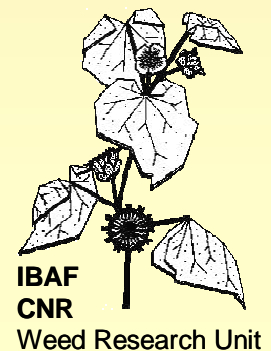


The problems of standardising RGR?

RA4.5 workshop, Rothamsted Res., 25 nov. 2008

Ivan Sartorato, IBAF-CNR



RGR Definition

RGR represents the efficiency of a plant as a producer of new material

$$\mathbf{RGR = \frac{1}{W} * \frac{dW}{dt}}$$

Istantaneous RGR

Functional approach

(many samplings, few or no replicates)

Instantaneous RGR

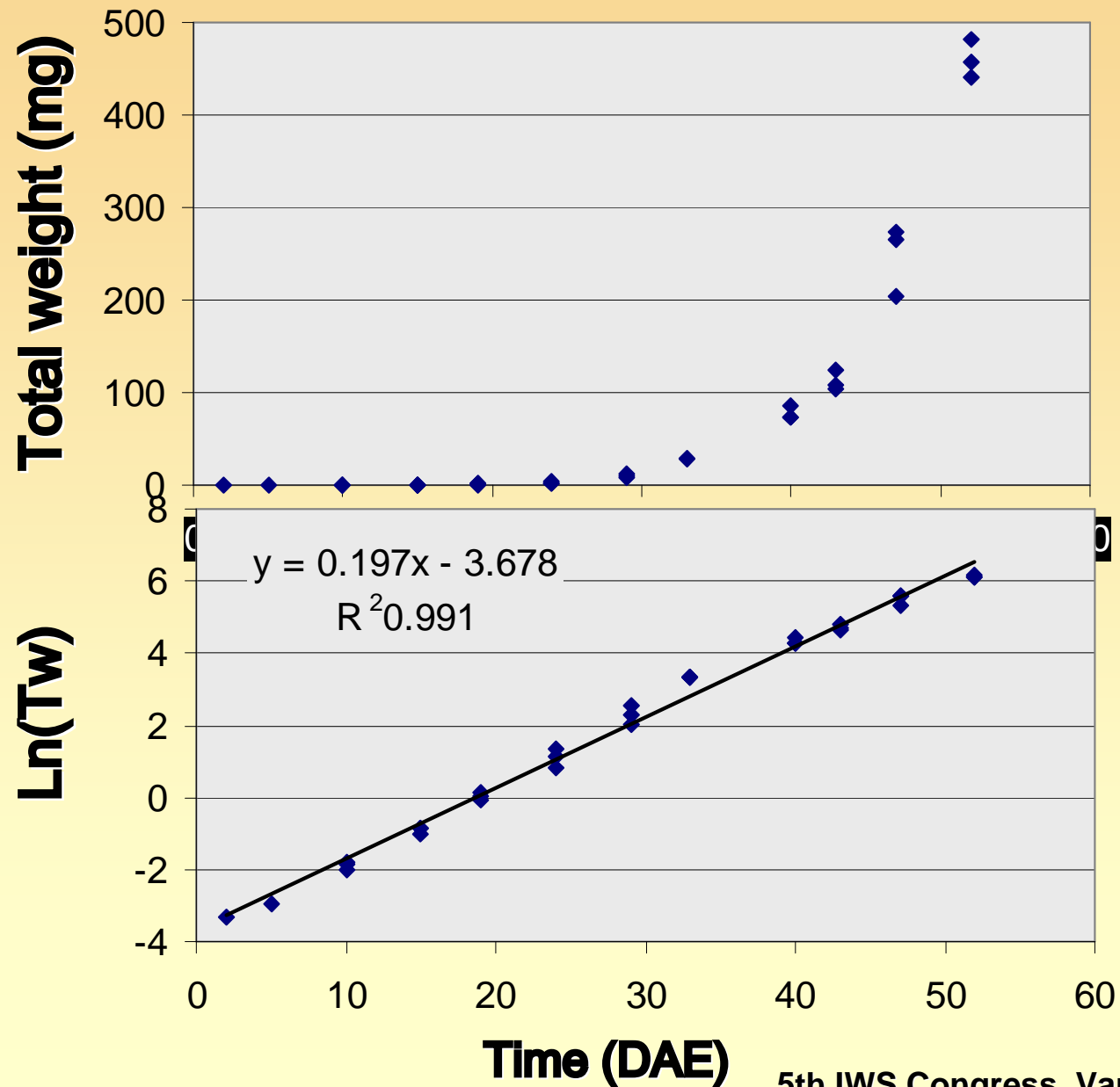
Exponential growth (seedlings?)

