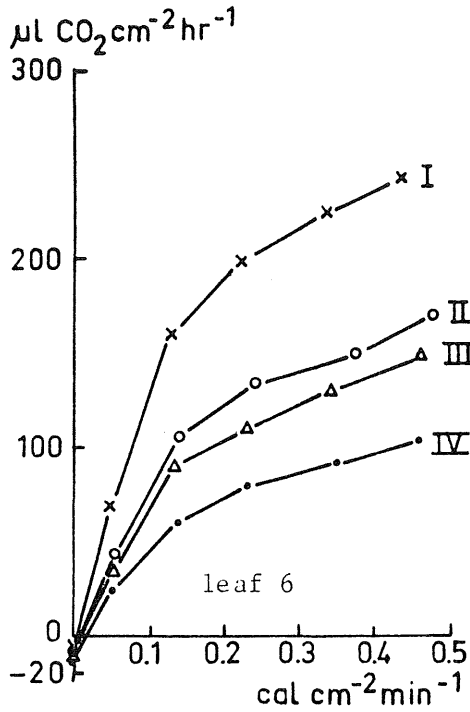


Species : Zea mays; maize  
 Scientist : Th. Alberda  
 Experiment : Effect of temperature pretreatment and leaf-aging on  
 CO<sub>2</sub>-assimilation at various CO<sub>2</sub>-concentrations  
 Pretreatment : climate room  
 temperature: see below  
 light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup>min<sup>-1</sup>  
 Age : 4 weeks  
 Measurement : temperature: see below  
 measurement leaf 4 and 6

		temperature pretreatment		measurement		
				temper- ature	CO <sub>2</sub>	
Figure	I	21 days 20°C	4 days 10°C	3 days		
		day 10°C/night 20°C			25°C	1000 ppm
	II	20°C			15°C	1000 ppm
	III	20°C			15°C	300 ppm
	IV	21 days 20°C	4 days 10°C	3 days		
		day 10°C/night 20°C			25°C	300 ppm
	V	20°C			25°C	1000 ppm
	VI	21 days 20°C	4 days 10°C	3 days		
		day 10°C/night 20°C			15°C	1000 ppm
	VII	21 days 20°C	4 days 10°C	3 days		
		day 10°C/night 20°C			15°C	300 ppm
	VIII	20°C				300 ppm



Species : Zea mays; maize  
 Scientist : Th. Alberda  
 Experiment : Effect of temperature pretreatment and leaf-aging on CO<sub>2</sub>-assimilation  
 Pretreatment : plant 1 - climate room 25°C (4 full grown leaves)  
                   plant 2 - " " 25°C (4 full grown leaves)  
                   plant 3 - " " 20°C (3 full grown leaves)  
                   light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
                   nutrient solution ½ Hoagland  
 Age : 6 weeks  
 Measurement : leaf, plant 1: 25°C  
                   " 2: 25°C  
                   " 3: 20°C



Species : Zea mays; maize

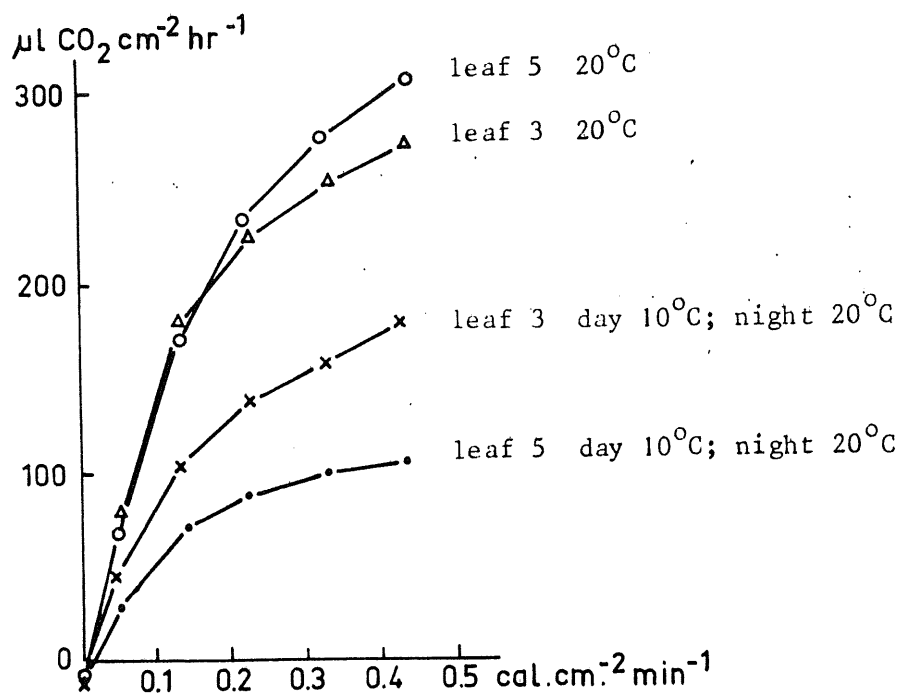
Scientist : Th. Alberda

Experiment : Effect of temperature pretreatment and leaf-aging on CO<sub>2</sub>-assimilation

Pretreatment : I 20°C  
 II 19 days 20°C, 7 days 10°C, at night 20°C. 2 days 20°C  
 III 19 " 20°C, 8 " " " 1 day 20°C  
 IV 19 " 20°C, 9 " " " "  
 light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>

Age : 4 weeks

Measurement : 2 different leaves of one plant, 25°C



Species : Zea Mays; maize

Scientist : Th. Alberda

Experiment : Effect of temperature pretreatment and leaf-aging on CO<sub>2</sub>-assimilation

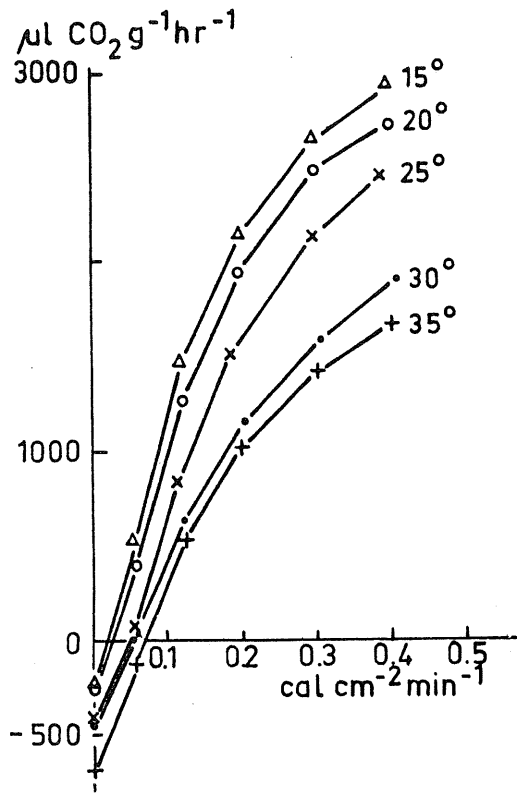
Pretreatment : climate room

temperature see figure

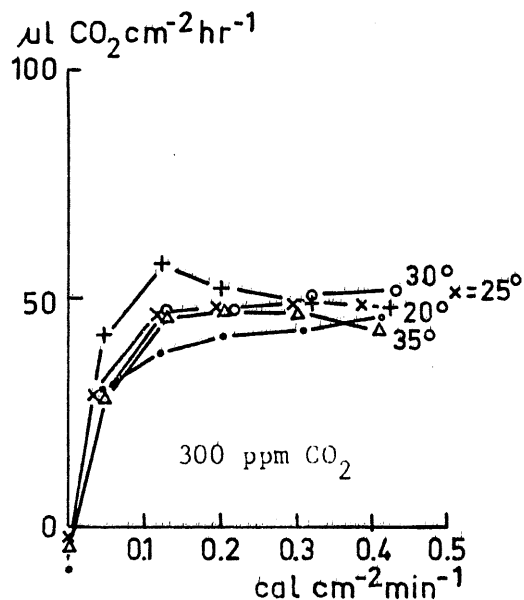
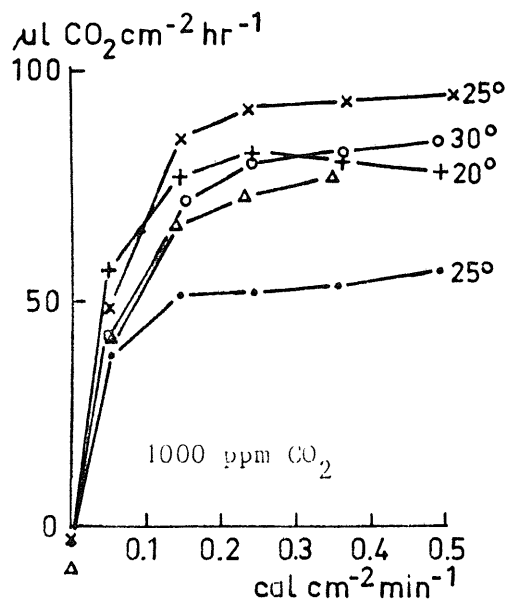
light period 17 hrs, light intensity  $0.08 \text{ cal cm}^{-2} \text{ min}^{-1}$

Age : ?

Measurement : leaf 25°C

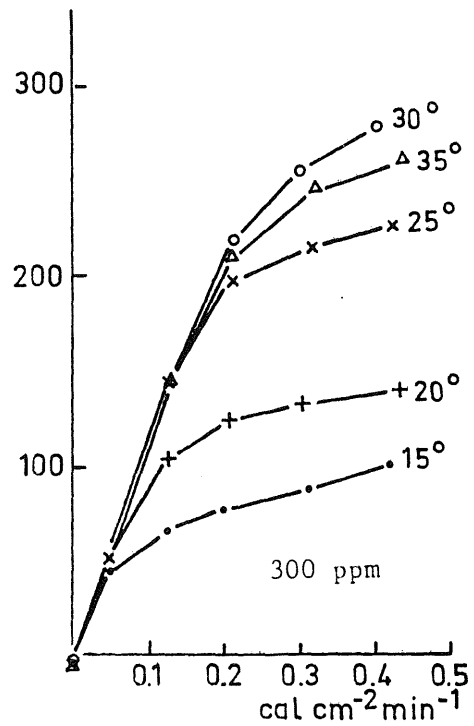
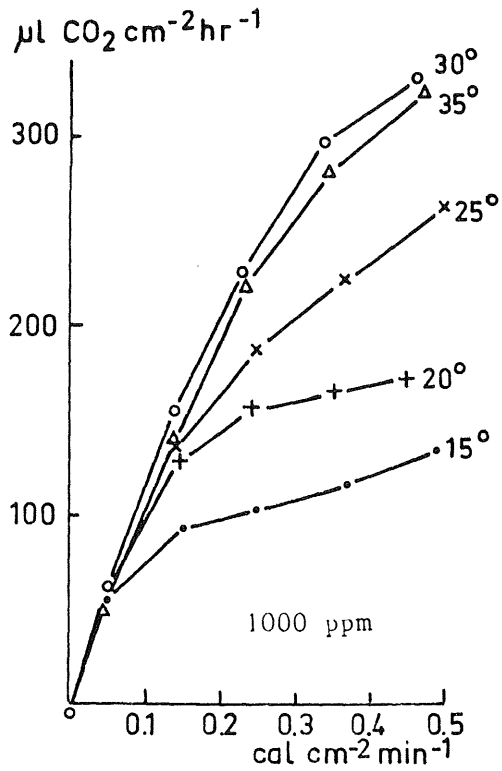


Species : *Stipa capensis*  
Scientist : Th. Alberda  
Experiment : Effect of temperature on CO<sub>2</sub>-assimilation  
Pretreatment : climate room 20°C  
light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
nutrient solution  $\frac{1}{2}$  Hoagland  
+ last 2 weeks aeration  
Age : 7 weeks  
Measurement : shoot

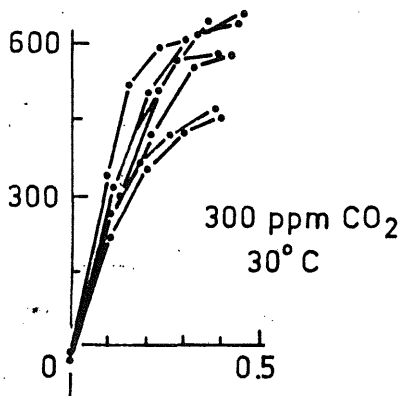
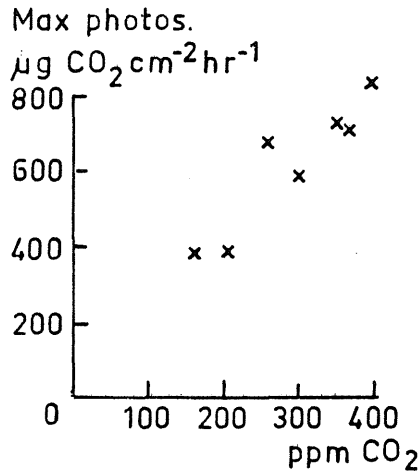
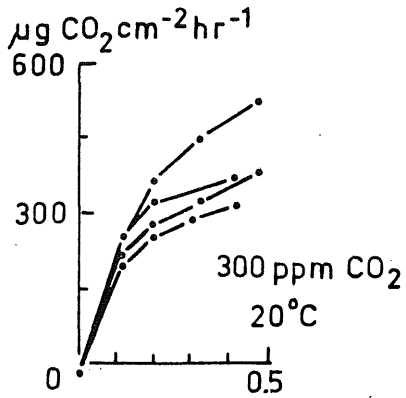


Species : *Phaseolus vulgaris*; brown bean  
 Scientist : Th. Alberda  
 Experiment : Effect of temperature and CO<sub>2</sub>-concentration on CO<sub>2</sub>-assimilation  
 Pretreatment : climate room 25°C  
 light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
 nutrient solution  $\frac{1}{2}$  Hoagland  
 Age : 3 weeks  
 Measurement : second ternate leaf, conditions see figure

