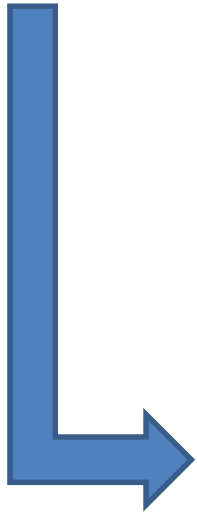


Estimating pest impacts under climate change:

Spodoptera litura (F.)

performance on brassica crops under elevated CO₂



Pham Anh Tuan, Papitchaya Teawkul, Shaw-Yhi Hwang
Dept. of Entomology, National Chung Hsing University, Taiwan

Email: tuan.nipp@gmail.com

Brief introduction

- **Place:** Taichung, Taiwan
- **University:**
 - National Chung Hsing University
 - Department of Entomology.
- **PhD thesis:** Insect –plant interaction under increasing CO₂ and temperature



國立中興大學
National Chung Hsing University

Common cut worm



- *Spodoptera litura* (F),
 - As global distribution
 - A highly polyphagous defoliator on a **wide host range** over 150 plant species (*Rao et al., 1993*),
 - An economically-important **agricultural pest**.
 - cause 26 - 100 % yield loss in ground nut (*Dhir et al., 1992*).
 - Loss of major crops between 10 and 30% (*Ferry et al., 2004*).
 - Has developed multiple types of **resistance against various insecticides** (*Mushtaq A. Saleem, et al. 2008*)
 - Raise the concern about outbreak of this pest in future (*Ahmad and Arif 2007*)

Plant resistance



Damaged by
physically.
herbivorous, disease

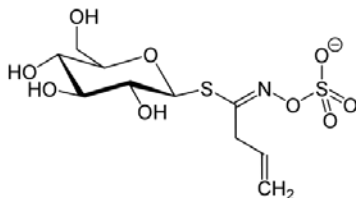


Few days

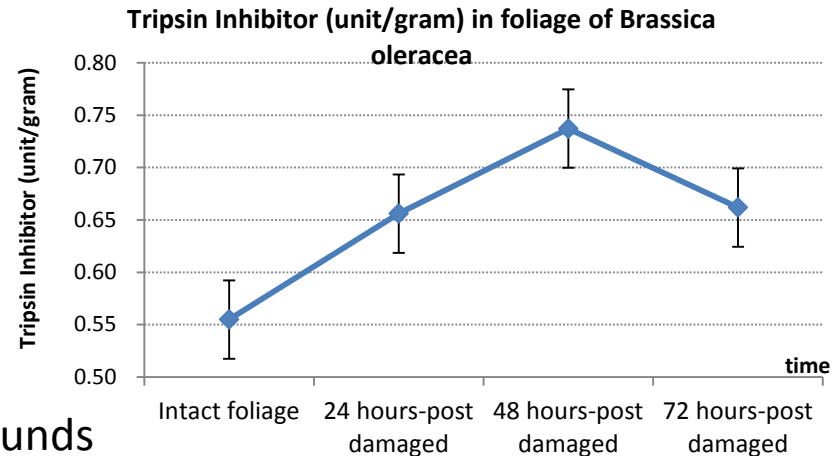
Constitutive-resistance

Induced-resistance

- Physical barrier
- Defensive compounds (200,000 chemical have been identified (Hartmann 2007))



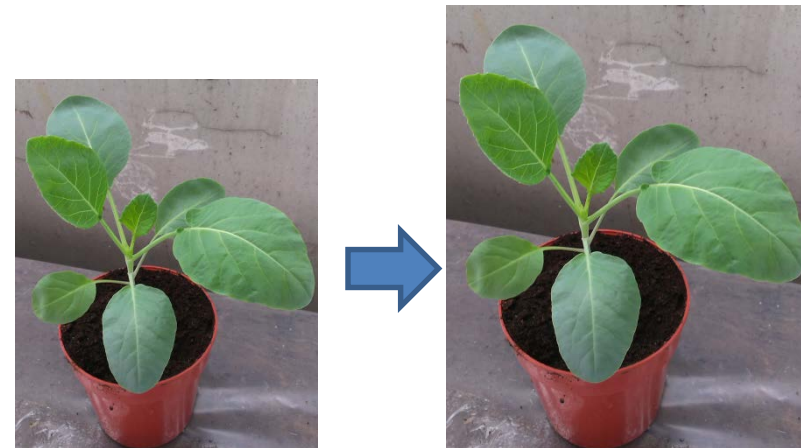
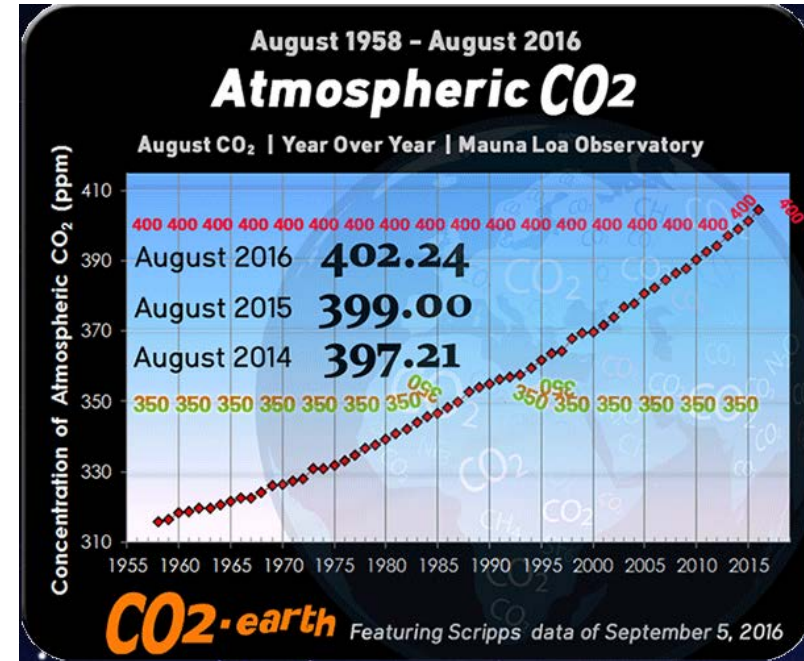
- Defensive compounds



CO₂ increasing issue

- Increasing of **CO₂** + **temp** are raising concern on *environmental issue* of global warming.
- Elevated CO₂ increase in the rate of **photosynthetic**.

Leaf photosynthetic rates **increase** by average of **40%** (Ainsworth, E. A. & Rogers, A. 2007).



Elevated CO_2 affect *insect performances* via *plant* ?

Elevated CO_2



The plant's quality

1. Fresh weight
2. Dry weight
3. Nitrogen compounds

Defensive compounds

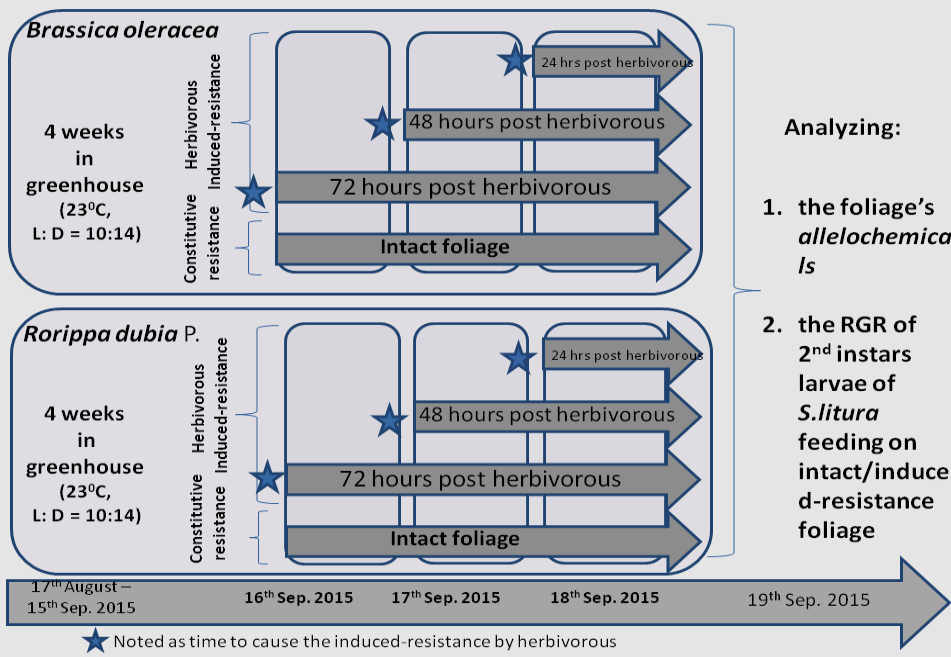
1. *Tripsin inhibitor*,
2. *Polyphenol oxydase*
3. *Phenonic compounds*
4. *Glucosinolate*