$$W_t = W_0 * e^{R*t}$$

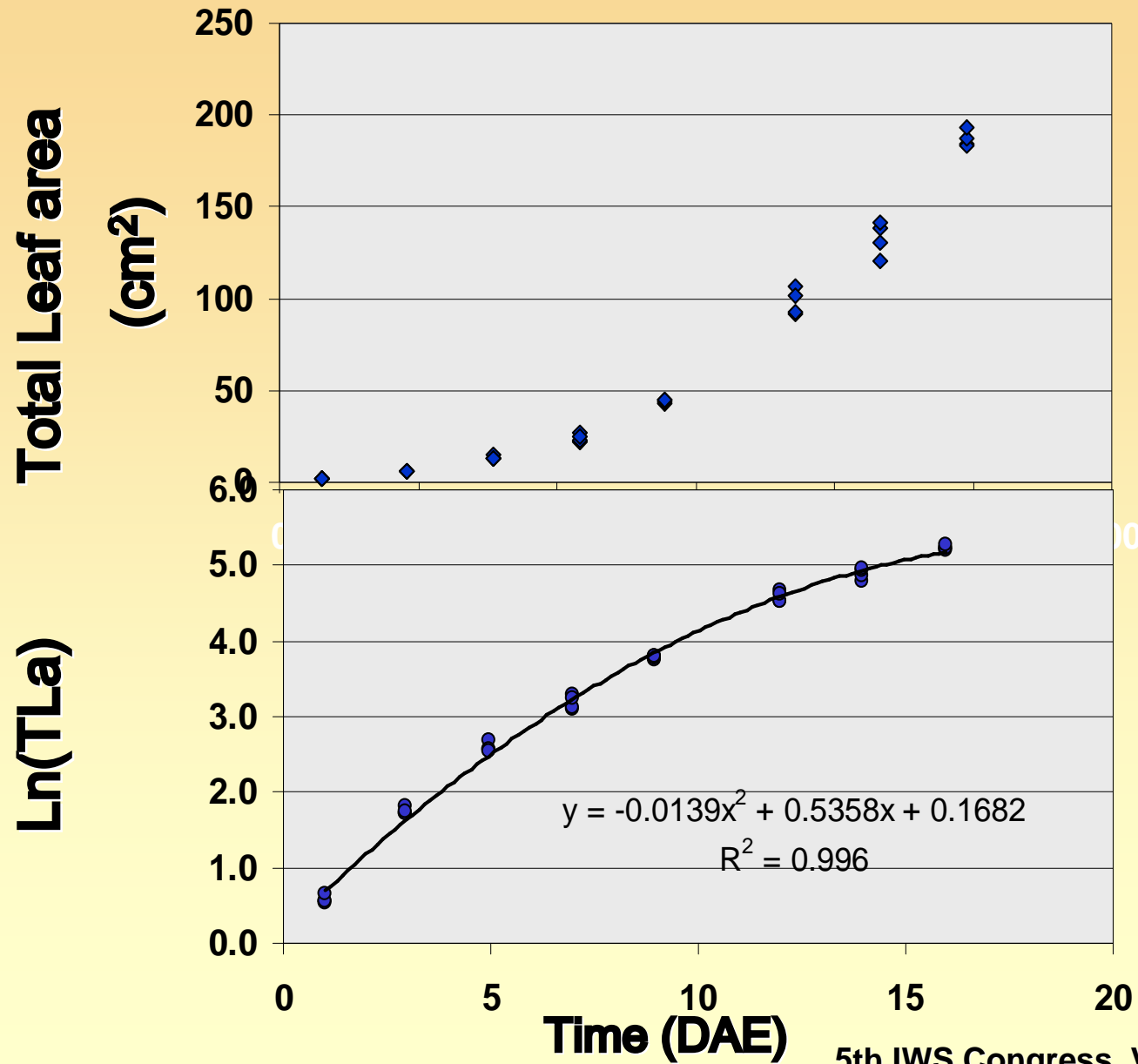
$$\ln(W_t) = \ln(W_0) + R*t$$

R can be constant or can vary with time

Growth curve of CYPDI (Tw)



Growth curve of XANST (TLa)



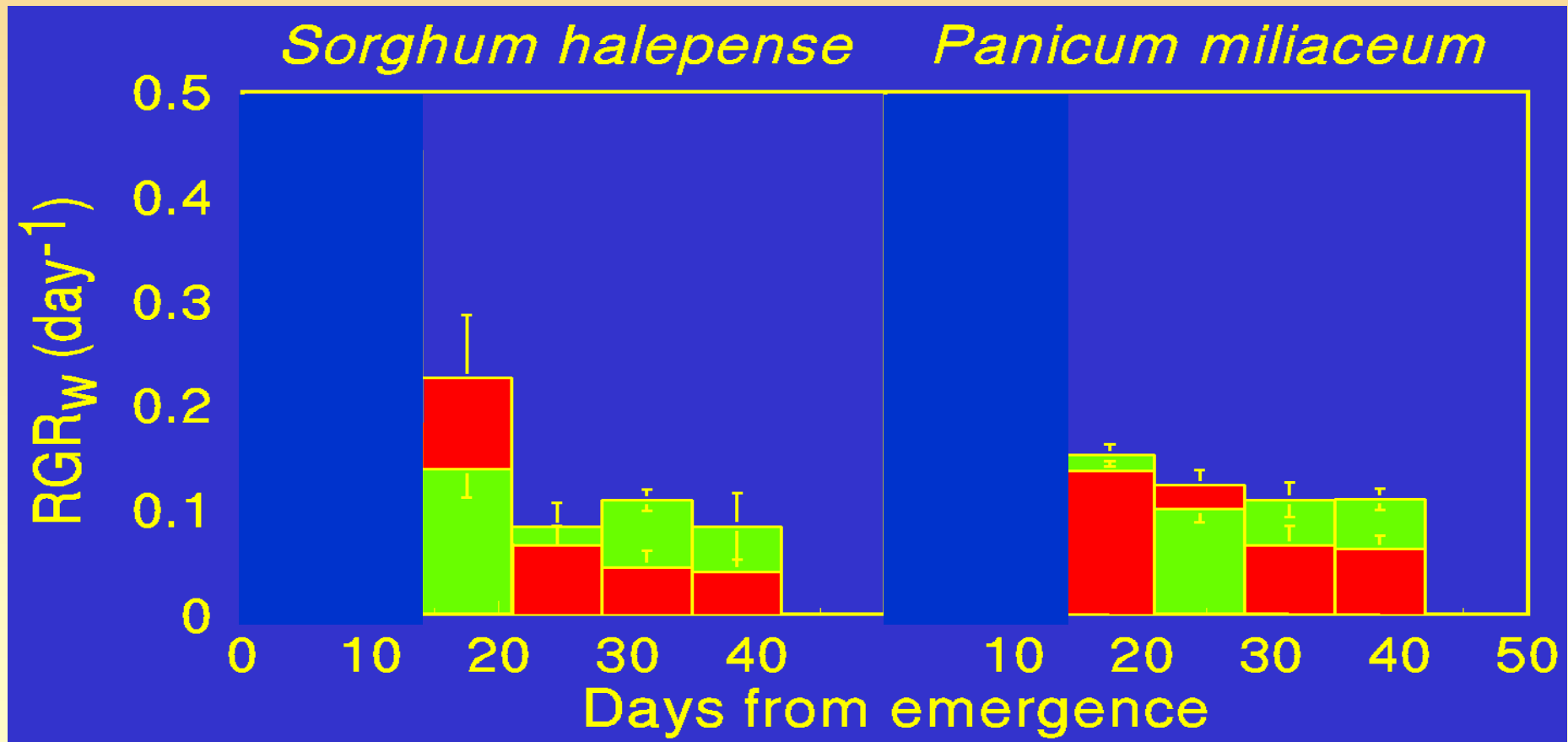
Mean RGR

$$\text{RGR}_{1-2} = \frac{\ln(W_2) - \ln(W_1)}{T_2 - T_1}$$

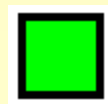
Classical approach

(relatively few samplings, replicates strongly needed)