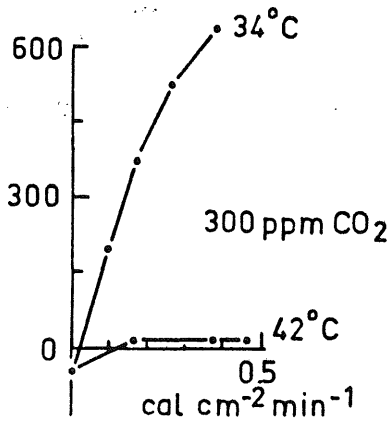


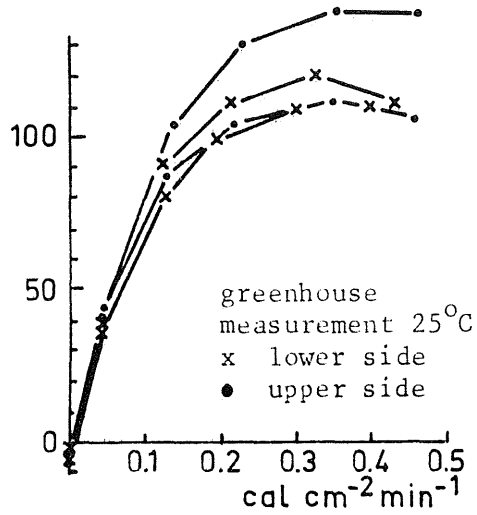
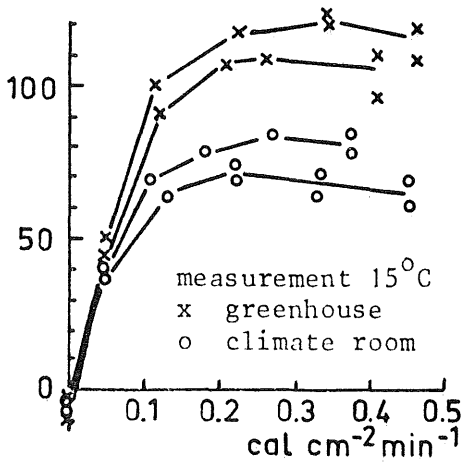
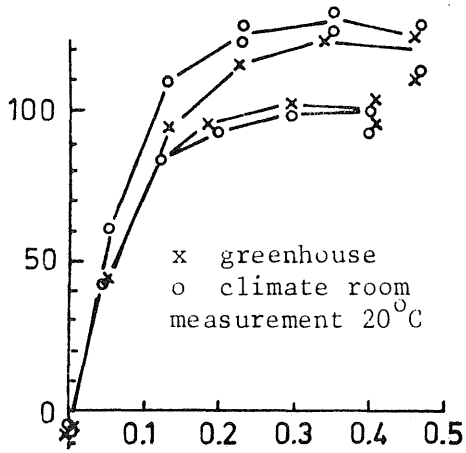
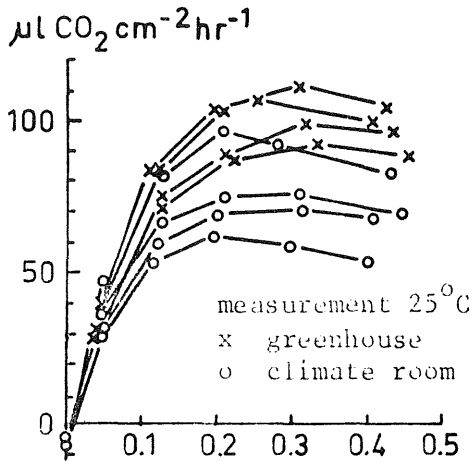


Species : Zea mays; maize  
 Scientist : Th. Alberda  
 Experiment : Effect of temperature and CO<sub>2</sub>-concentration on CO<sub>2</sub>-assimilation  
 Pretreatment : climate room 25°C  
 light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
 nutrient solution  $\frac{1}{2}$  Hoagland  
 Age : 3 weeks  
 Measurement : leaf 6



Species : Zea mays, maize  
 Scientist : H. van Keulen, F.W.T. Penning de Vries  
 Experiment : Effect of temperature and  $\text{CO}_2$ -concentration on photosynthesis  
 Pretreatment : greenhouse +  $20^\circ\text{C}$  (July 1972) nutrient solution  $\frac{1}{2}$  Hoagland  
 Age : 18 days  
 Measurement : temperature: see figures leaf 4  $300 \text{ ppm CO}_2$





Species : *Lolium perenne* 4N,  
ryegrass

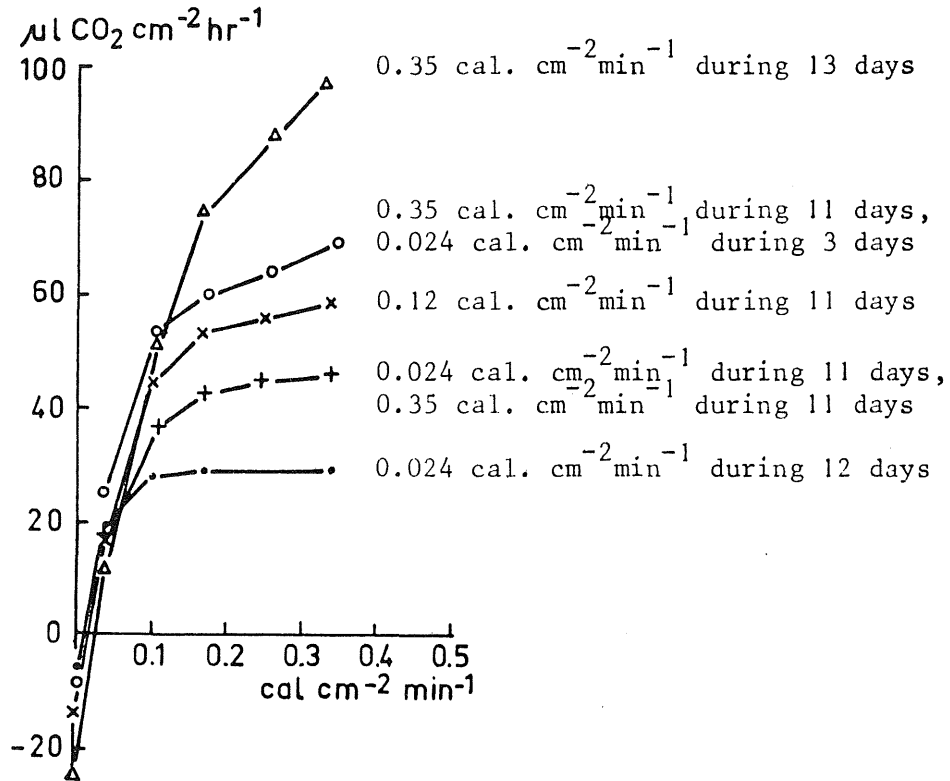
Scientist : Th. Alberda

Experiment : Effect of light  
pretreatment on  
CO<sub>2</sub>-assimilation

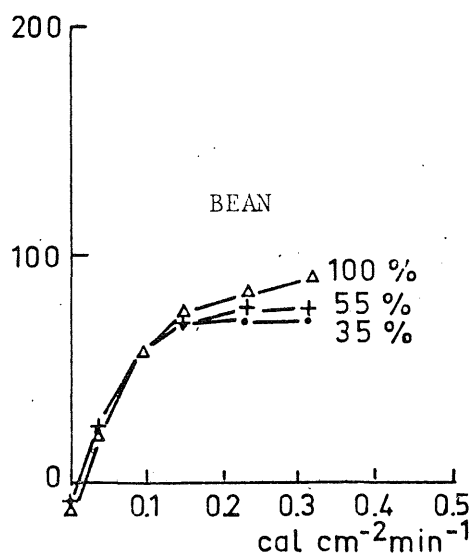
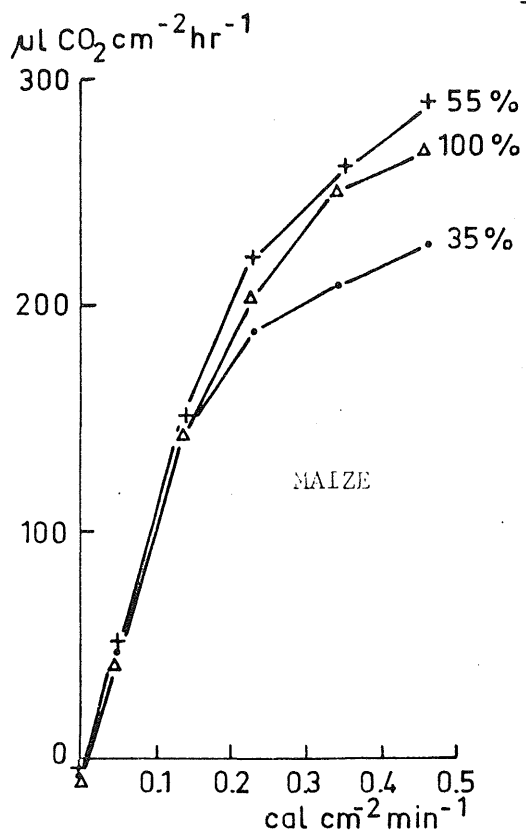
Pretreatment : greenhouse 15°C  
climate room 15°C  
light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>;  
light period 17 hrs.  
nutrient solution:  
½ Hoagland

Measurement : youngest full grown  
leaf of vegetative  
shoots;  
temperature see figure

Age : greenhouse: planted  
10 weeks  
climate room: planted  
3 months



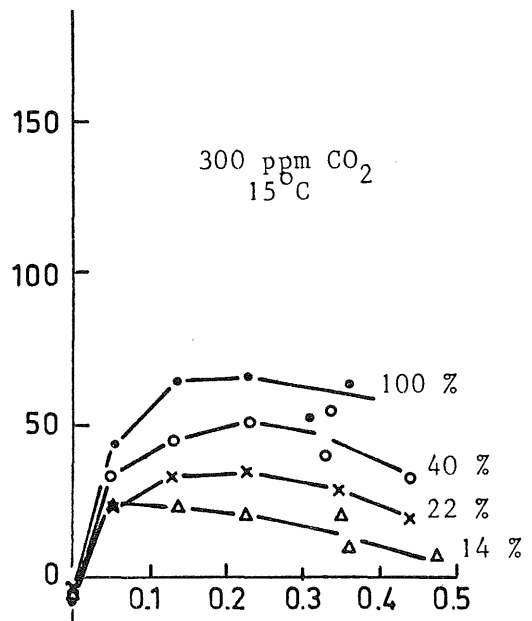
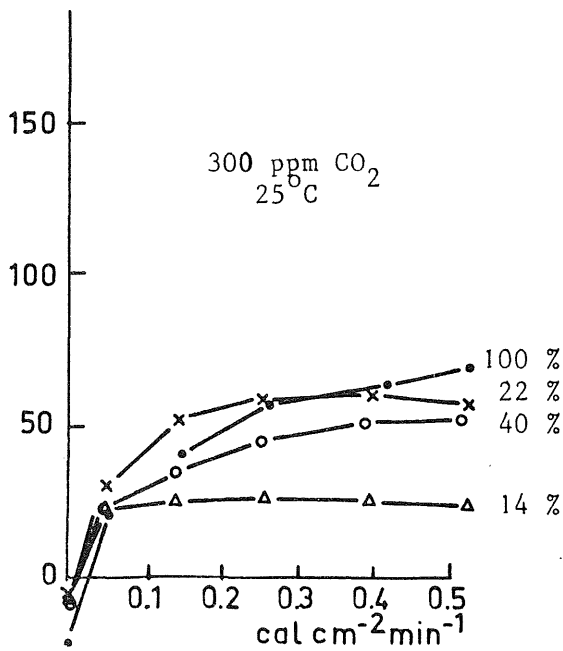
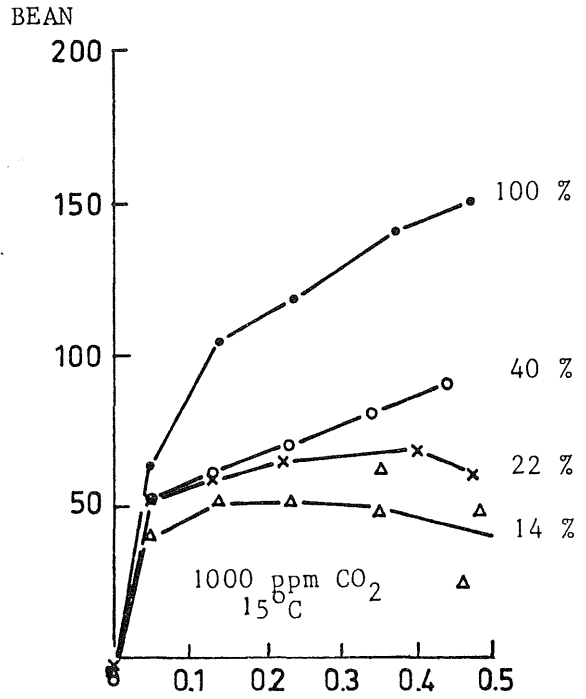
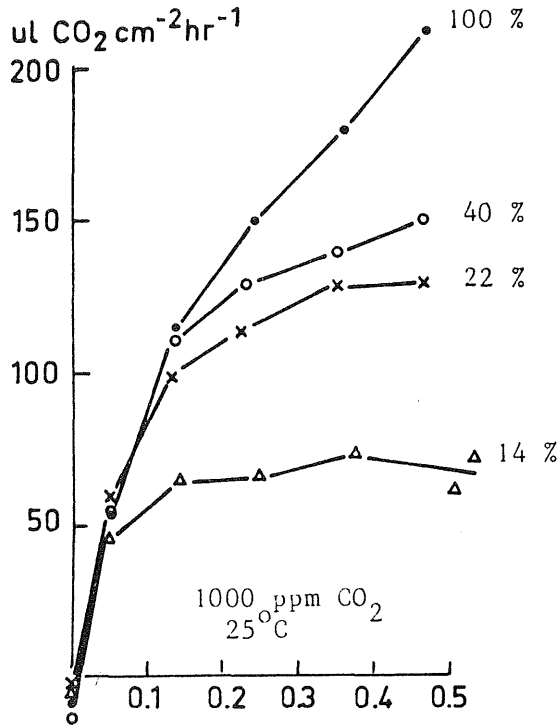
Species : *Phaseolus vulgaris*; brown bean  
Scientist : W. Louwerse  
Experiment : Effect of light intensity pretreatment on  $\text{CO}_2$ -assimilation  
Pretreatment : climate room  $20^\circ\text{C}$   
light period 17 hrs, light intensity: see figure  
nutrient solution  $\frac{1}{2}$  Hoagland  
Age : 18-21 days  
Measurement : primary leaves (cotyledons)  $25^\circ\text{C}$