Constitutive-resistance

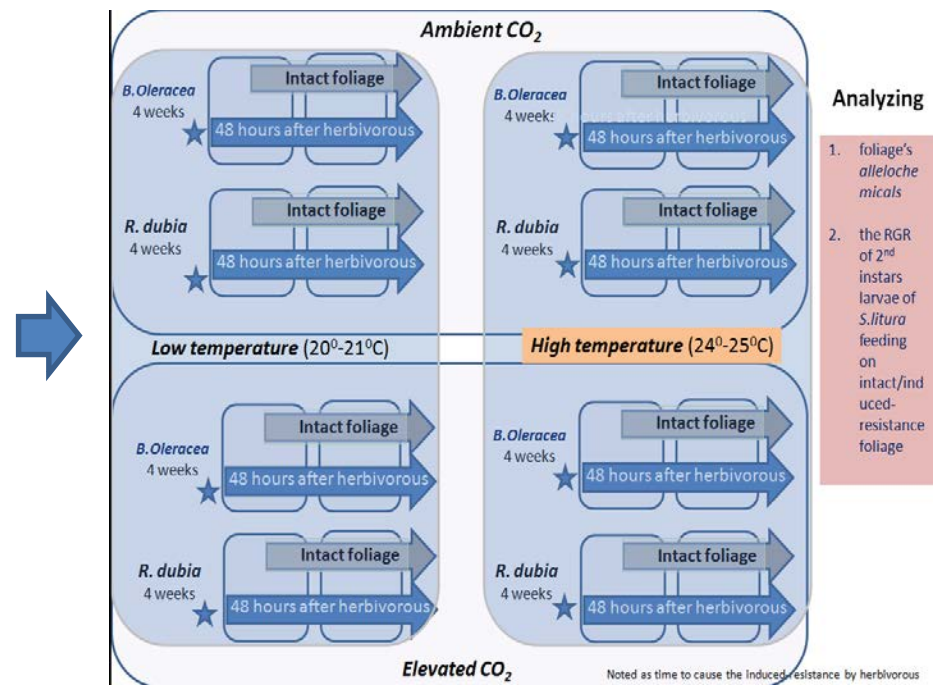
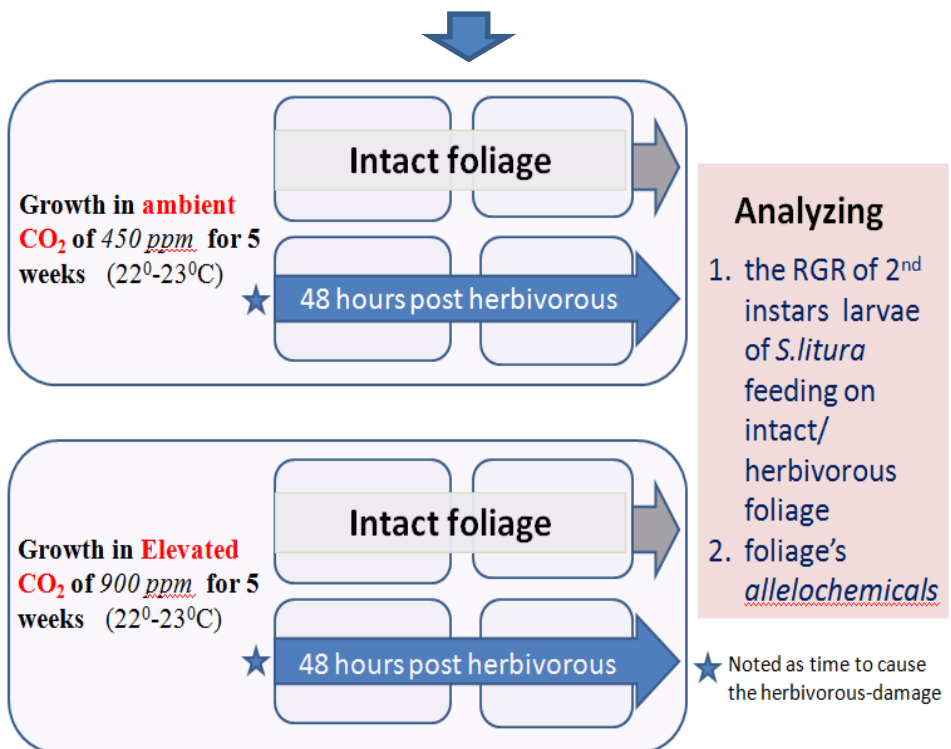
Induced-resistance



Relative growth rate (RGR) of generalist insect (*Spodoptera litura*. F)?



Experiment design



Materials and methods

1. **Insect:** *Spodoptera litura* (F.)
2. **Plant:**
Cabbage (*Brassica oleracea* var. botrytis L.)
Wildtype (*Rorippa dubia*)
3. **Insect performance:** *Relative growth rate of 2nd instars of larvae*
4. **Chemical analysis:**
Tripsin Inhibitor,
Polyphenol Oxydase

Phenonic compounds
Glucosinolate



Brassica oleracea

Elevated CO₂ control chambers

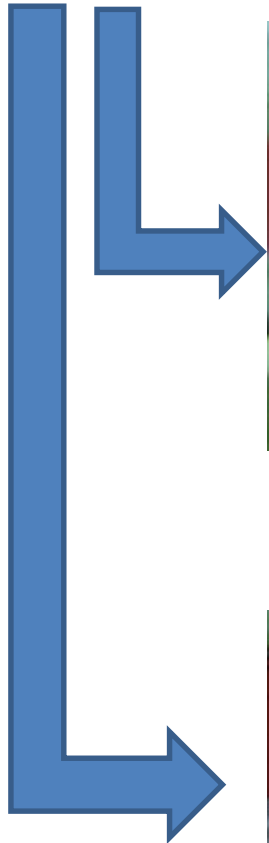


Spodoptera litura

- population was maintained on **artificial diet**
- Rear in **growth chamber** ($25 \pm 1^{\circ}\text{C}$, L: D = **10:14** time period and 75 % RH)
- at **Entomology Dept.**, National Chung Hsing University, Taiwan



Herbivorous damage



Brassica oleracea

20% damage of leaf areas



Rorippa dubia

Induced foliage



Intact foliage



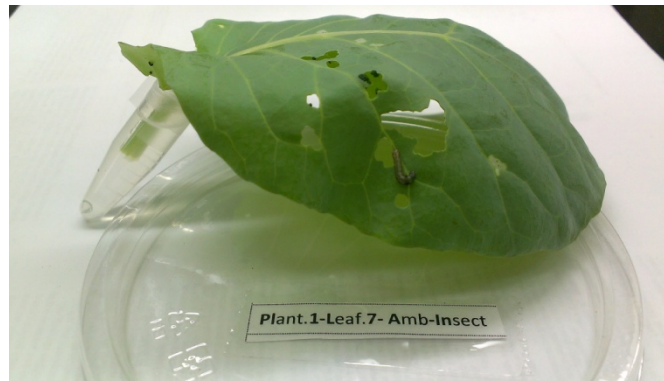
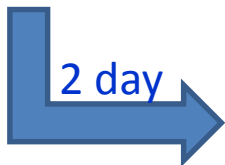
Insect performance