Effects of two contrasting PPFD levels on RGR of two monocots

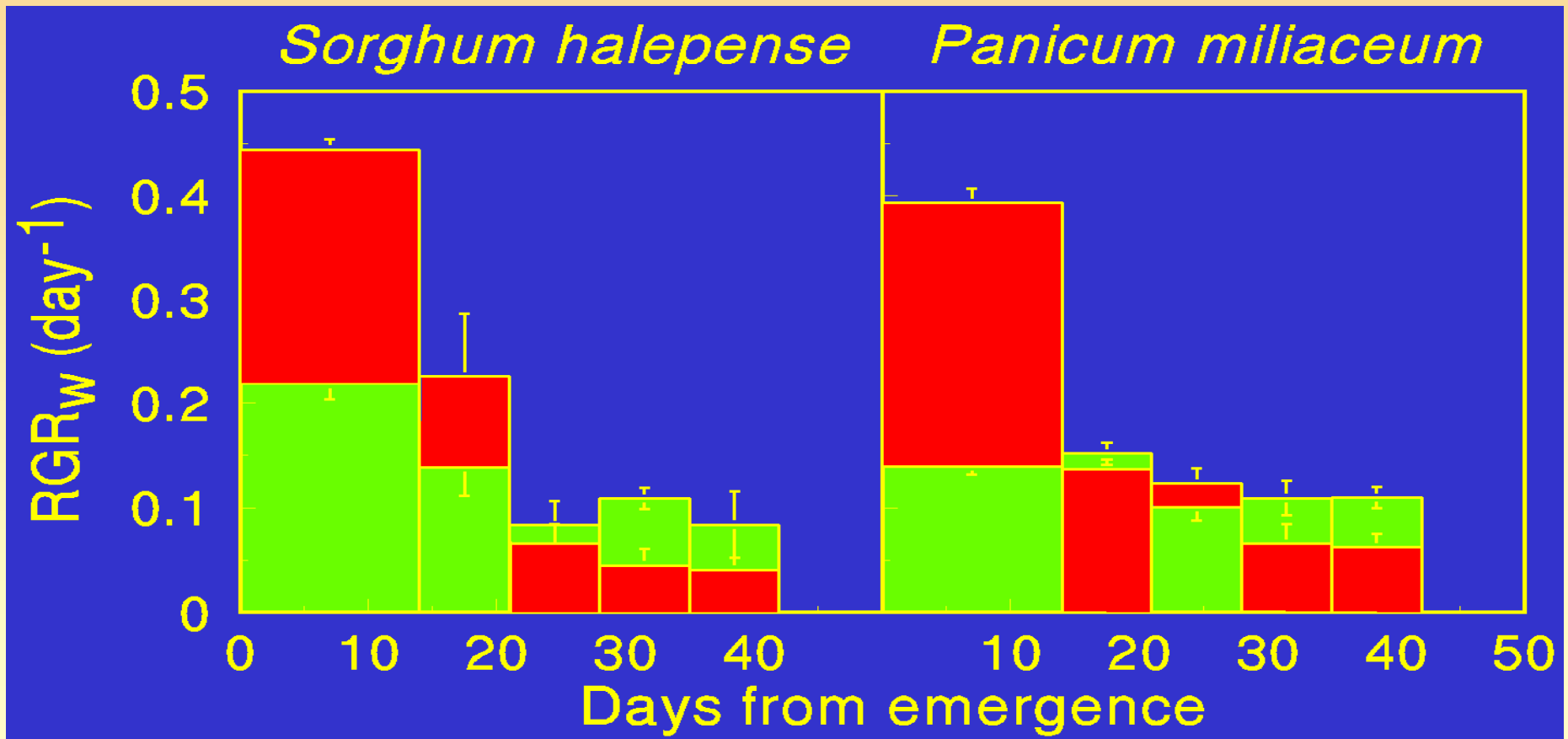


PPFD = 400 μmol m⁻² s⁻¹

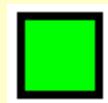


PPFD = 100 μmol m⁻² s⁻¹

Effects of two contrasting PPFD levels on RGR of two monocots



PPFD = 400 μmol m⁻² s⁻¹



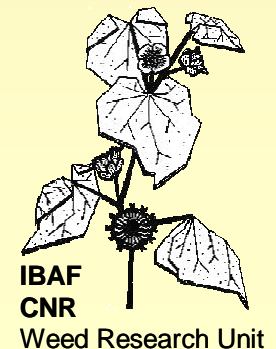
PPFD = 100 μmol m⁻² s⁻¹

Analysis of early growth of weeds and crops as influenced by temperature regime

I. Sartorato, G. Pignata and M. Sattin

Institute of Agro-environmental and Forest Biology (IBAF)
NATIONAL RESEARCH COUNCIL - CNR
Legnaro – Italy

Presented at



Objective

To analyze early growth of a range of well differentiated spring and summer weeds of the Mediterranean/temperate climate

Initial question:

is early growth really exponential?

- **Influence of temperature regime on RGR and its components**
- **Relationship between RGR and seed weight**
- **T_{base} of the considered species**

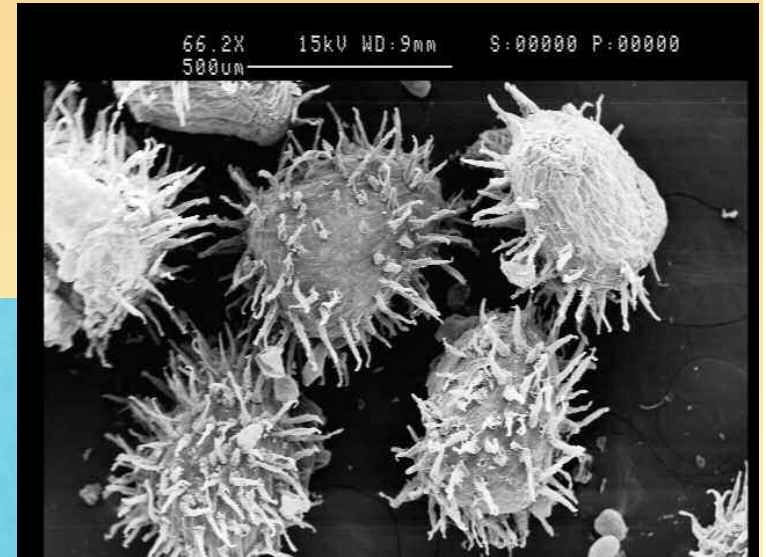
22 species studied

- *Abutilon theophrasti* Med.
- *Amaranthus cruentus* L.
- *Ambrosia artemisiifolia* L.
- *Ammannia coccinea* Rottb.
- *Beta vulgaris* var. *sacchar.* L.
- *Bidens frondosa* L.
- *Bidens tripartita* L.
- *Buddleja davidii* Franchet
- *Chenopodium album* L.
- *Convolvulus arvensis* L.
- *Cyperus difformis* L.
- *Datura stramonium* L.
- *Echinochloa crus-galli* (L.) Beauv.
- *Glycine max* (L.) Merr.
- *Hibiscus trionum* L.
- *Panicum miliaceum* L.
- *Polygonum lapathifolium* L.
- *Sinapis alba* L.
- *Solanum nigrum* L.
- *Sorghum halepense* (L.) Pers.
- *Triticum aestivum* L.
- *Xanthium strumarium* L.