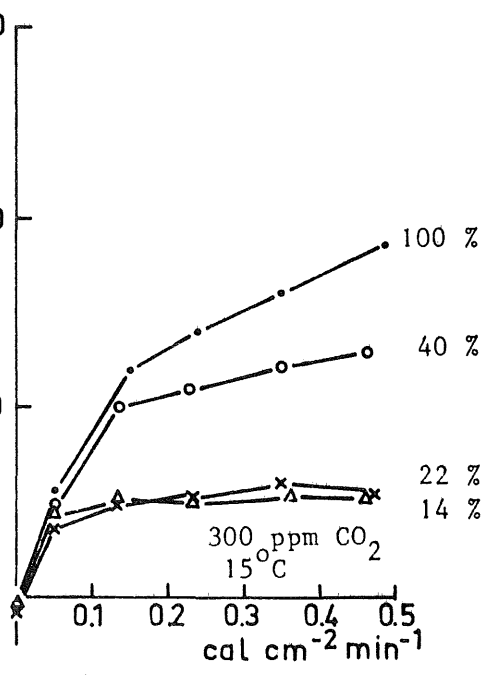
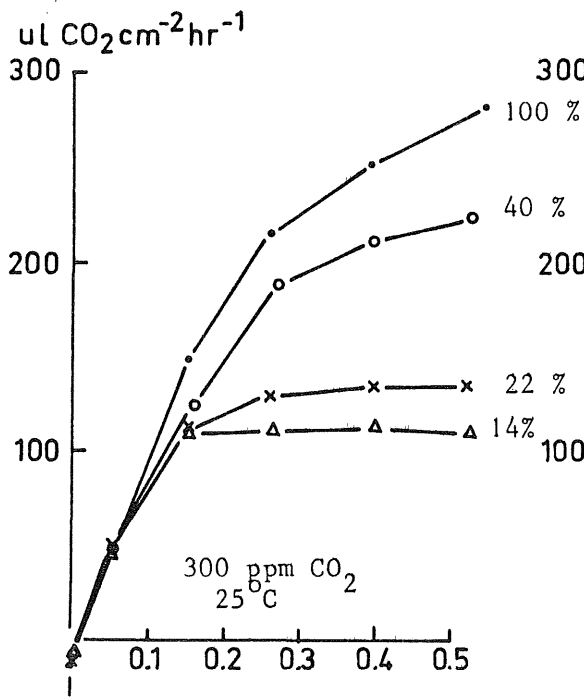
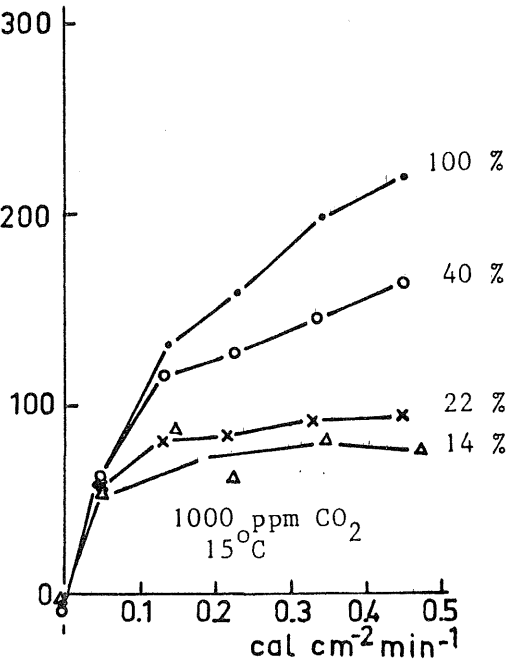
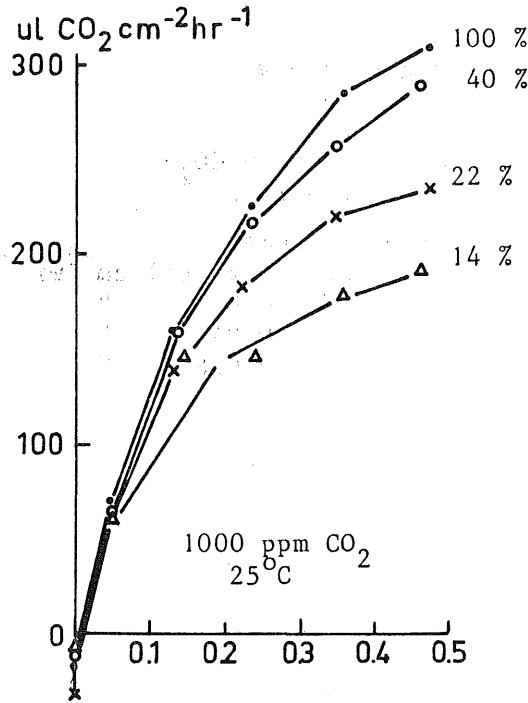
Species : Zea mays, maize; Phaseolus vulgaris, brown bean  
Scientist : Th. Alberda  
Experiment : Effect of light intensity pretreatment on CO<sub>2</sub>-assimilation  
Pretreatment : greenhouse 20°C  
light intensity: see figures  
nutrient solution ½ Hoagland  
Age : ± 4 weeks  
Measurement : leaf 25°C



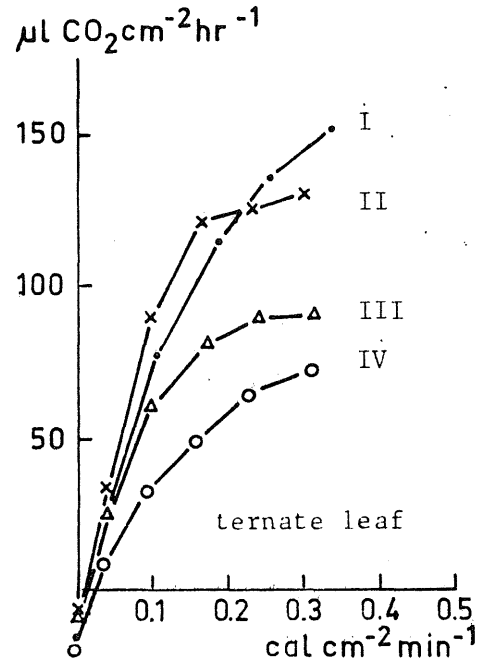
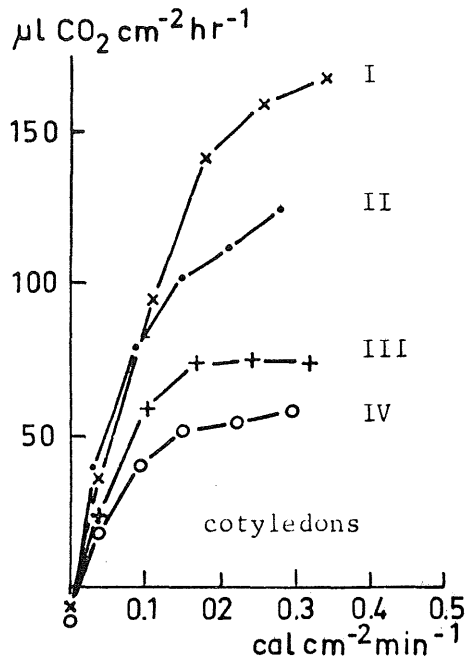








Species : Zea mays; maize, Phaseolus vulgaris; bean  
Scientist : Th. Alberda  
Experiment : Effect of light intensity pretreatment on CO<sub>2</sub>-  
assimilation at various CO<sub>2</sub>-concentrations  
Pretreatment : Plants are grown at 20°C in climate rooms.  
Light intensity 100 % corresponds with 0.2 cal cm<sup>-2</sup> min<sup>-1</sup>  
" " 40 % " " 0.08 "  
" " 22 % " " 0.044 "  
" " 14 " " 0.028 "  
Age : maize : 4 weeks  
beans : 3 weeks  
Measurement : maize : 6th leaf  
beans : 3rd ternate leaf  
temperature and CO<sub>2</sub>-concentration see figure

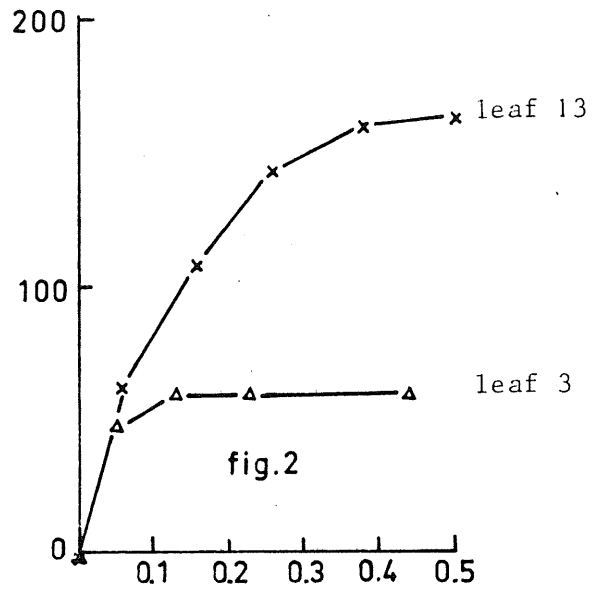
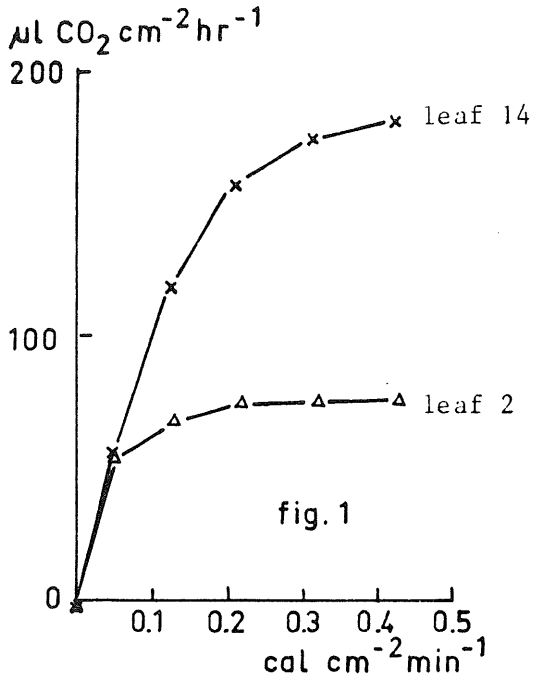


Species : Phaseolus vulgaris; brown bean  
 Scientist : Th. Alberda  
 Experiment : Effect of light intensity pretreatment and leaf-aging  
 on CO<sub>2</sub>-assimilation at various CO<sub>2</sub>-concentrations  
 Pretreatment :

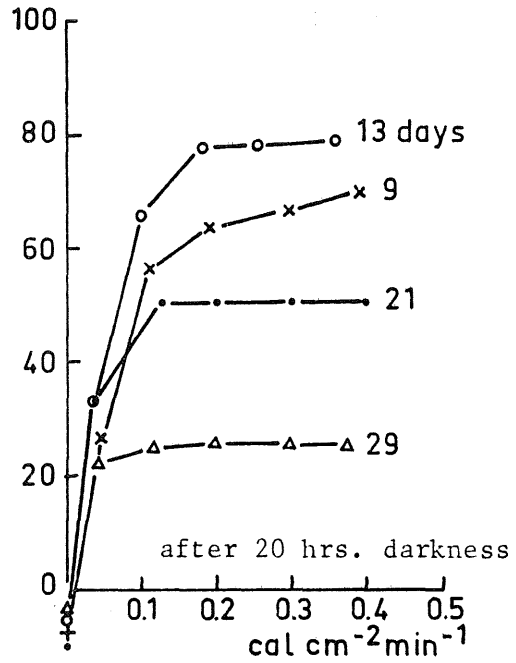
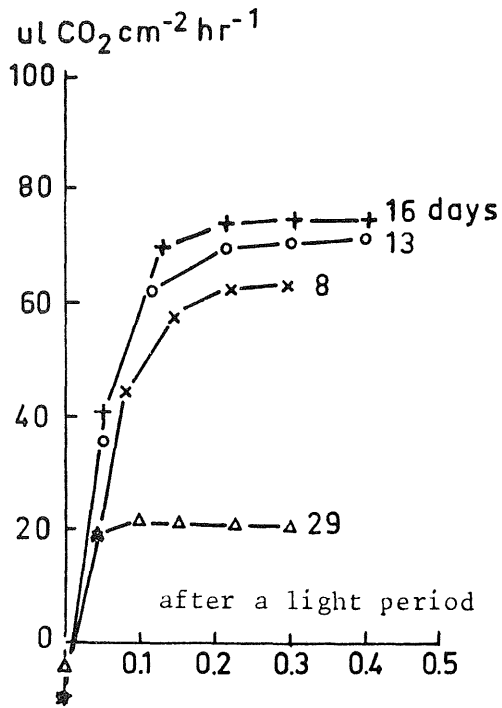
cotyledons		ternate leaf	
I	greenhouse 25°C 1000 ppm CO <sub>2</sub>	I	climate room 20°C light 0.2 cal cm <sup>-2</sup> min <sup>-1</sup> 1000 ppm CO <sub>2</sub>
II	climate room 23°C light 0.08 cal cm <sup>-2</sup> min <sup>-1</sup> , 1000 ppm CO <sub>2</sub>	II	greenhouse 25°C, 1000 ppm CO <sub>2</sub>
III	greenhouse 25°C, 300 ppm CO <sub>2</sub>	III	greenhouse 25°C, 300 ppm CO <sub>2</sub>
IV	climate room 23°C light 0.08 cal cm <sup>-2</sup> min <sup>-1</sup> , 300 ppm CO <sub>2</sub>	IV	climate room 20°C light 0.2 cal cm <sup>-2</sup> min <sup>-1</sup> 300 ppm CO <sub>2</sub>