- Criteria

- RGR

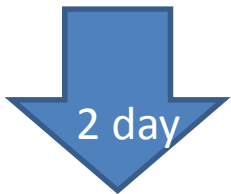
$$\text{Relative Growth Rate} = \frac{\left\{ \text{Body weight of insect when stop experiment} \right\} - \left\{ \text{Body weight of insect when start experiment} \right\}}{\text{Duration of experiment (day)}} \text{ (mg/day)}$$

- From newly-molting 2nd instars – to end 2nd Instars
(2 days – 7th-9th May, 2015)



Insect performance

Newly-molting 2nd instars



Late 2nd instars



Elevated CO₂

25 constitute plants

25 induce-respond plants

Ambient CO₂

25 constitute plants

25 Induce-respond plants



Condition (25°C; RH= 70%)

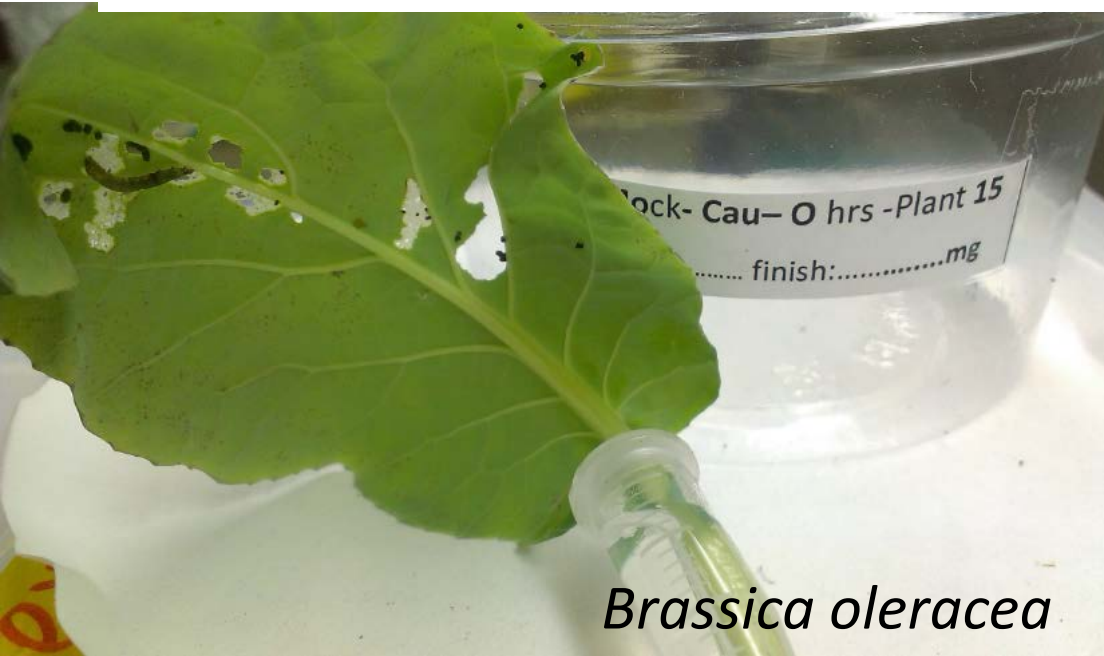
Relative Growth Rate (mg/day)

Spodoptera litura Fabricius



Rorippa dubia

$$\text{Relative Growth Rate} = \frac{\left\{ \begin{array}{l} \text{Body weight of insect} \\ \text{when stop experiment} \end{array} \right\} - \left\{ \begin{array}{l} \text{Body weight of insect} \\ \text{when start experiment} \end{array} \right\}}{\text{Duration of experiment (day)}} \text{ (mg/day)}$$