Well differentiated range of species



XANST, “seed” weight 56.1 mg



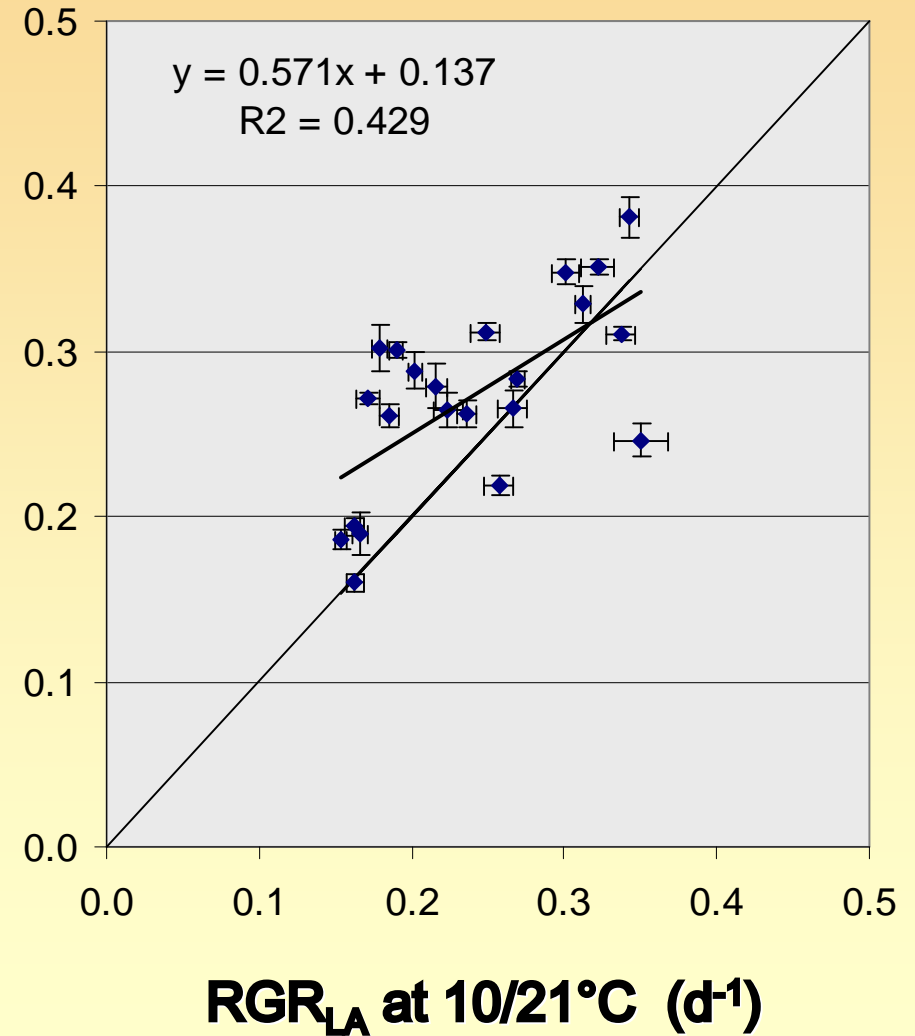
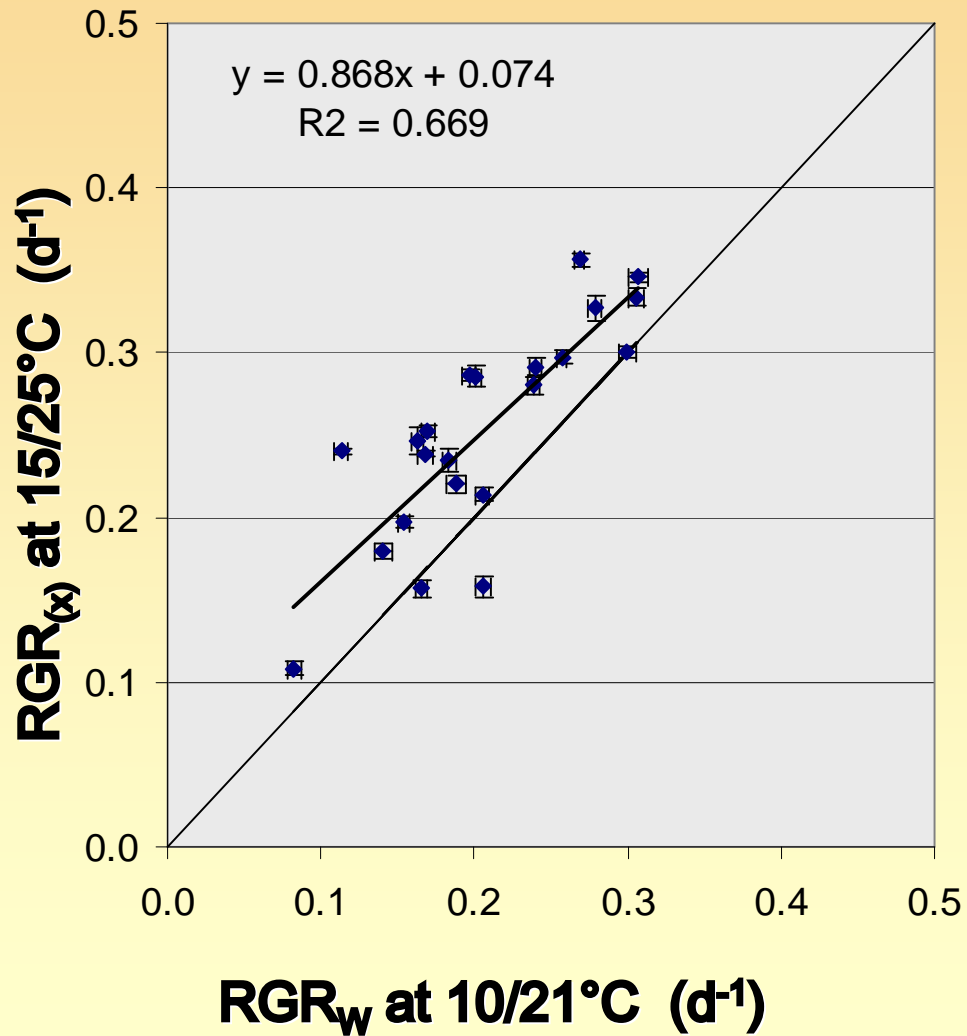
0.5 mm