Age : three weeks

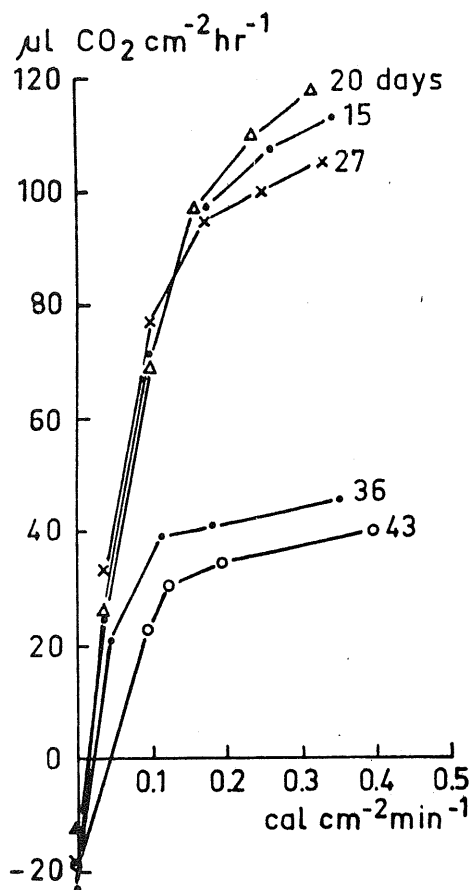
Measurement : leaf, 25°C; conditions are indicated in figure



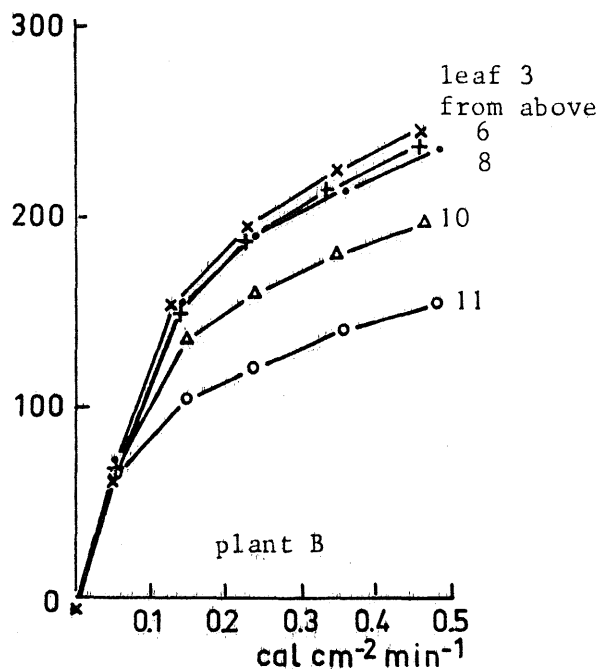
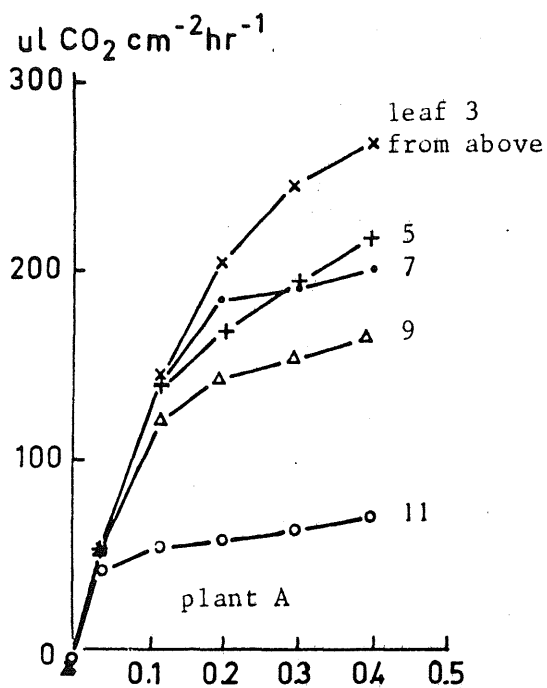
Species : Helianthus annuus; sunflower  
Scientist : W. Louwense  
Experiment : Effect of light-intensity pretreatment and leaf-aging on CO<sub>2</sub>-assimilation  
Pretreatment : greenhouse + 23°C  
nutrient solution: ½ Hoagland  
Age : 2 months  
Measurement : leaf, 25°C  
fig. 1. plant after 17 hrs. darkness  
fig. 2. plant after 0.5 hr darkness



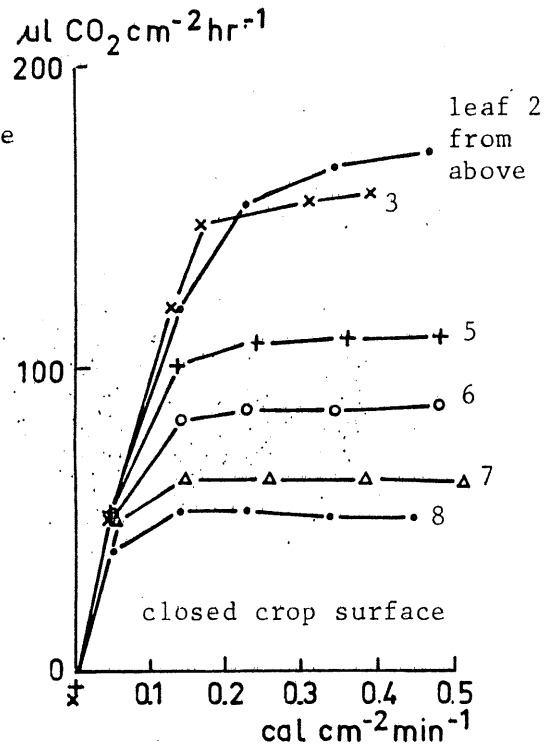
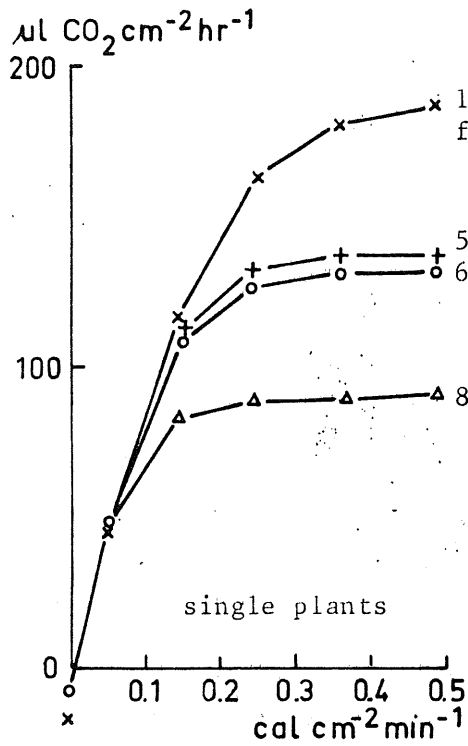
Species : *Phaseolus vulgaris*; brown bean  
Scientist : W. Louwerse  
Experiment : Effect of leaf-aging on CO<sub>2</sub>-assimilation  
Pretreatment : climate room 20°C  
light period 17 hrs; light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
Age : see figure  
Measurement : cotyledons, 25°C



Species : Cucumis sativus; cucumber  
Scientist : W. Louwarse  
Experiment : Effect of leaf-aging on CO<sub>2</sub>-assimilation  
Pretreatment : climate room 20°C  
light period 17 hrs; light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
nutrient solution ½ Hoagland  
Age : see figure  
Measurement : first and second secondary leaves, 25°C

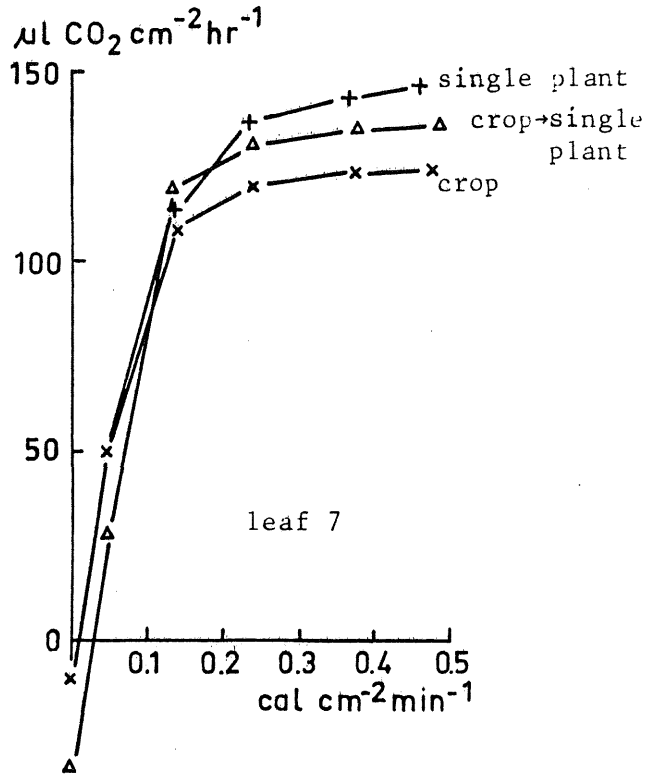
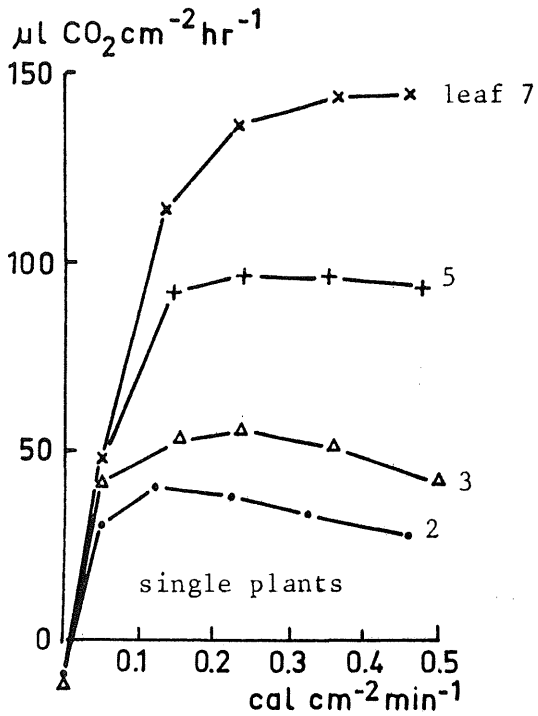


Species : Zea mays; maize  
 Scientist : W. Louwerse  
 Experiment : Effect of leaf-aging on CO<sub>2</sub>-assimilation  
 Pretreatment : greenhouse 23°C  
 nutrient solution  $\frac{1}{2}$  Hoagland  
 Age : 10 weeks (plants have 14 leaves)  
 Measurement : leaf 25°C