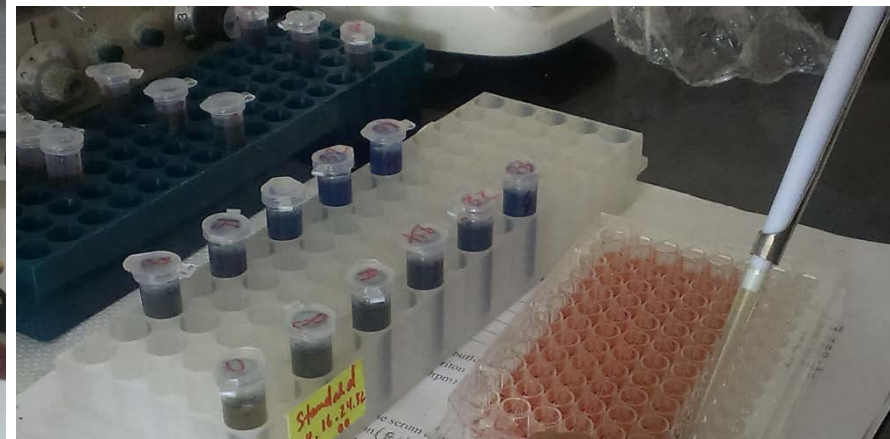
Brassica oleracea



Plant-1-Leaf-7- Amb-Insect

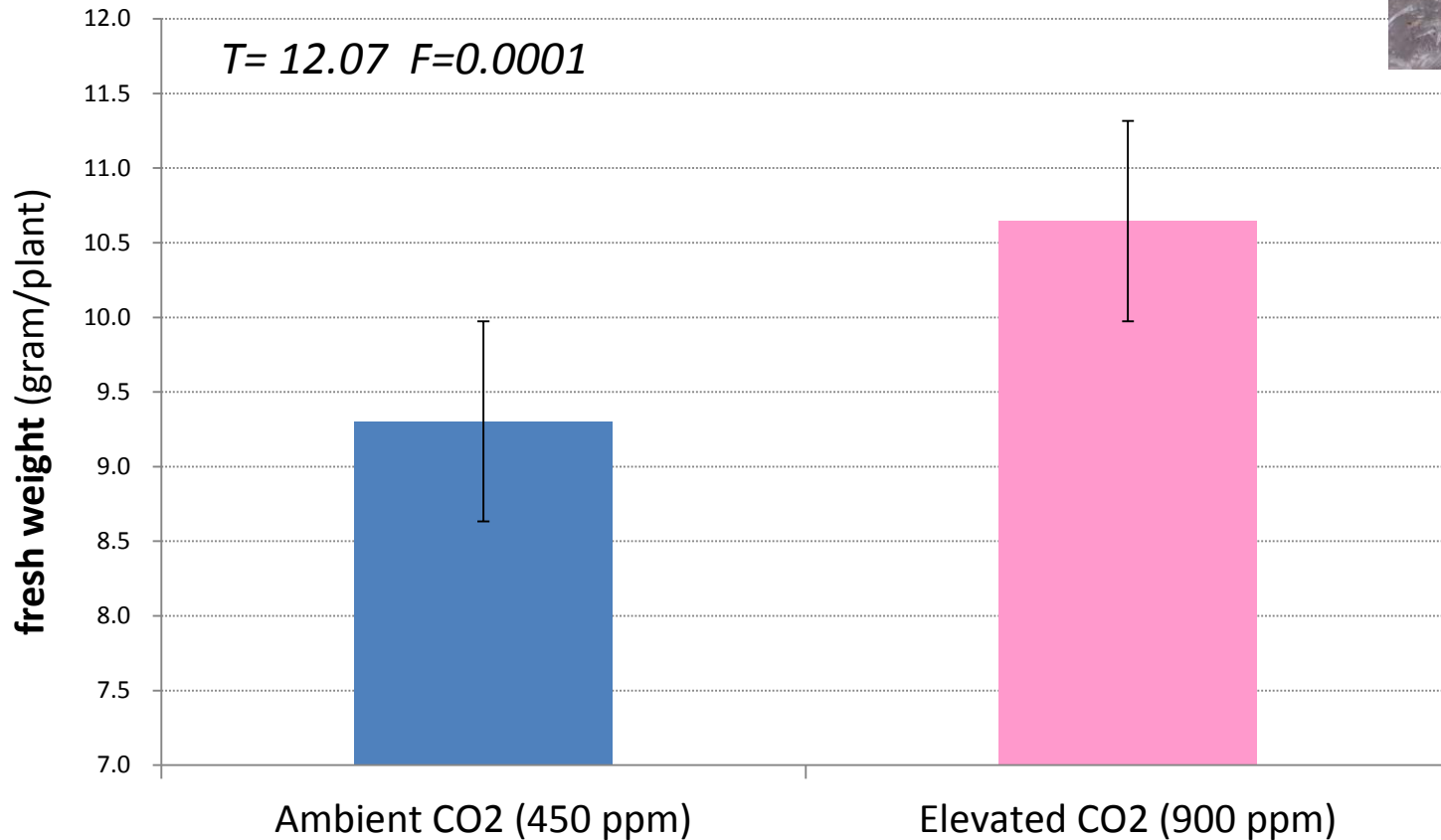
Defensive compounds analysis

1. Trypsin inhibitor
2. Polyphenol Oxidase
3. Total phenolic compounds
4. Glucosinolate (*signigrin*)

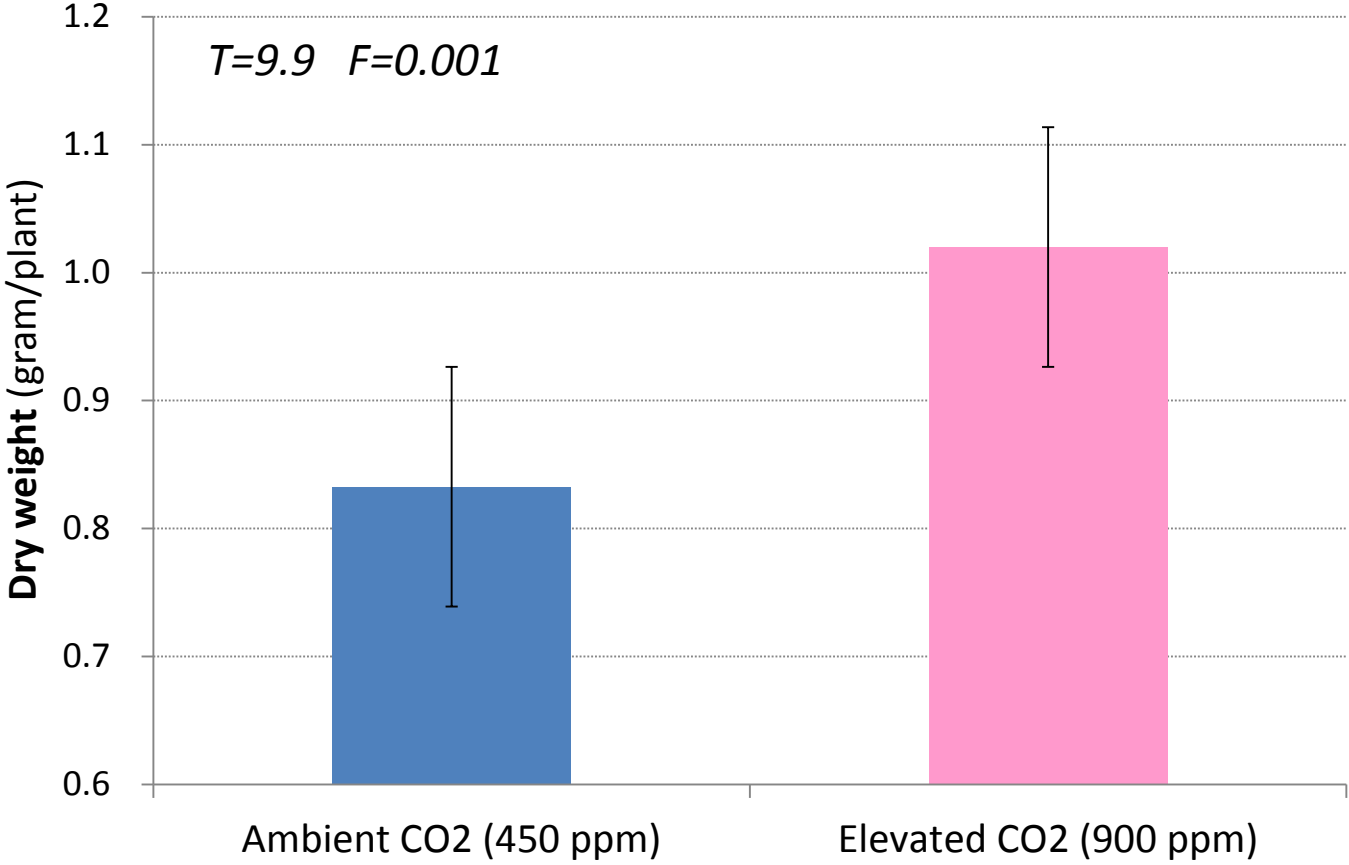


Results

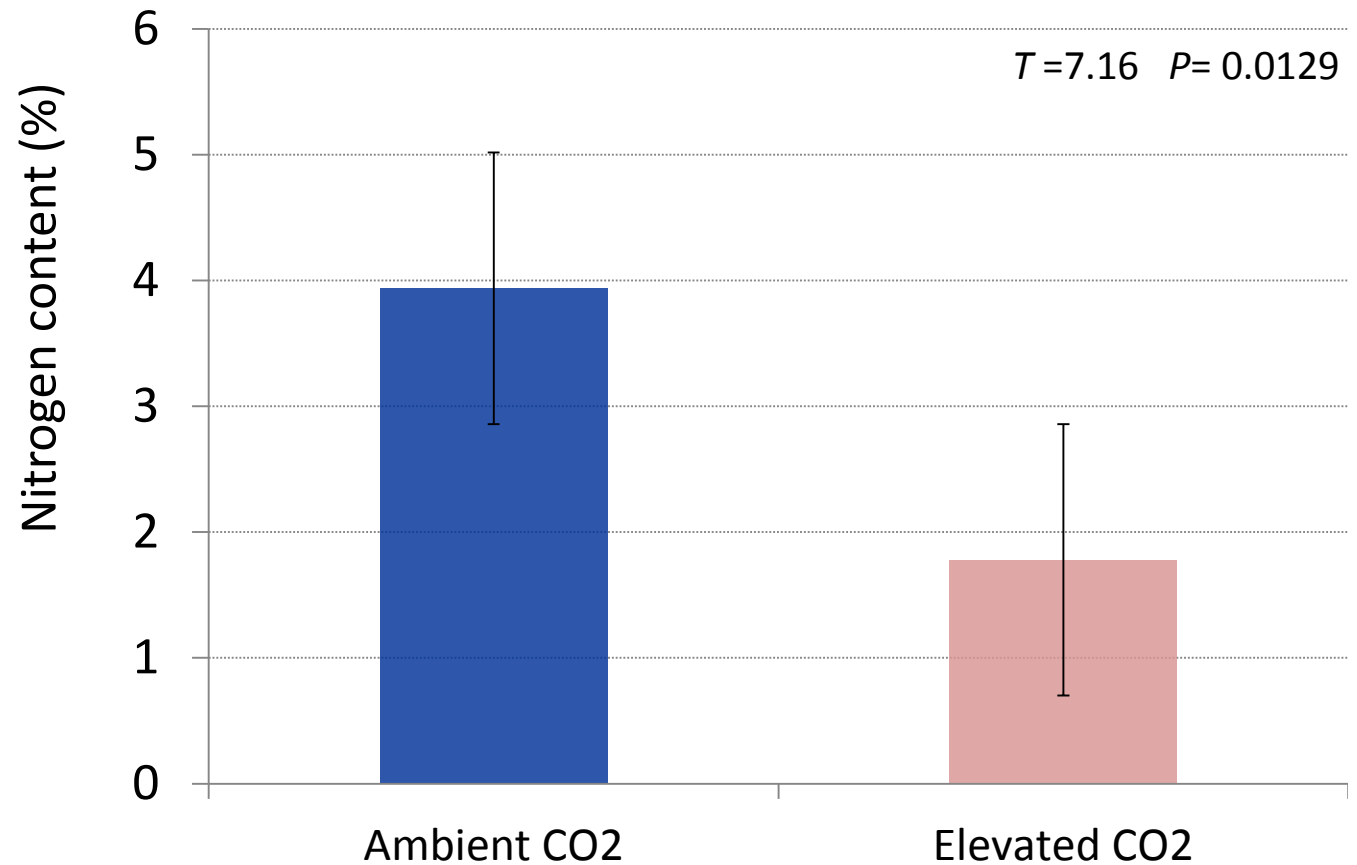
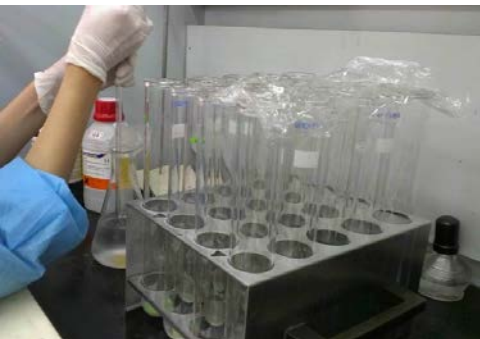
Fresh weight of *Brassica oleracea*