**AMMCO
seed weight 0.016 mg**

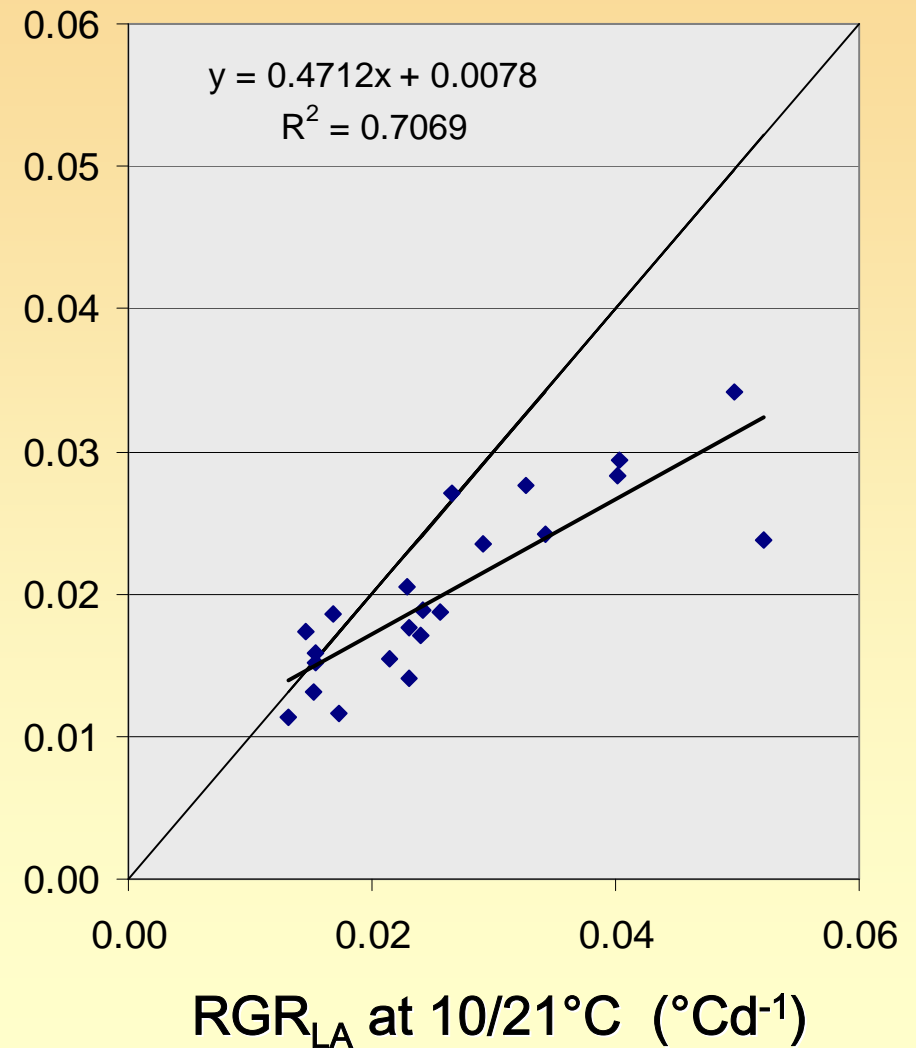
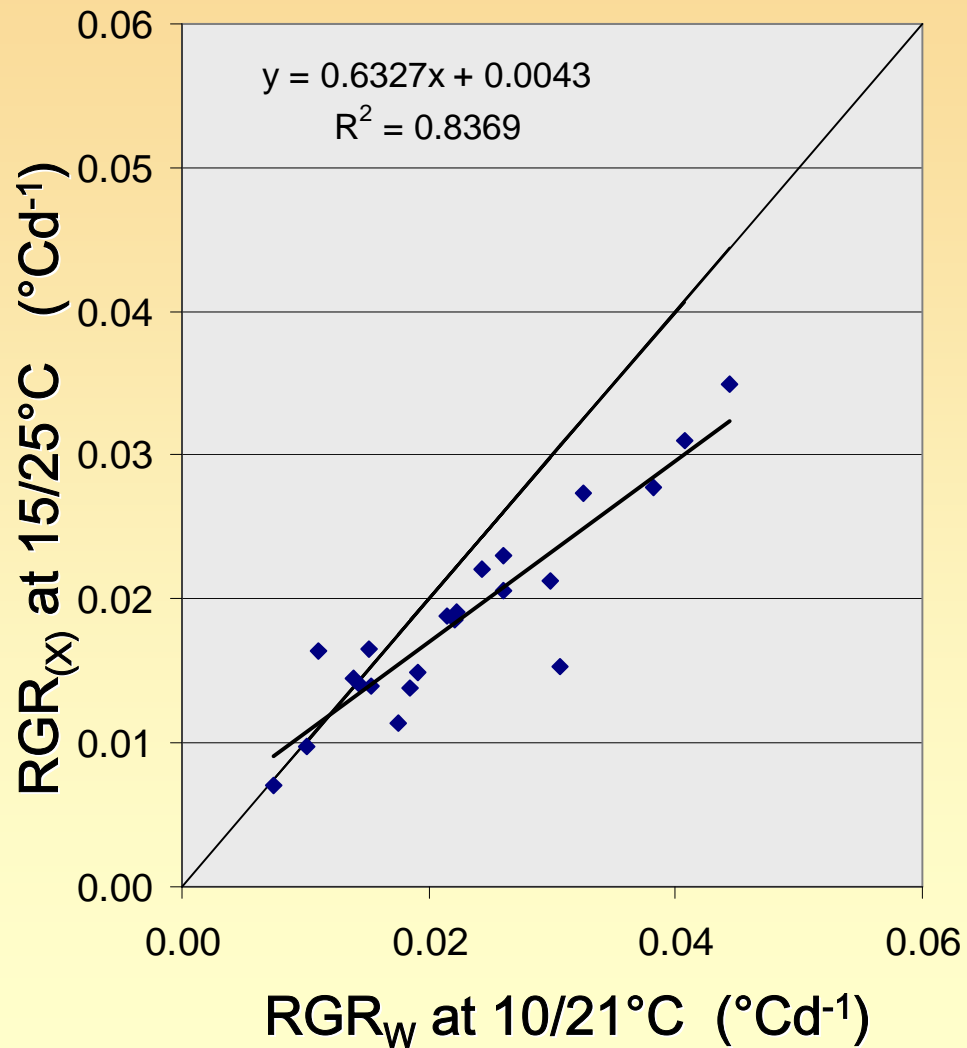
Overall results

- **176 RGR estimates from 44 datasets by linear regression of $\ln(Tw)$, $\ln(TLa)$, $\ln(TLw)$, $\ln(Rw)$ over time for the entire period of growth**
- **Time = days and temperature sum (GDD)**
- **All regressions were significant ($P < 0.05$)**
- **Best fit for total weight**

RGR relationships (time based)



RGR relationships (temperature-sum based)



And then?

- **Very low data variability =>**
detailed analysis of RGR evolution with time =>

$$\mathbf{RGR = K ?}$$

Polynomials fitted and RGR course (18 species * 2 temperature regimes)

	Order of the best fit polynomial	Number of datasets	RGR course
Tw	I	8	-
	II	11	↑ = 6 ↓ = 5
	III	17	↑↓ = 14 ↓↑ = 3
TLa	I	3	-
	II	12	↑ = 3 ↓ = 9
	III	21	↑↓ = 6 ↓↑ = 15

And then?