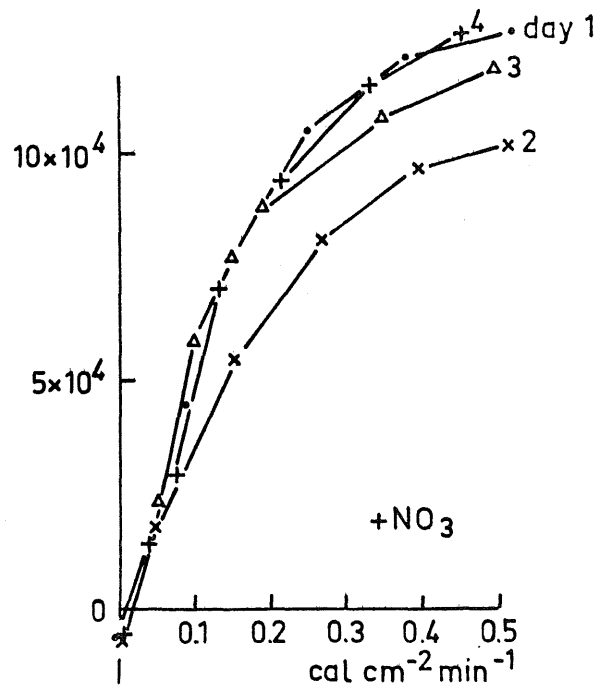
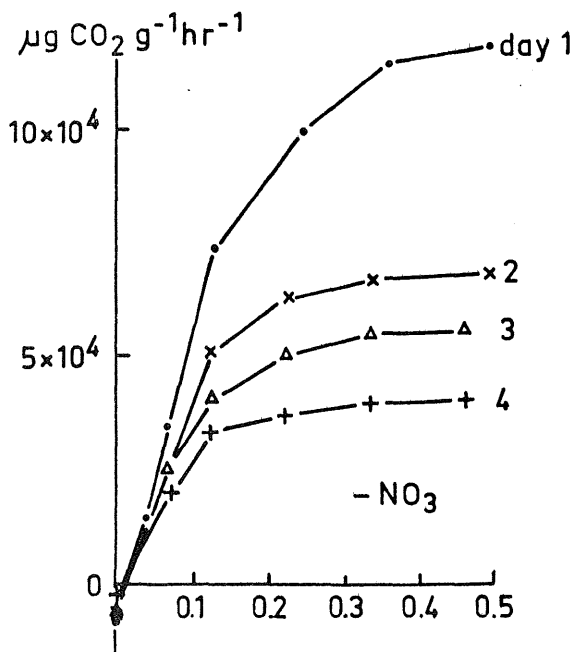
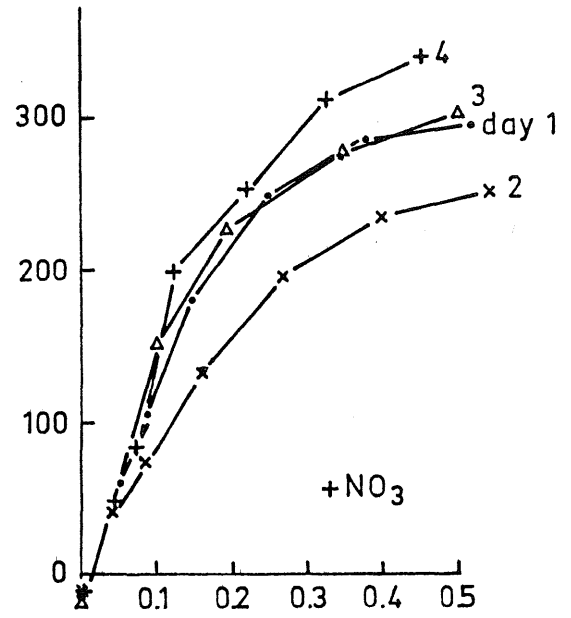
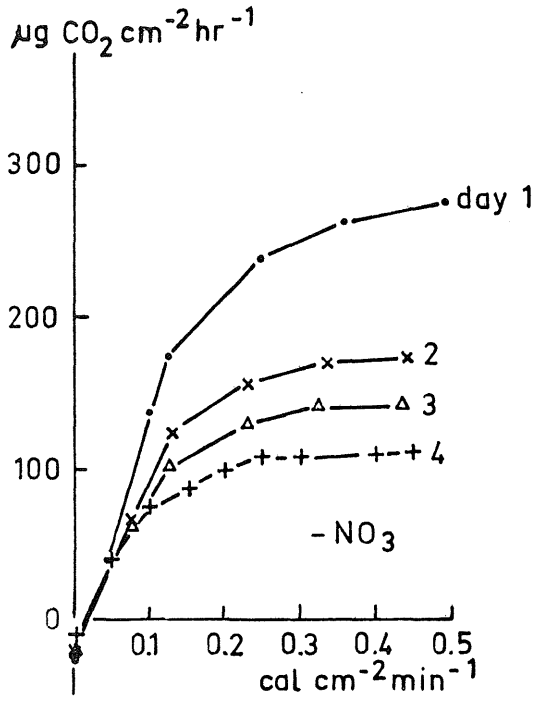


Species : Cannabis sativa; Hemp  
 Scientist : Th. Alberda  
 Experiment : Effect of leaf-aging and plant density on CO<sub>2</sub>-assimilation  
 Pretreatment : climate room 25°C  
 light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
 nutrientsolution  $\frac{1}{2}$  Hoagland  
 treatment only in the last week  
 Age : 5 weeks  
 Measurement : leaf, 25°C

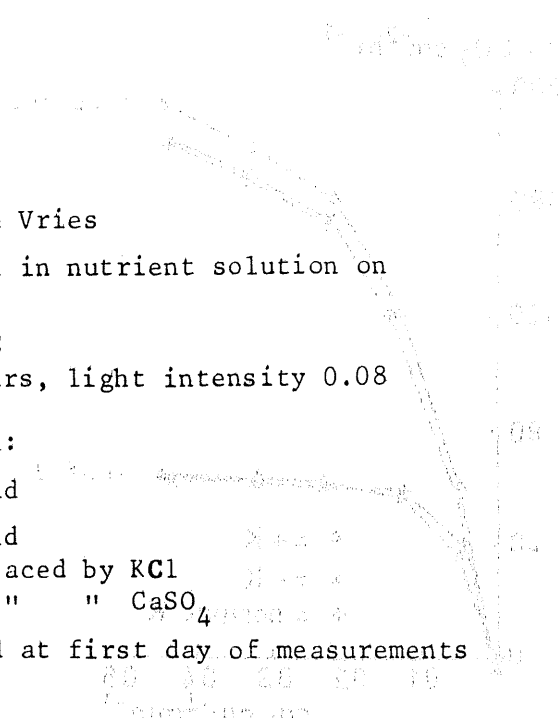


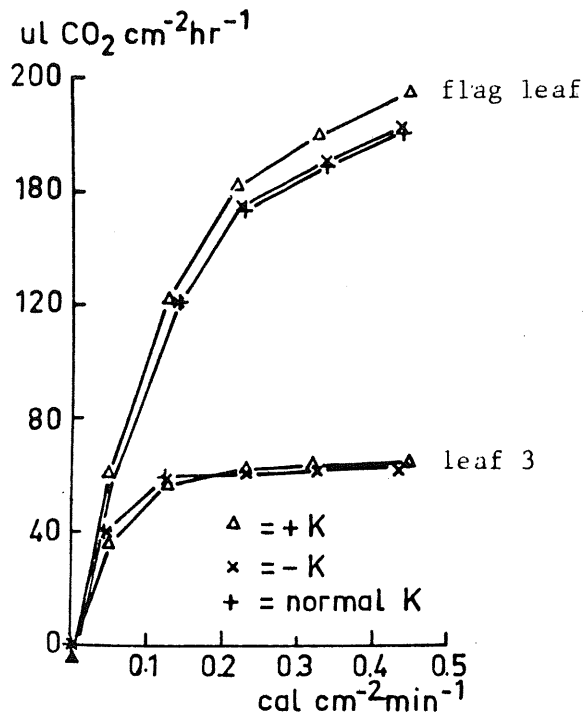


Species : Cannabis sativa; hemp  
 Scientist : Th. Alberda  
 Experiment : Effect of leaf-aging and plant density on CO<sub>2</sub>-assimilation  
 Pretreatment : climate room 20°C  
 light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
 nutrient solution ½ Hoagland  
 Age : ?  
 Measurement : leaf 25°C



Species : Zea mays; maize  
Scientist : F.W.T. Penning de Vries  
Experiment : Effect of nitrate in nutrient solution on CO<sub>2</sub>-assimilation  
Pretreatment : climate room 25°C  
light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
nutrient solution:  
+NO<sub>3</sub> ½ Hoagland  
-NO<sub>3</sub> ½ Hoagland  
KNO<sub>3</sub> replaced by KCl  
Ca(NO<sub>3</sub>)<sub>2</sub> " " CaSO<sub>4</sub>  
treatment started at first day of measurements  
Age : 10 days  
Measurement : shoot, 25°C

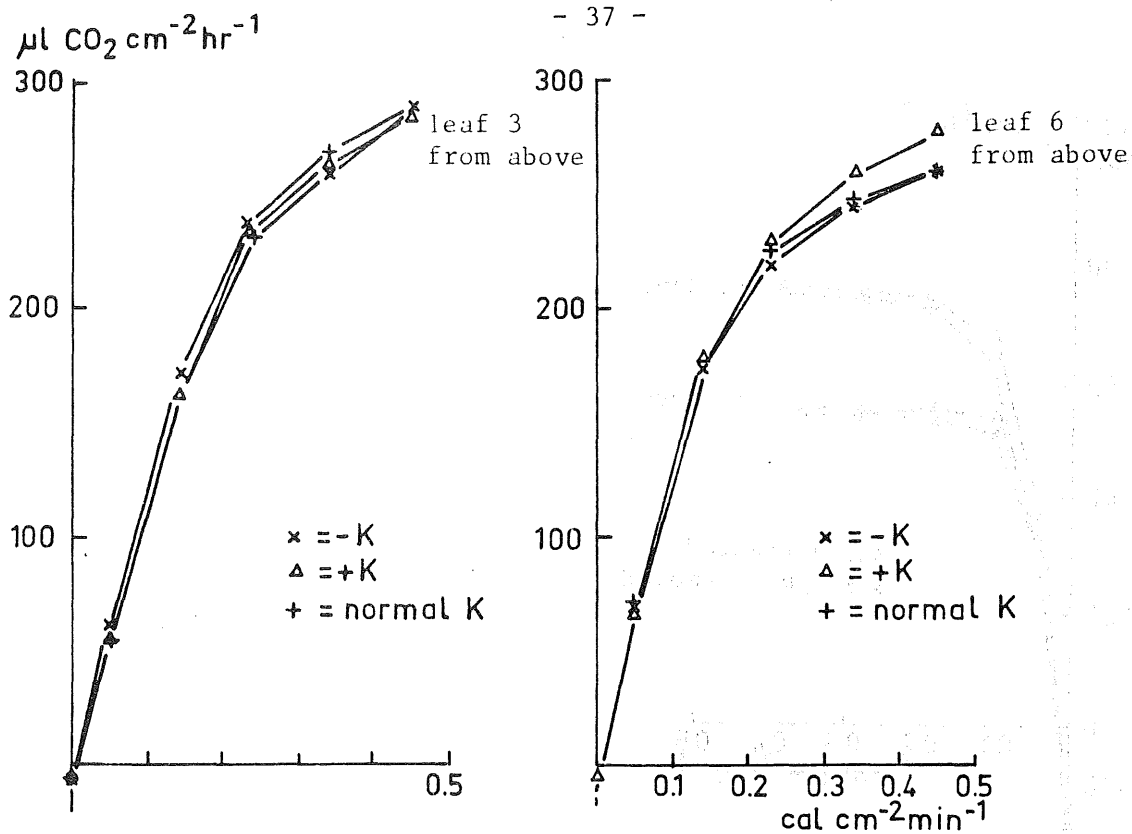




Species : Avena sativa; oats  
 Scientist : W. Louwerse  
 Experiment : Effect of Potassium in nutrient solution on CO<sub>2</sub>-assimilation  
 Pretreatment : climate room 15°C  
 light period 17 hrs, light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
 nutrient solution:

normal K	+K	-K
0.5 mmol MgSO <sub>4</sub>	normal K	0.5 mmol MgSO <sub>4</sub>
0.25 KH <sub>2</sub> PO <sub>4</sub>	+	0.25 KH <sub>2</sub> PO <sub>4</sub>
1.25 KNO <sub>3</sub>	1.87 mmol K <sub>2</sub> SO <sub>4</sub>	1.88 Ca (NO <sub>3</sub> ) <sub>2</sub>
1.25 Ca (NO <sub>3</sub> ) <sub>2</sub>		

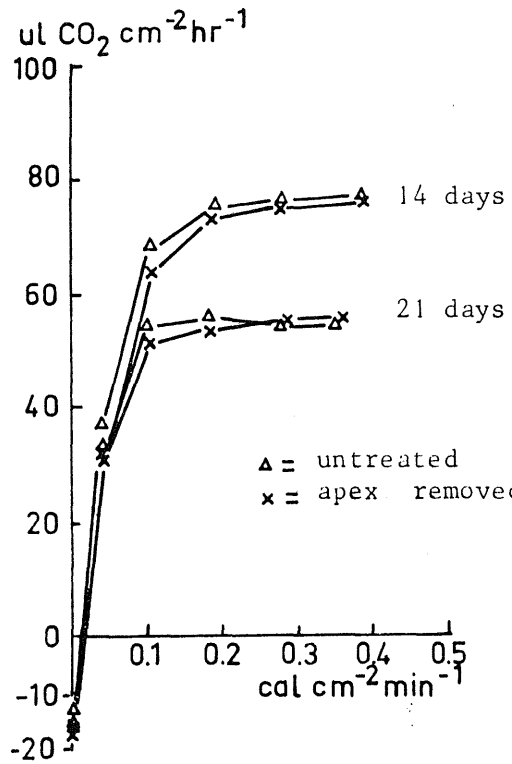
Age : 2 months  
 Measurement : leaf 25°C



Species : Zea mays; maize  
 Scientist : W. Louwse  
 Experiment : Effect of Potassium in nutrient solution on  $\text{CO}_2$ -assimilation  
 Pretreatment : climate room  $20^\circ\text{C}$   
 light period 17 hrs; light intensity  $0.08 \text{ cal cm}^{-2} \text{ min}^{-1}$   
 nutrient solution

normal K	+K	-K
0.5 mmol $\text{MgSO}_4$	normal K	0.5 mmol $\text{MgSO}_4$
0.25 $\text{KH}_2\text{PO}_4$	+	0.25 $\text{KH}_2\text{PO}_4$
1.25 $\text{KNO}_3$	1.87 mmol $\text{K}_2\text{SO}_4$	1.88 $\text{Ca}(\text{NO}_3)_2$
1.25 $\text{Ca}(\text{NO}_3)_2$		