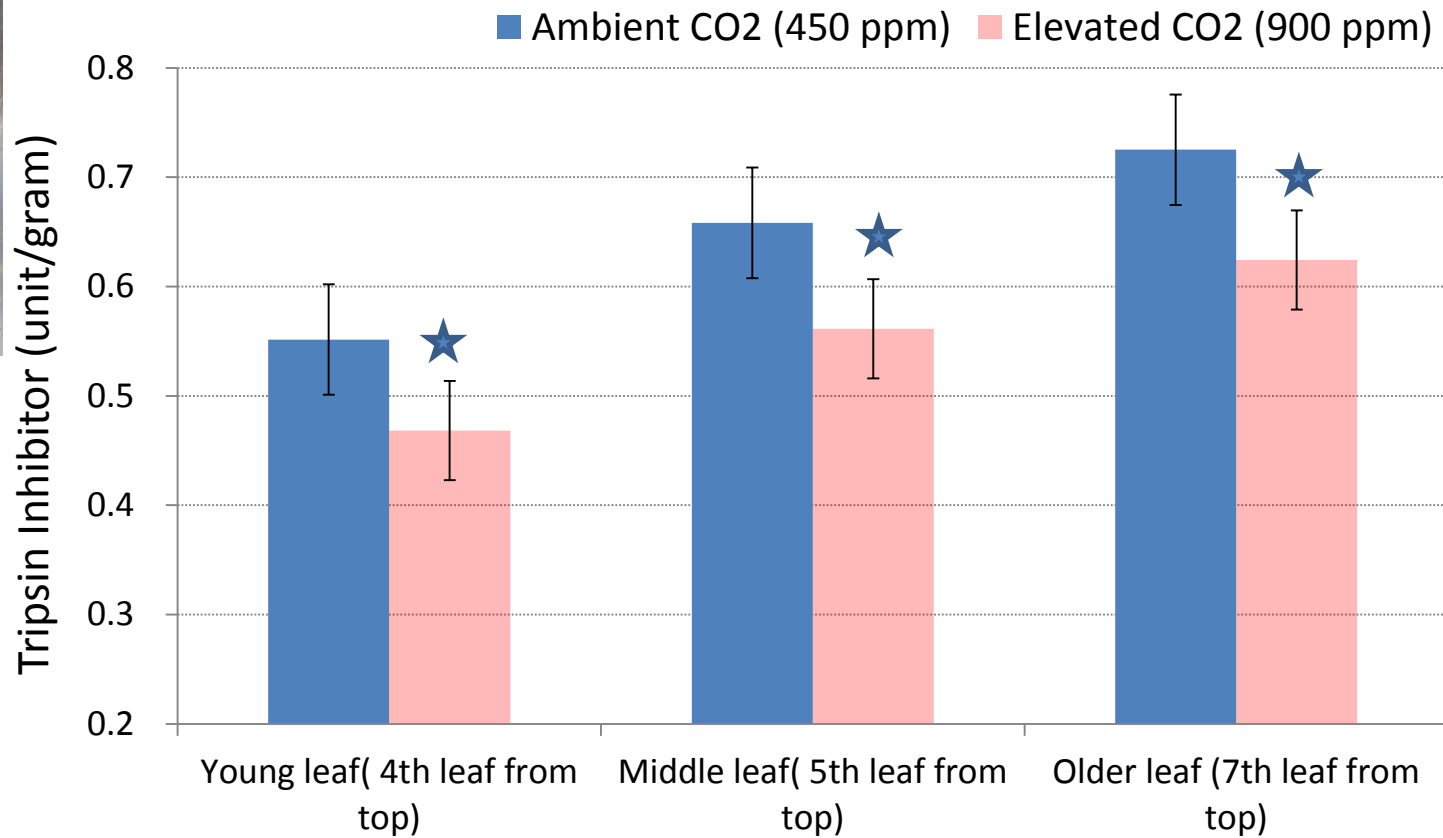
Dry weight of *Brassica oleracea*



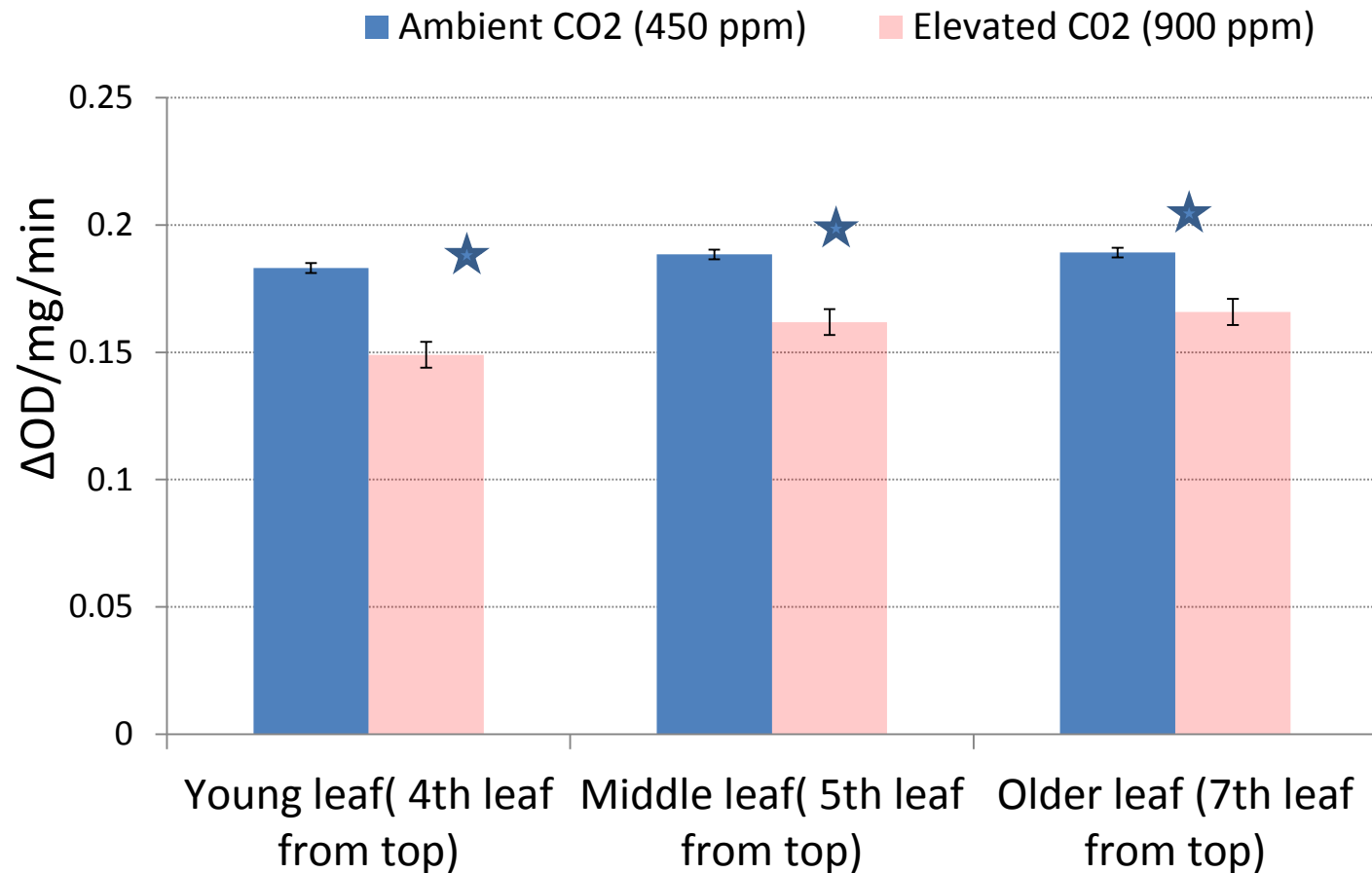
Nitrogen content of cabbage's foliage growth under different CO₂ condition.