- **Very low data variability =>**
detailed analysis of RGR evolution with time =>

$$\mathbf{RGR = K ?}$$

- **Seedlings are very dynamic “systems” in which:**

- **Leaf area and leaf weight are often not clearly definable**
- **Comparison at a given Tsum reduces but not eliminates bias due to ontogenetic shift**

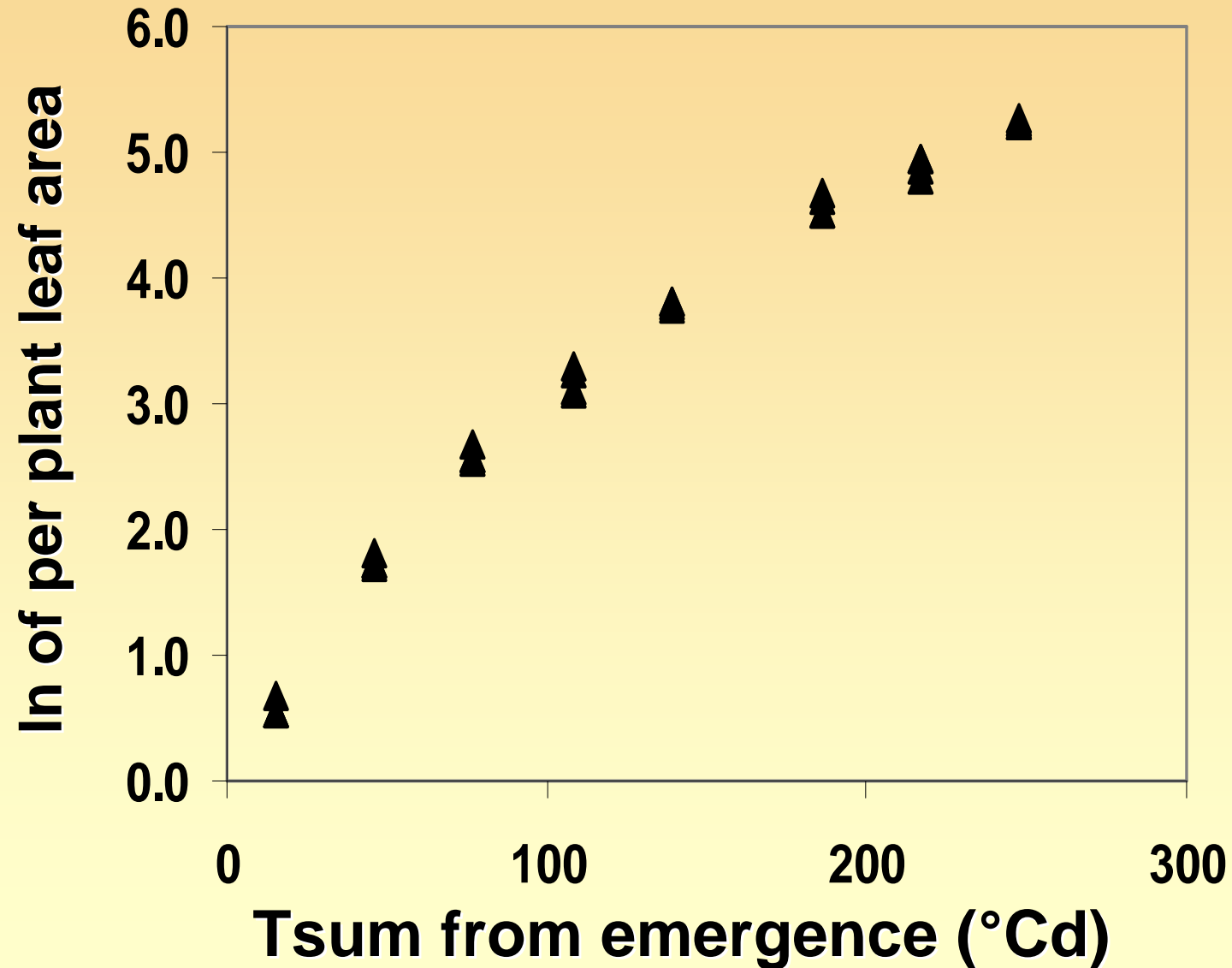


Unreliable estimates of NAR (Net Assimilation Rate) and of its evolution

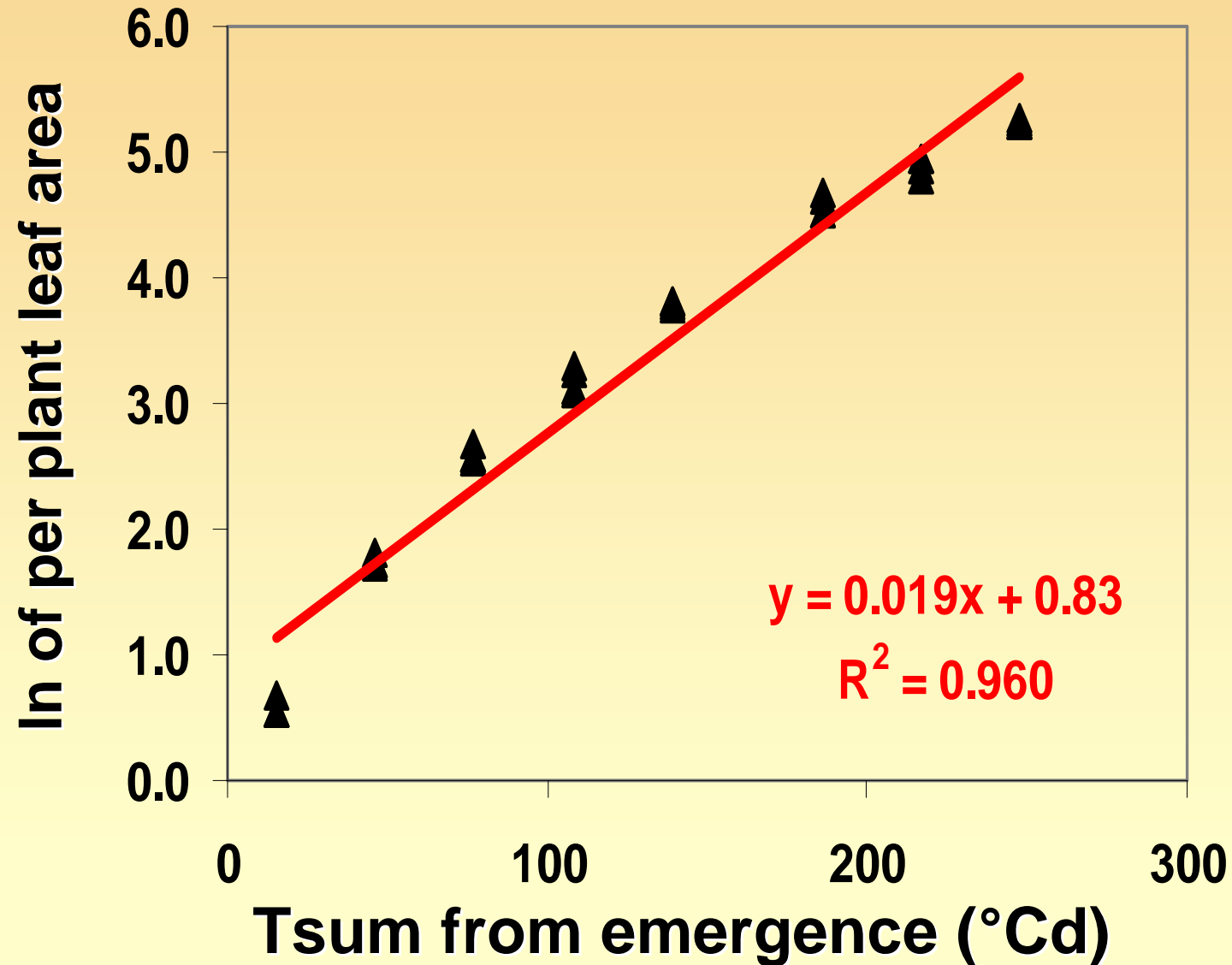
Conclusions

- **Wide range of RGR values**
- **Expressing RGR in terms of Tsum does not completely explain the effects of different temperature regimes**
- **As a first approximation RGR during early growth can be assumed to be constant**