Age : 1 month  
 Measurement : leaf  $25^\circ\text{C}$



Species : Phaseolus vulgaris; brown bean

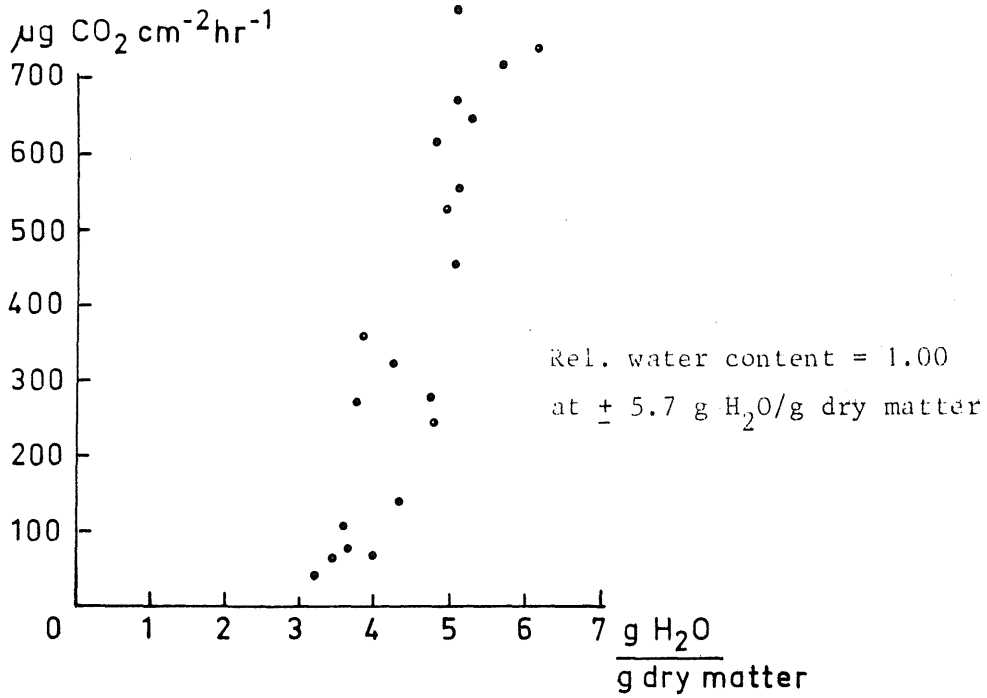
Scientist : W. Louwerse

Experiment : Effect of removing apex "sink" on CO<sub>2</sub>-assimilation

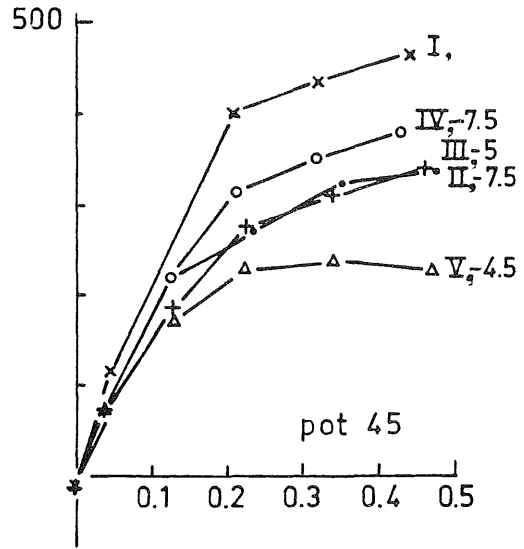
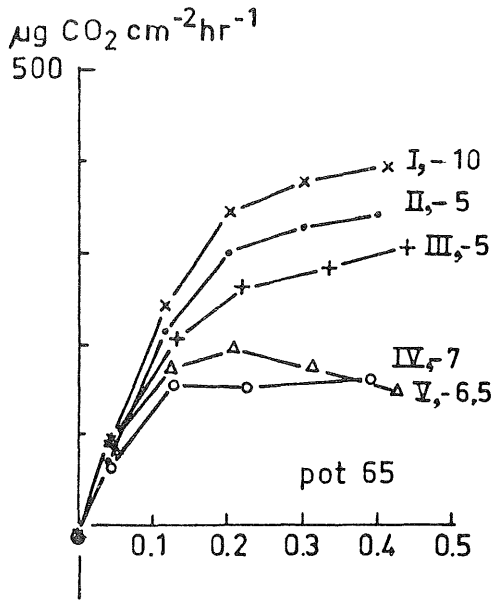
Pretreatment : climate room 20°C  
light period 17 hrs, light intensity 0.08 cm<sup>-2</sup>min<sup>-1</sup>  
apexes are removed at age of 1 week

Age : see figure

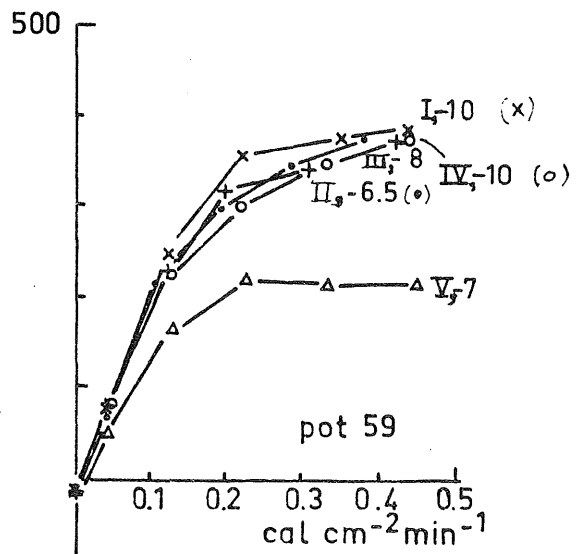
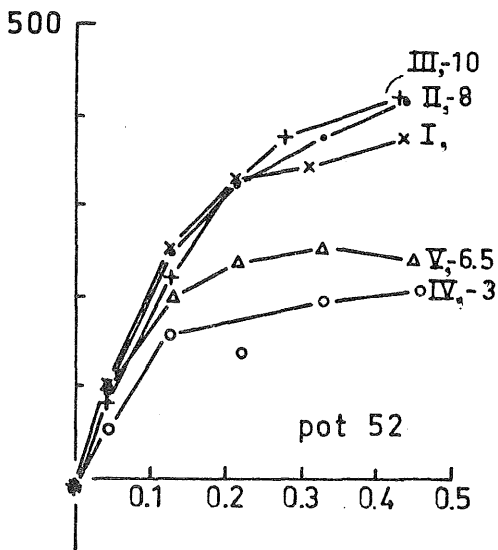
Measurement : whole plant 25°C



Species : Zea mays, maize  
Scientists : H. van Keulen, F.W.T. Penning de Vries  
Experiment : Effect of relative water content on photosynthesis  
Pretreatment : greenhouse  $\pm 20^{\circ}\text{C}$  (July, 1972)  
nutrient solution  $\frac{1}{2}$  Hoagland  
Age : 18 days  
Measurement : leaf 4, 300 ppm CO<sub>2</sub>  
light intensity 0.4 cal. cm<sup>-2</sup> min<sup>-2</sup>



AMARANTHUS





Species : Amaranthus hybridus cv "NON DAM"

Scientists : L. Stroosnijder and F.W.T. Penning de Vries

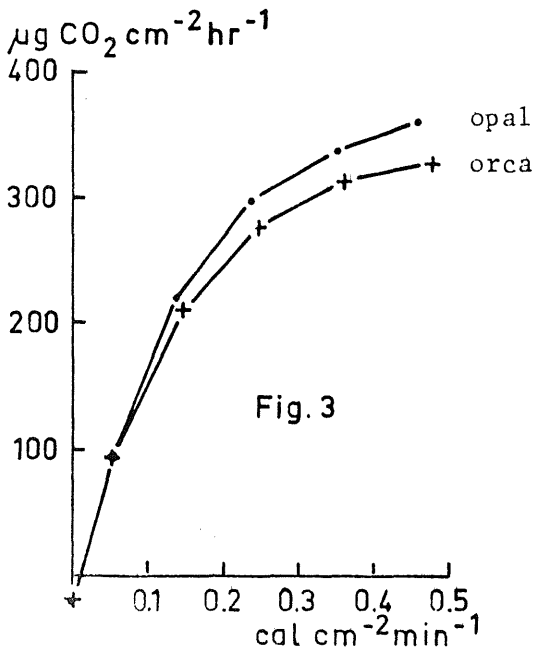
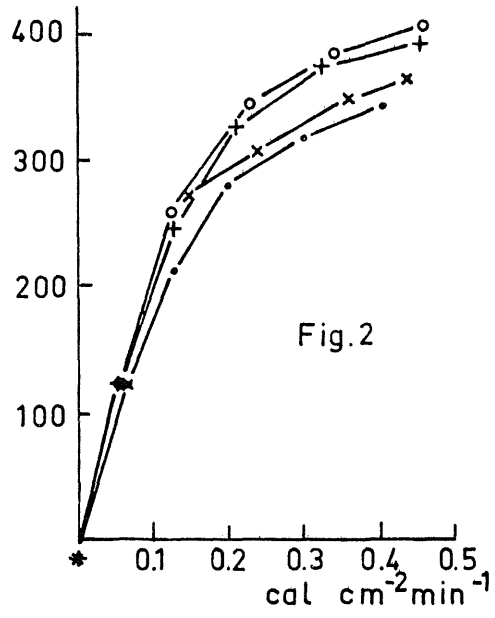
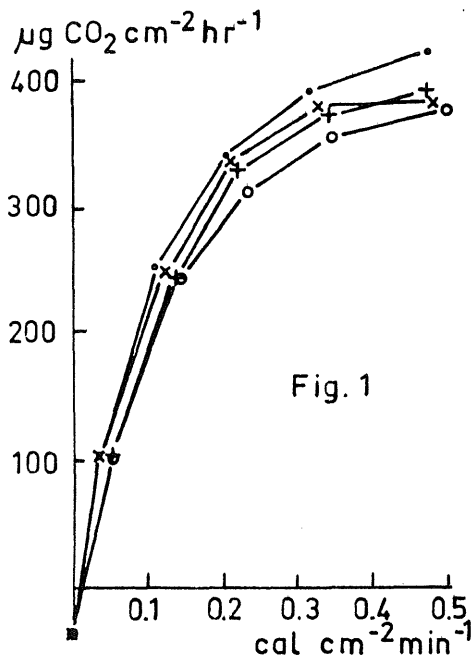
Experiment : Effect of leaf water potential on photosynthesis

Pretreatment : greenhouse 25°C, relative humidity  $\pm$  60 %,  
light intensity 17.000 lux  
grown on 5 ltr pots with loam

relative water content	pot 65	11	%	( -0.50 bar )
	" 45	15.5	%	( -0.25 " )
	" 52	6	%	( -2.50 " )
	" 59	20	%	( -0.15 " )

Age : 3 months

Measurement : Leaf, 25°C.  
Plants dried the soil from day I till day V; leaf water potentials are indicated in the figure in arabic numbers (unit: bar).  
Leaf water potential is determined by vapour exchange method.



Scientist : G. Dantuma

Fig. 1

Triticum aestivum (Artois x Mexico 43), summer wheat

Plants are grown in climate room at 16°C

Stage : flag leaf full grown, first ears appear

Measurement: flag leaf, 25°C

Fig. 2

Triticum aestivum (Jufy), summer wheat

Plants are grown in climate room at 15°C

Stage : flag leaf full grown, first ears appear

Measurement: flag leaf, 25°C

Fig. 3

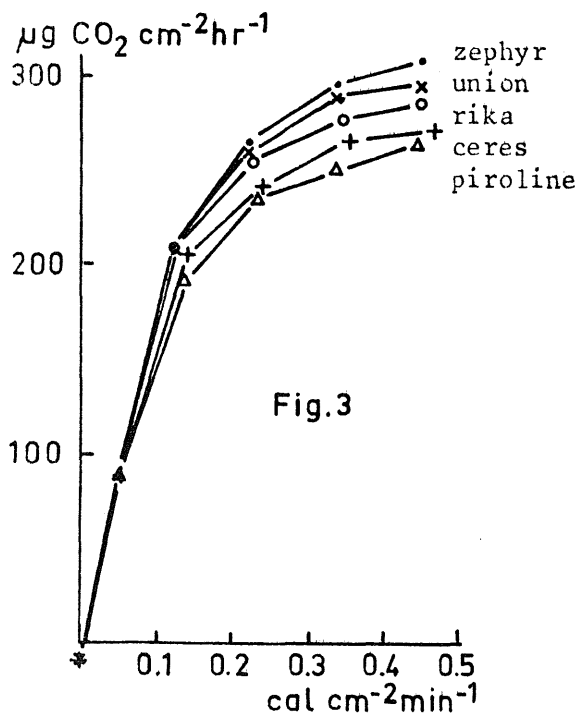
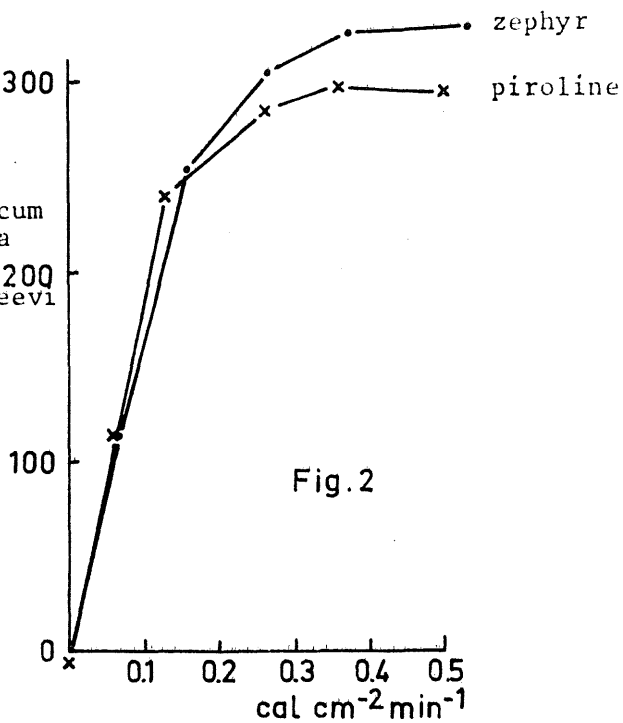
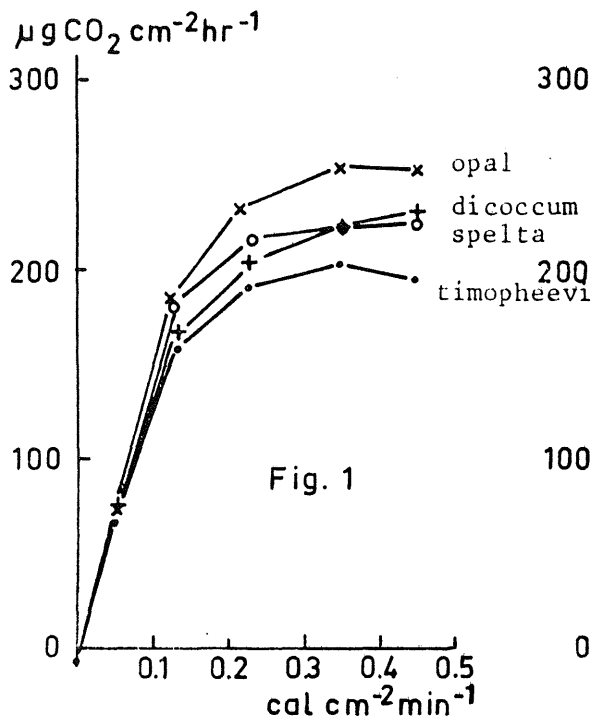
Triticum aestivum (Opal, Orca)