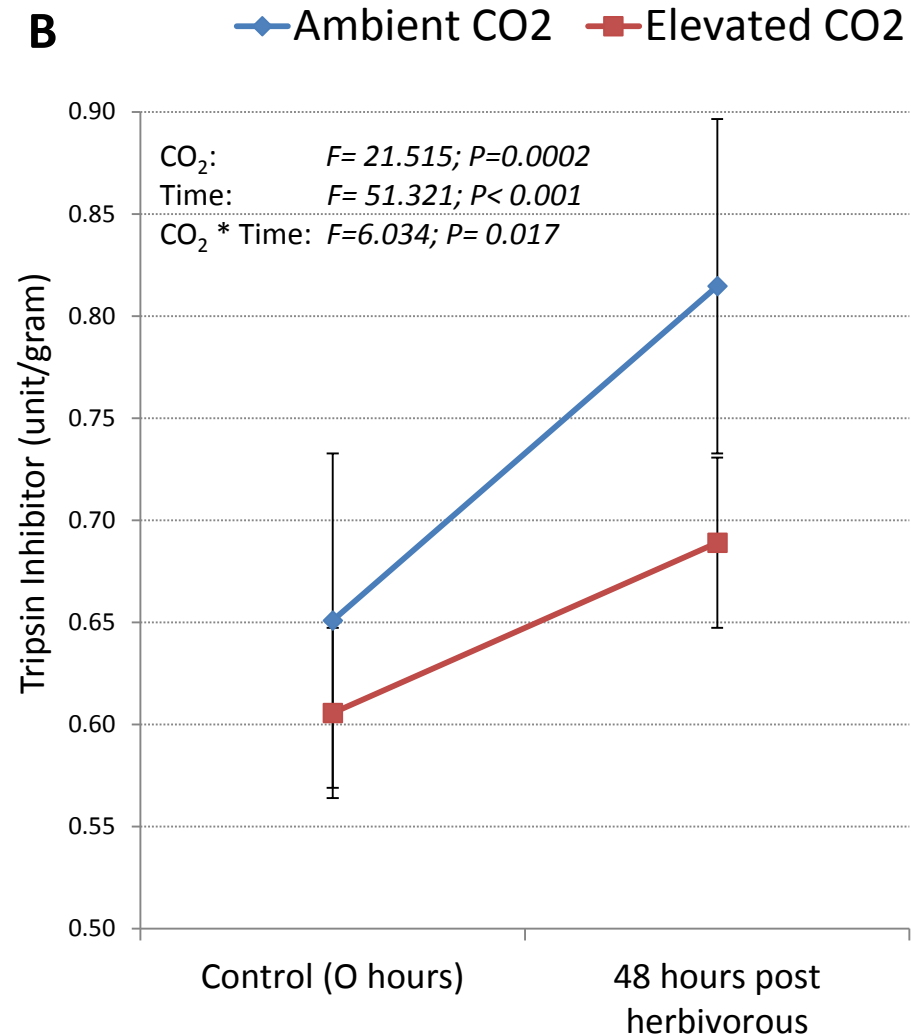
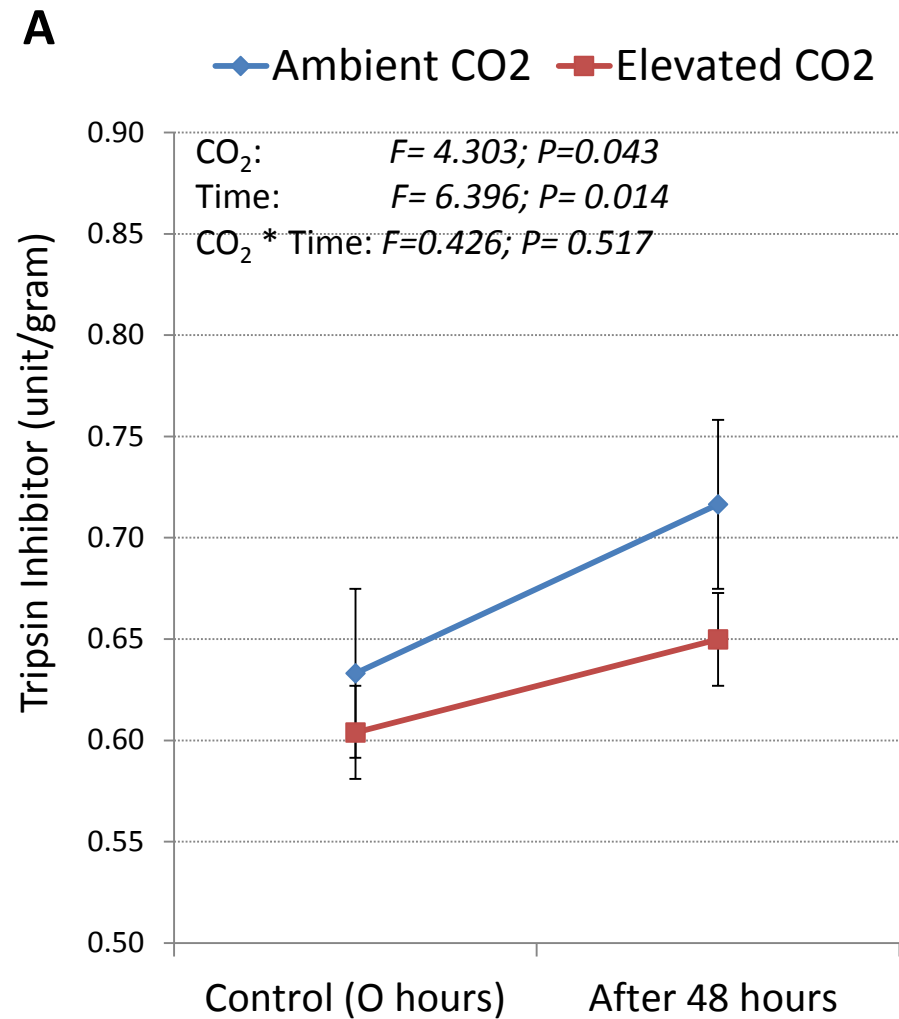
trypsin inhibitor in intact cabbage's foliage growth in elevated CO₂ condition.