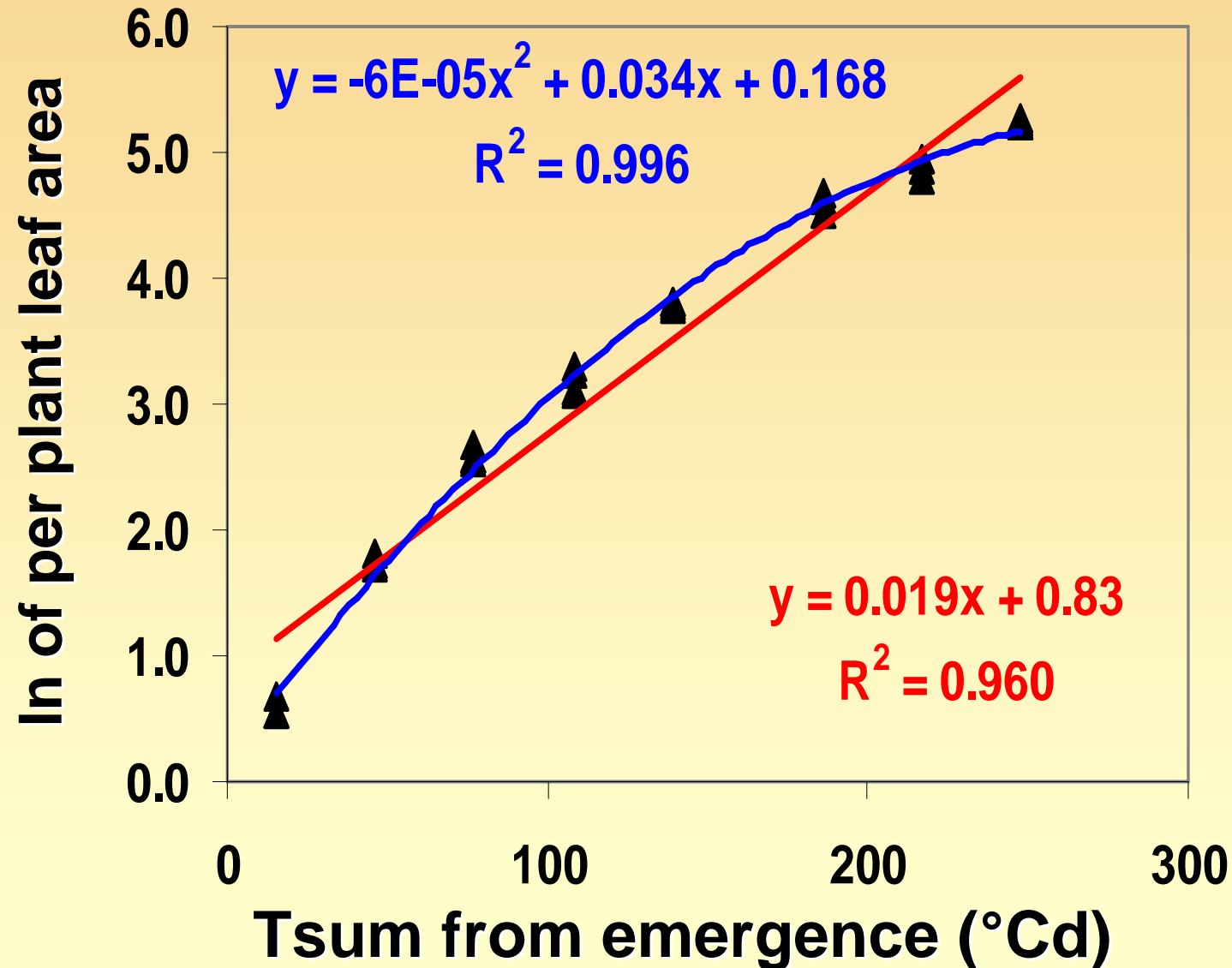
Leaf area evolution in *Xanthium strumarium*



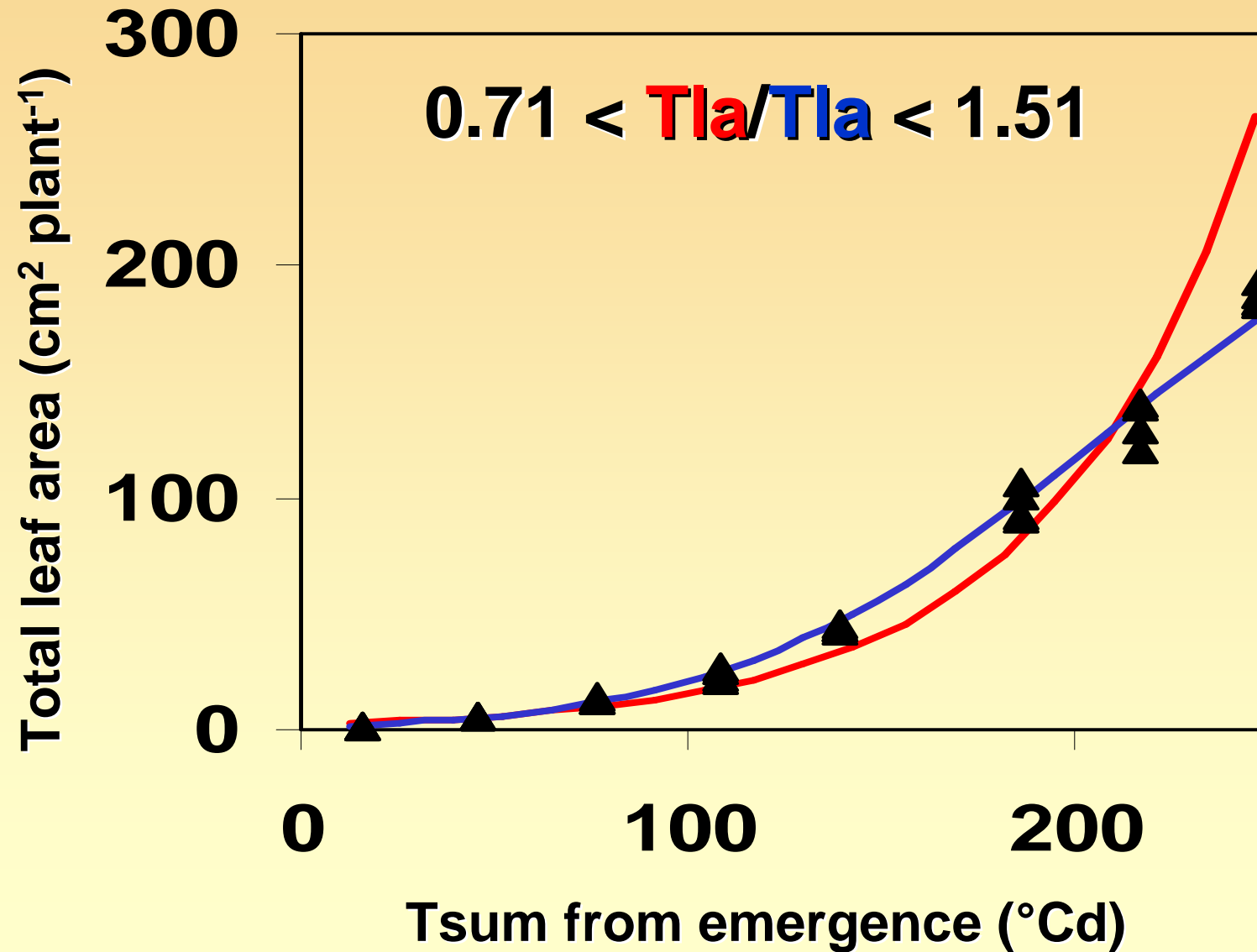
Leaf area evolution in *Xanthium strumarium*