Plants are grown in climate room at 15°C

Stage : Opal 10<sup>+</sup> - 10.1 (first ears appear)

Orca 9 - 10 (1 flag leaf full grown)

Measurement: flag leaf, 25°C



Scientist : G. Dantuma

Fig. 1

Triticum aestivum, wheat

Plants are cultivated in pots in the field

Stage :	T. aestivum (opal)	10-4.2
	T. aestivum (dicoccum)	10
	T. aestivum (spelta)	10 <sup>-</sup>
	T. aestivum (timopheevi)	10 <sup>+</sup>

Measurement : last leaf but one, 25°C

Fig. 2

Hordeum, summer barley

Plants are grown in climate rooms at 20°C

Stage : 50 % of plants has ears

Measurement: last leaf but one, 25°C

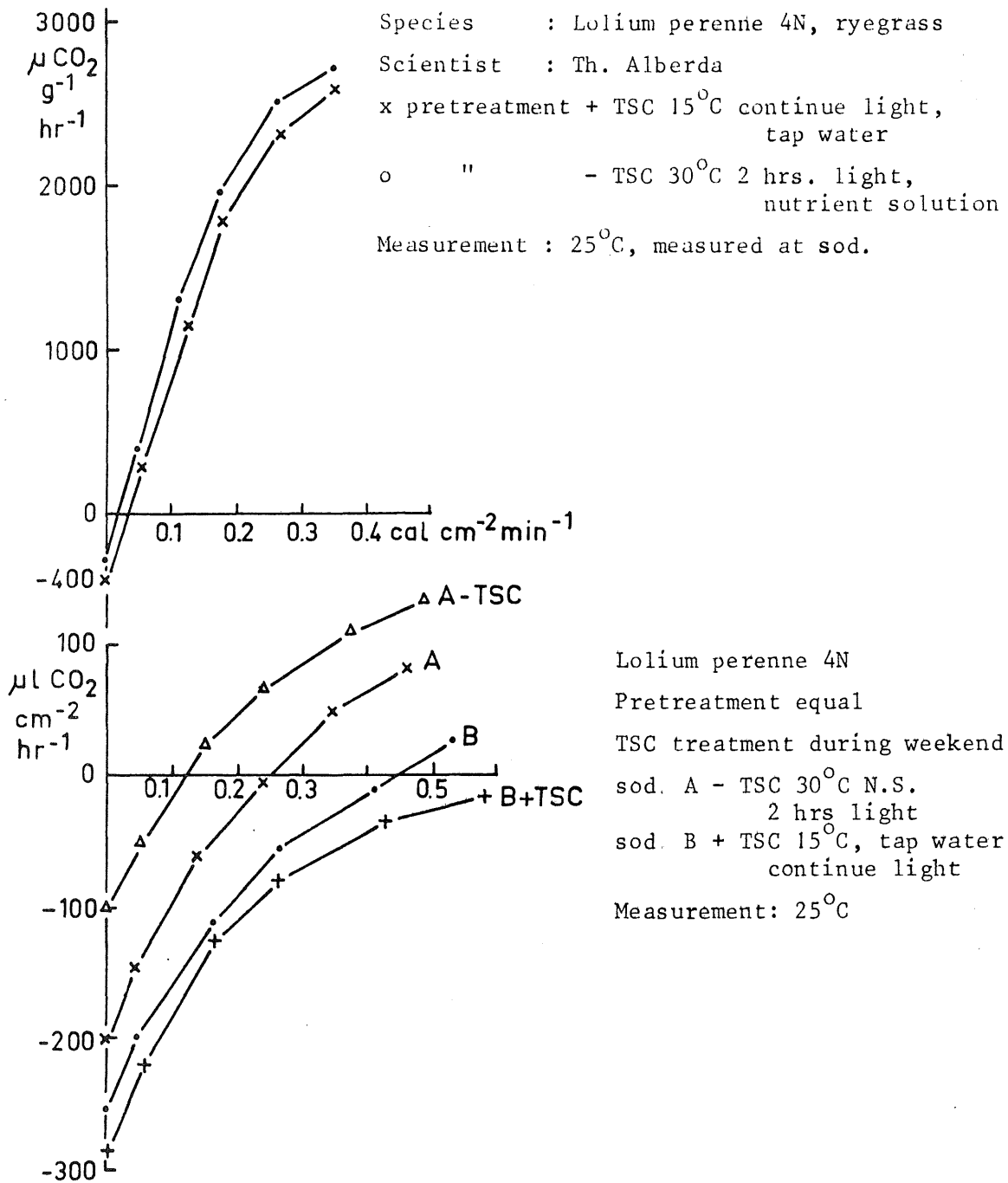
Fig. 3

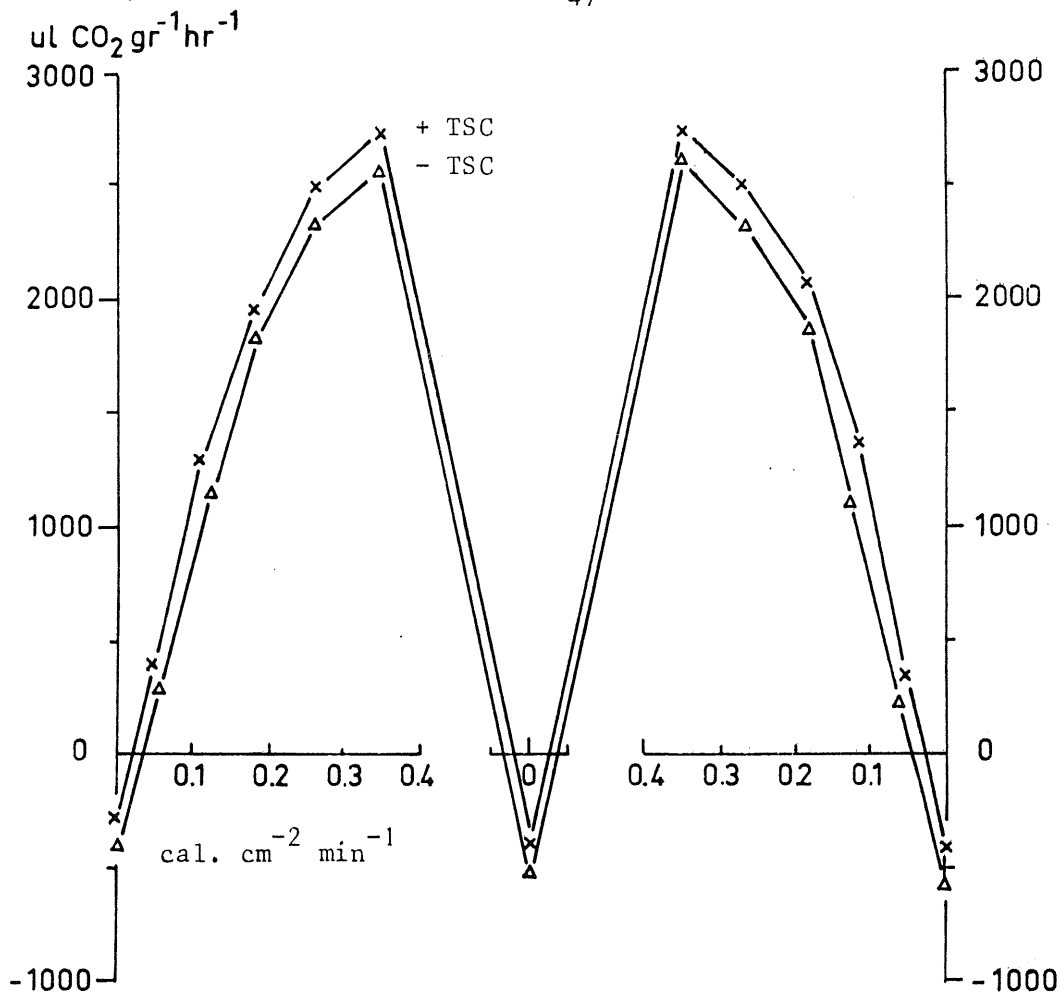
Hordeum, spring barley

Plants are grown in climate rooms at 20°C

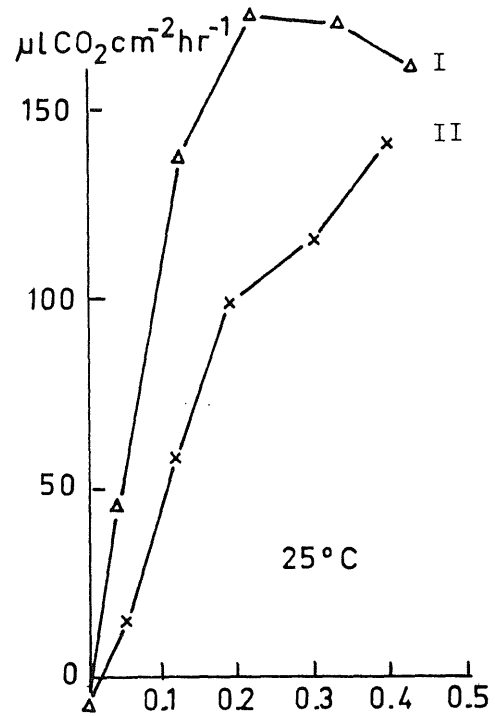
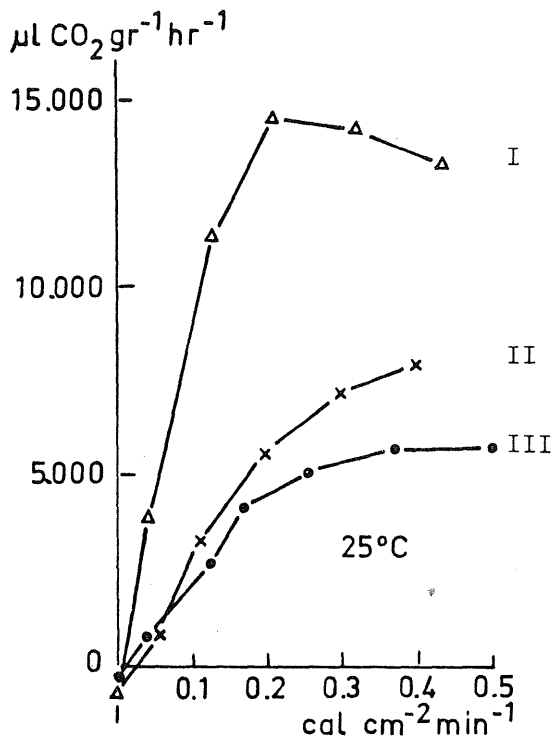
Stage : just full grown

Measurement: last leaf but one, 25°C



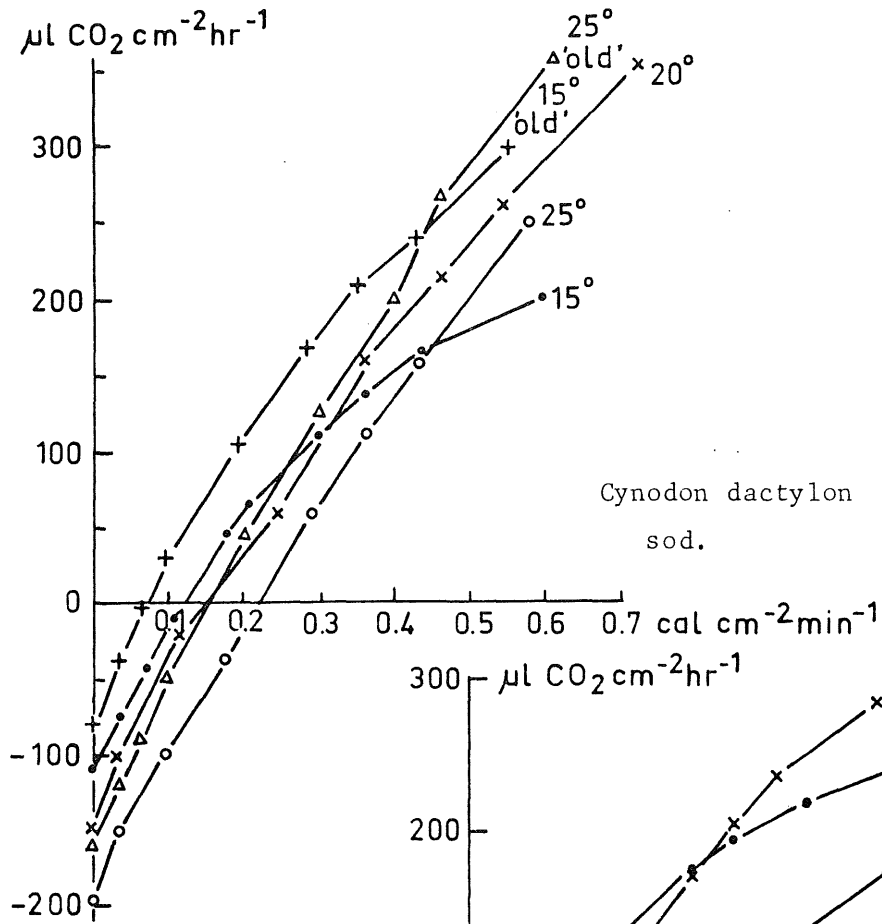


Species : *Lolium perenne* (4N); ryegrass  
Scientist : Th. Alberda  
Pretreatment : climate room, 24 hrs per day light, 15°C, plants on water (+ TSC)  
climate room, 2 hrs per day light, 30°C, plants on nutrient solution ( $\frac{1}{2}$  Hoagland), (-TSC)  
Measurement : sod; darkness, increasing light intensities, darkness, decreasing light intensities