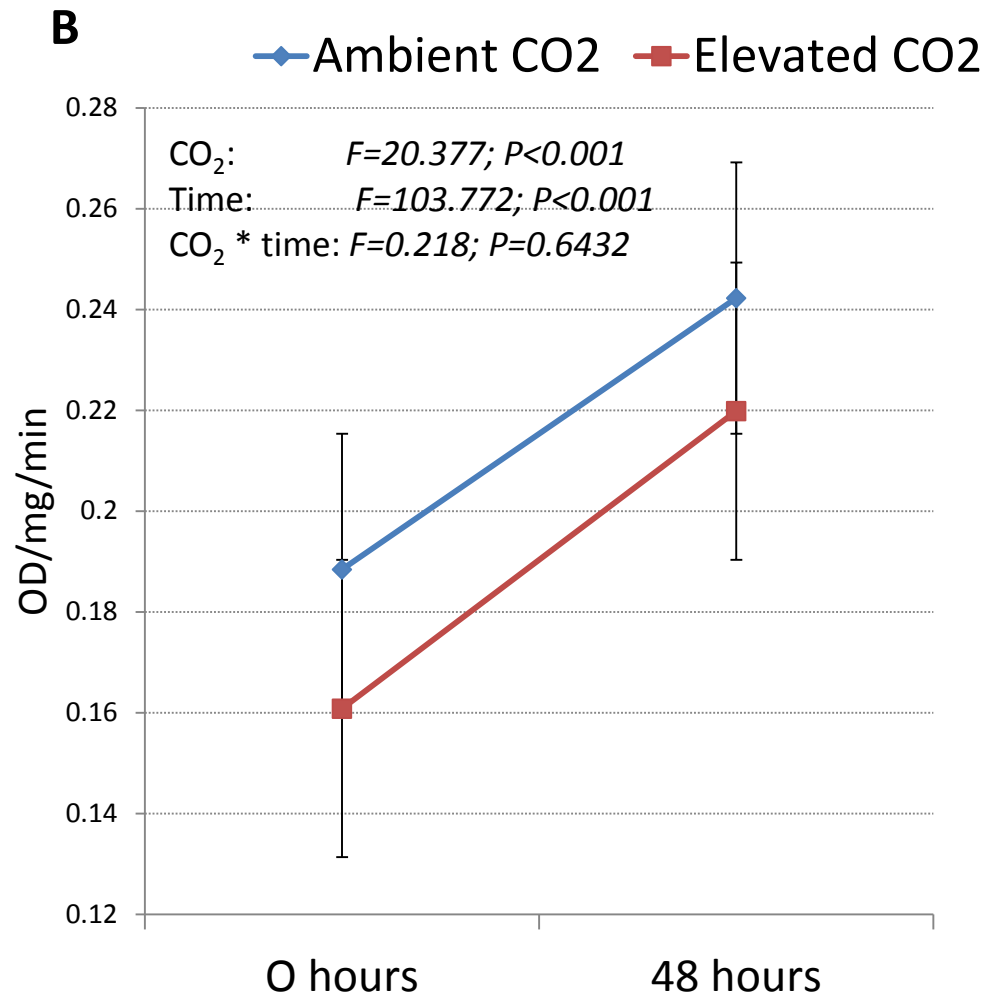
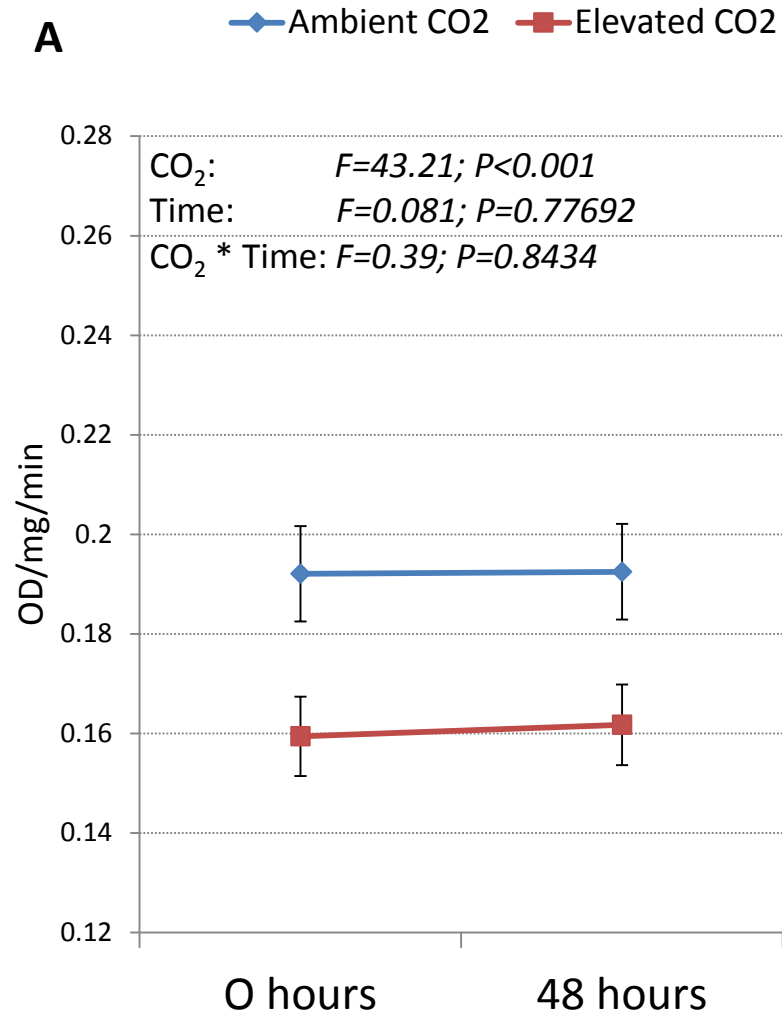
Polyphenol Oxydase on intact cabbage's foliage growth under elevated CO₂ condition.



Tripsin Inhibitor from intact-foilage (a) and herbivorous-damaged foliage (B) of cabbage growth on CO₂ condition.



Polyphenol Oxydase from intact-foilage (a) and herbivorous-damaged foliage (b) of cabbage growth on diffirent CO₂ condition.



The change of TI concentration on direct-induced leaf to control after herbivorous.



CO₂



CO₂

CO₂

CO₂

CO₂

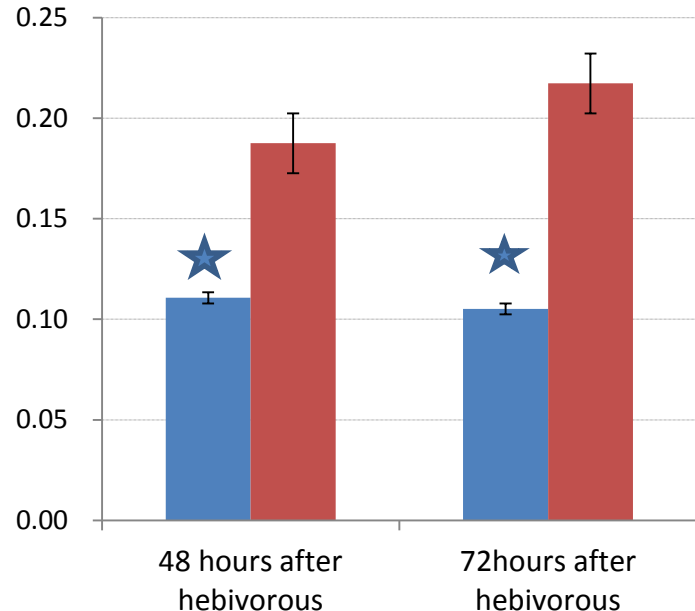
CO₂

CO₂

CO₂

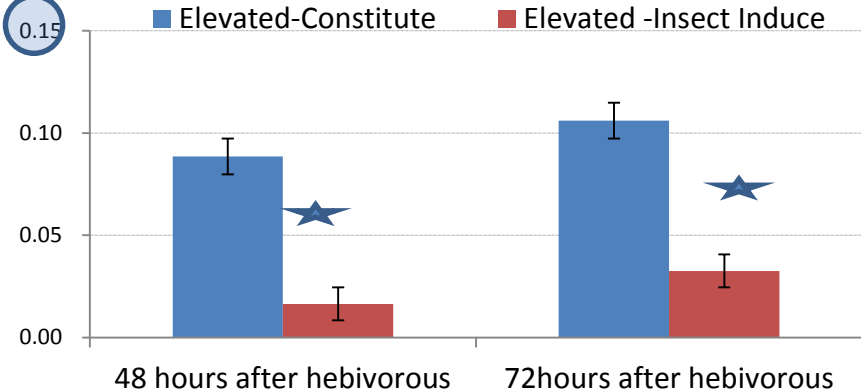
Change of TI to control (unit/gram)