Leaf area evolution in *Xanthium strumarium*



Leaf area evolution in *Xanthium strumarium*



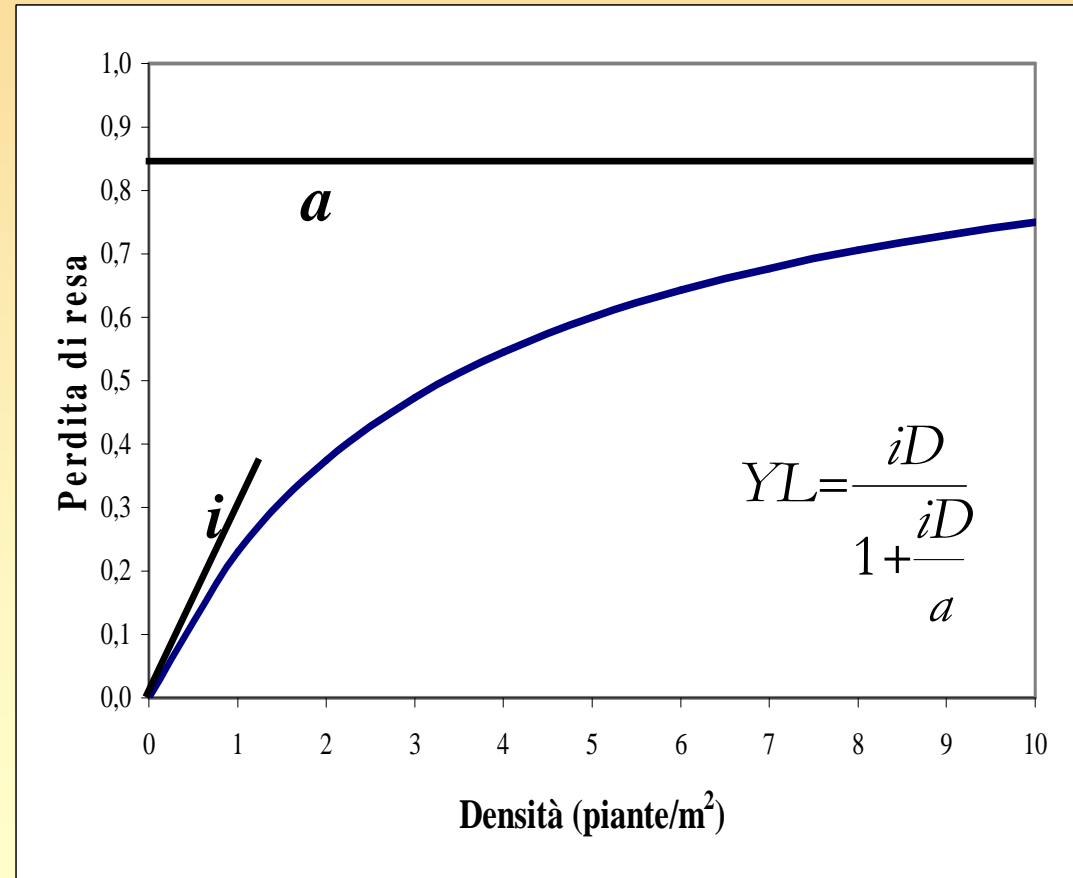
Simple competition models: Cousens model (1985)

$$YL = \frac{iD}{1 + \frac{iD}{a}}$$

D = weed density

i = YL when $N_w \Rightarrow 0$

a = max YL when $D \Rightarrow \infty$



Simple competition models: Kropff and Spitters model (1991)

$$YL = \frac{q Lw}{1 + \left(\frac{q}{m} - 1 \right) Lw}$$

Lw = contribution of weed species to total LAI

q = relative damage coefficient

m = max YL when $Lw \Rightarrow 1$

q vary with time because leaf area of competing species grows at different rates

Simple competition models: Kropff and Spitters model (1991)

$$q = q_0 e^{(RGRLc - RGRLw) t}$$

$RGRLc, RGRLw$ = relative growth rate of the leaf area ($^{\circ}\text{C}^{-1} \text{d}^{-1}$) of crop and weed

t = time expressed in degree days ($^{\circ}\text{C} \text{d}$)

q_0 = value of q when Lw is observed at $t = 0$ (the moment of observation for which q has been determined from experimental data).

Assumption: growth rates of leaf area of crop and weed are exponential

1999-2000 EWRS common experiment

- 4 species (BETVU, TRIAE, SINAL, CHEAL)
- 10 locations
- 2 years

- Quasi-potential situation
- Pure stands of spaced plants
- Up to 40 days of growth
- Up 12 samplings, 3 replicates

RGR_{TLA} relationships

Loc.	TRIAE		SINAL		RGR _T - RGR _S	
	1999	2000	1999	2000	1999	2000
FI com	0.0066	0.0113	0.0105	0.0168	-0.004	-0.006
FI loc	0.0066	0.0108	0.0105	0.0168	-0.004	-0.006
DK	0.0154	0.0137	0.0164	0.0180	-0.001	-0.004
NLAB	0.0135	0.0157	0.0179	0.0187	-0.004	-0.003
NLTP	0.0083		0.0142		-0.006	
UKRO	0.0064	0.0116	0.0145	0.0174	-0.008	-0.006
UKLA	0.0139		0.0204		-0.007	
ITPD	0.0099	0.0049	0.0148	0.0127	-0.005	-0.008
ITVT		0.0085		0.0138		-0.005
PL		0.0077		0.0121		-0.004
PO	0.0102		0.0146		-0.004	
Average	0.0101	0.0108	0.0154	0.0156	-0.0048	-0.0053
Min	0.0064	0.0071	0.0105	0.0121	-0.0081	-0.0077
Max	0.0154	0.0155	0.0204	0.0187	-0.0010	-0.0030

Conclusions?

- Strong variability in time and space
- Highly heterogeneous value found in literature
- Power of power often misconsidered
- Which initial weight/area for which RGR?
- RGR values included in WTDB must be linked to the possible use and period of validity

Thank you