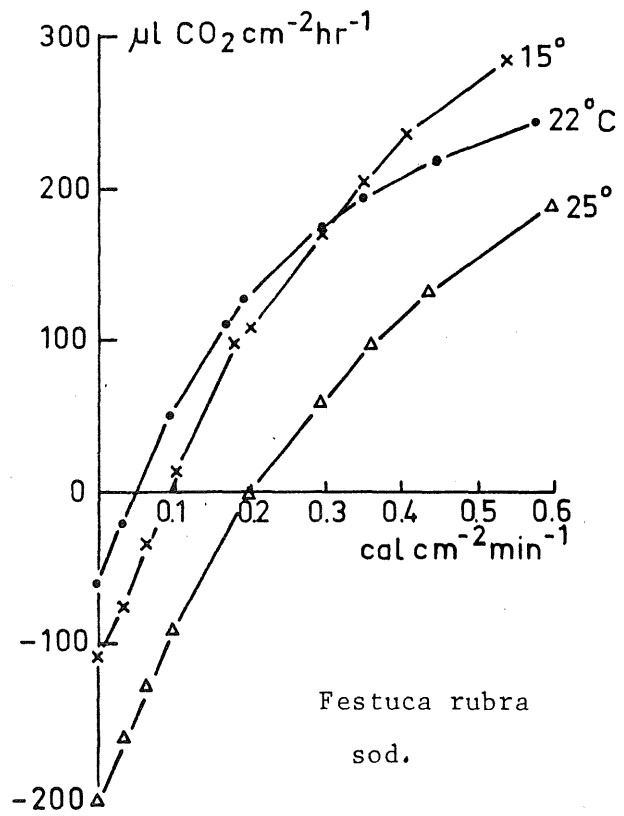
Species : Chloris gayana; Rhodes grass  
 Scientist : Th. Alberda  
 Experiment : CO<sub>2</sub>-assimilation in different assimilation chambers  
 Pretreatment : climate room 25°C  
 light period 17 hrs; light intensity 0.08 cal cm<sup>-2</sup> min<sup>-1</sup>  
 nutrient solution  $\frac{1}{2}$  Hoagland  
 Age : 5-6 weeks  
 Measurement : I chamber includes only horizontal leaves  
 II chamber includes shoots  
 III chamber includes shoots plus roots plus root medium



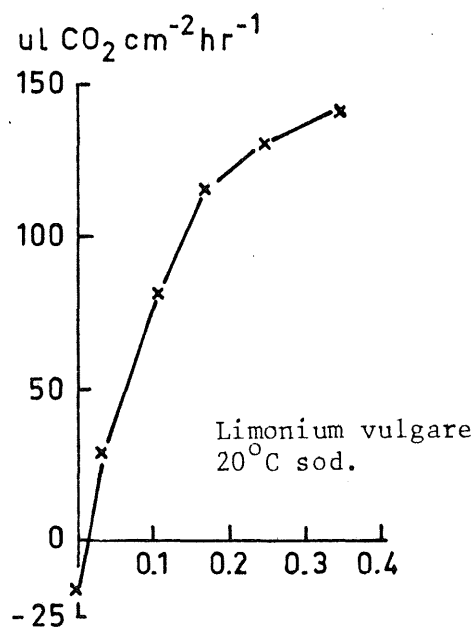
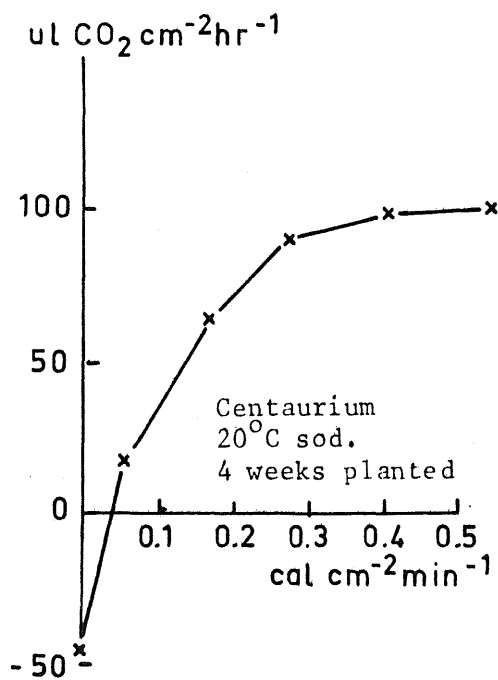
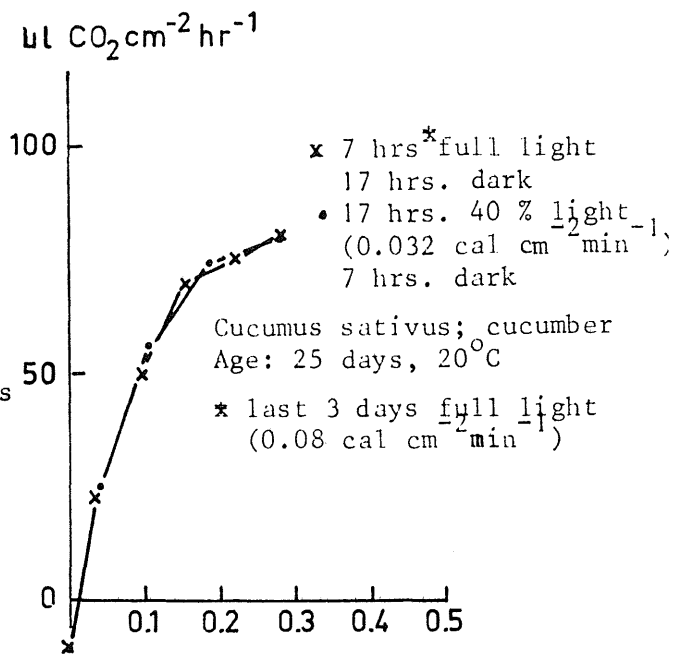
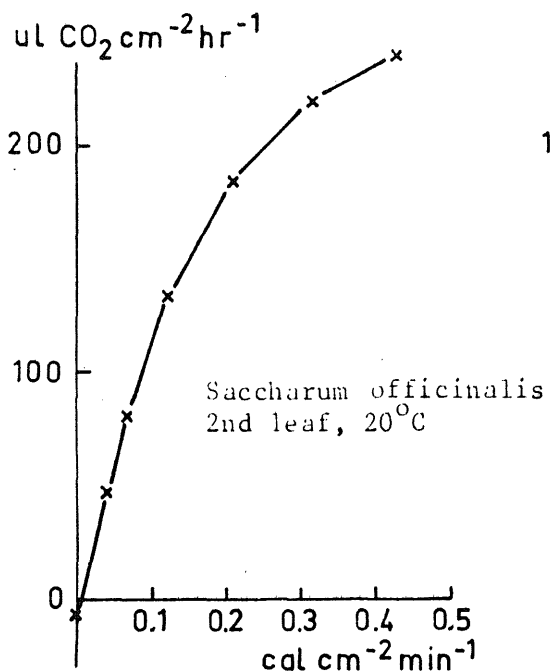


Cynodon dactylon  
sod.

Scientist: Th. Alberda



Festuca rubra  
sod.



	$\frac{\mu\text{g CO}_2}{\text{cm}^2 \text{ hour}}$	$\frac{\mu\text{l CO}_2^*}{\text{cm}^2 \text{ hour}}$	$\frac{\mu\text{mole CO}_2}{\text{dm}^2 \text{ min}}$	$\frac{\text{mg CO}_2}{\text{dm}^2 \text{ hour}}$	$\frac{\text{g CO}_2}{\text{m}^2 \text{ hour}}$	$\frac{\text{kg CO}_2}{\text{ha hour}}$	$\frac{\text{kg CO}_2}{\text{ha day}}$	$\frac{\text{kg CH}_2\text{O}^{**}}{\text{ha hour}}$	$\frac{\text{kg CH}_2\text{O}^{**}}{\text{ha day}}$
$\frac{\text{mg CO}_2}{\text{cm}^2 \text{ hour}}$	1.000	0.552	0.0379	0.100	0.010	0.10	2.4	0.0682	1.635
$\frac{\mu\text{l CO}_2^*}{\text{cm}^2 \text{ hour}}$	1.815	1.000	0.0688	0.1815	0.0182	0.1815	4.35	0.1235	2.97
$\frac{\mu\text{mole CO}_2}{\text{dm}^2 \text{ min}}$	26.4	14.55	1.000	2.64	0.264	2.64	63.4	1.80	43.2
$\frac{\text{mg CO}_2}{\text{dm}^2 \text{ hour}}$	10.000	5.52	0.379	1.000	0.100	1.000	24.0	0.682	16.35
$\frac{\text{g CO}_2}{\text{m}^2 \text{ hour}}$	100.00	55.2	3.79	10.00	1.000	10.00	240.0	6.82	163.5
$\frac{\text{kg CO}_2}{\text{ha hour}}$	10.00	5.52	0.379	1.000	0.10	1.000	24.00	0.682	16.35
$\frac{\text{kg CO}_2}{\text{ha day}}$	0.417	0.230	0.01575	0.0417	0.00417	0.0417	1.000	0.0284	0.682
$\frac{\text{kg CH}_2\text{O}^{**}}{\text{ha hour}}$	14.67	8.10	0.555	1.467	0.1467	1.467	36.2	1.000	24.0
$\frac{\text{kg CH}_2\text{O}^{**}}{\text{ha day}}$	0.612	0.338	0.0232	0.0612	0.00612	0.0612	1.467	0.0417	1.000

\* at 25°C, and 1 atm.  
 \*\* these units should be avoided as much as possible

	cal			lumen m <sup>-2</sup>				foot candle				Einstein cm <sup>-2</sup> sec <sup>-1</sup>		
	cm <sup>2</sup> min <sup>-1</sup>	J cm <sup>2</sup> s <sup>-1</sup>	J m <sup>2</sup> s <sup>-1</sup>	incandescent	HPL	TL	sunlight	incandescent	HPL	TL	sunlight	400 nm	550 nm	700 nm
cal cm <sup>2</sup> min <sup>-1</sup>	1	0.0098	6.94	3.41 10 <sup>4</sup>	2.85 10 <sup>8</sup>	1.95-2.5 10 <sup>8</sup>	3.23 10 <sup>8</sup>	3.17 10 <sup>7</sup>	2.45 10 <sup>7</sup>	2.1-2.7 10 <sup>7</sup>	3. 10 <sup>7</sup>	2.33 10 <sup>-7</sup>	3.22 10 <sup>-7</sup>	4.10 10 <sup>-7</sup>
J cm <sup>2</sup> s <sup>-1</sup>	14.33	1	10 <sup>4</sup>	4.84 10 <sup>9</sup>	4.09 10 <sup>9</sup>	2.8-3.6 10 <sup>9</sup>	4.63 10 <sup>9</sup>	4.5 10 <sup>8</sup>	3.8 10 <sup>8</sup>	3.0-3.9 10 <sup>8</sup>	4.31 10 <sup>8</sup>	3.35 10 <sup>-6</sup>	4.11 10 <sup>-6</sup>	5.86 10 <sup>-6</sup>
J m <sup>2</sup> s <sup>-1</sup>	1.433 10 <sup>-3</sup>	10 <sup>-4</sup>	1	4.84 10 <sup>5</sup>	4.09 10 <sup>5</sup>	2.8-3.6 10 <sup>5</sup>	4.63 10 <sup>5</sup>	4.5 10 <sup>4</sup>	3.8 10 <sup>4</sup>	3.0-3.9 10 <sup>4</sup>	4.31 10 <sup>4</sup>	3.35 10 <sup>-10</sup>	4.11 10 <sup>-10</sup>	5.86 10 <sup>-10</sup>
Lumen m <sup>-2</sup>														
incandescent	2.93 10 <sup>-9</sup>	2.07 10 <sup>-10</sup>	2.07 10 <sup>-6</sup>	1										
HPL	3.51 10 <sup>-9</sup>	2.44 10 <sup>-10</sup>	2.44 10 <sup>-6</sup>		1				10.76					no conversion possible
TL	5.13-4.0 10 <sup>-9</sup>	3.57-2.78 10 <sup>-10</sup>	3.57-2.78 10 <sup>-6</sup>			1								
sunlight	3.10 10 <sup>-9</sup>	2.16 10 <sup>-10</sup>	2.16 10 <sup>-6</sup>				1							
Foot candle														
incandescent	3.15 10 <sup>-8</sup>	2.22 10 <sup>-9</sup>	2.22 10 <sup>-5</sup>					1						no conversion possible
HPL	3.77 10 <sup>-8</sup>	2.63 10 <sup>-9</sup>	2.63 10 <sup>-5</sup>		0.093				1					
TL	4.76-3.70 10 <sup>-8</sup>	3.33-2.56 10 <sup>-9</sup>	3.33-2.56 10 <sup>-5</sup>							1				
sunlight	3.33 10 <sup>-8</sup>	2.32 10 <sup>-9</sup>	2.32 10 <sup>-5</sup>								1			
Einstein cm <sup>-2</sup> s <sup>-1</sup>														
400 nm	4.29 10 <sup>6</sup>	2.985 10 <sup>5</sup>	2.985 10 <sup>9</sup>	no conversion possible				no conversion possible				1		
550 nm	3.11 10 <sup>6</sup>	2.17 10 <sup>5</sup>	2.17 10 <sup>9</sup>										1	
700 nm	2.44 10 <sup>6</sup>	1.71 10 <sup>5</sup>	1.71 10 <sup>9</sup>											1

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