■ Ambient-Constitute ■ Ambient-Insect Induce

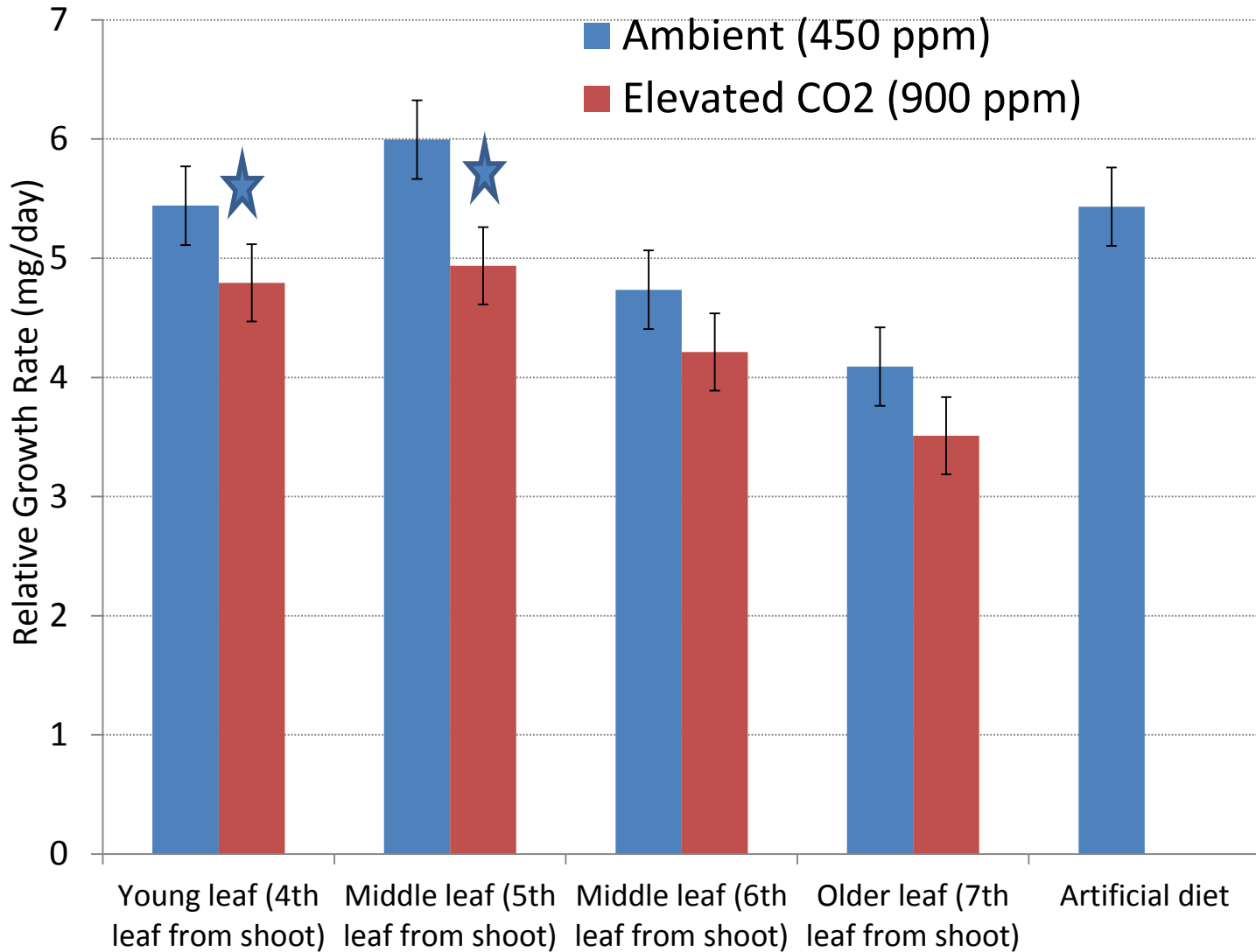


Change of TI to control (unit/gram)

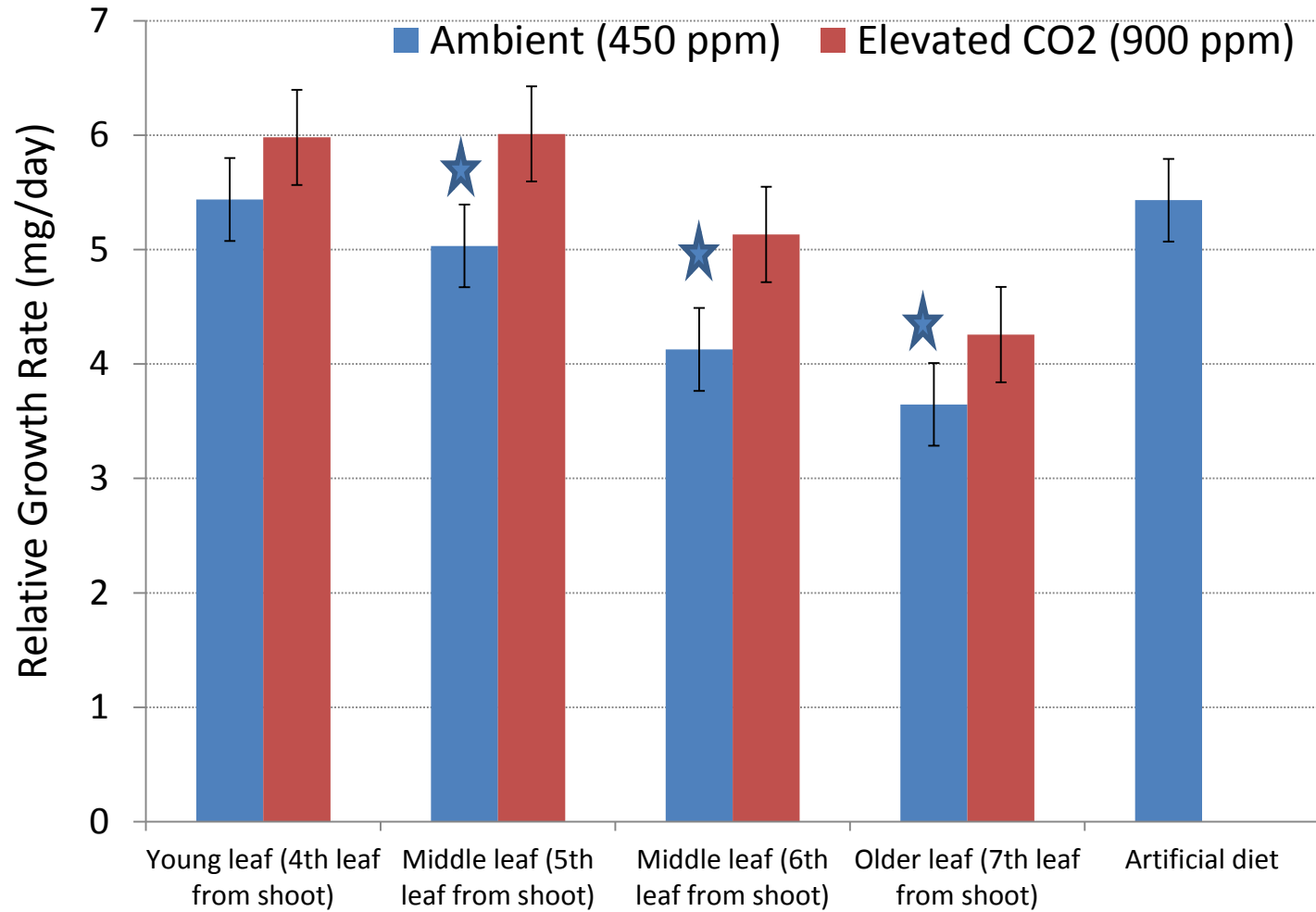
■ Elevated-Constitute ■ Elevated -Insect Induce



Growth rate of *S. litura* on intact foliage



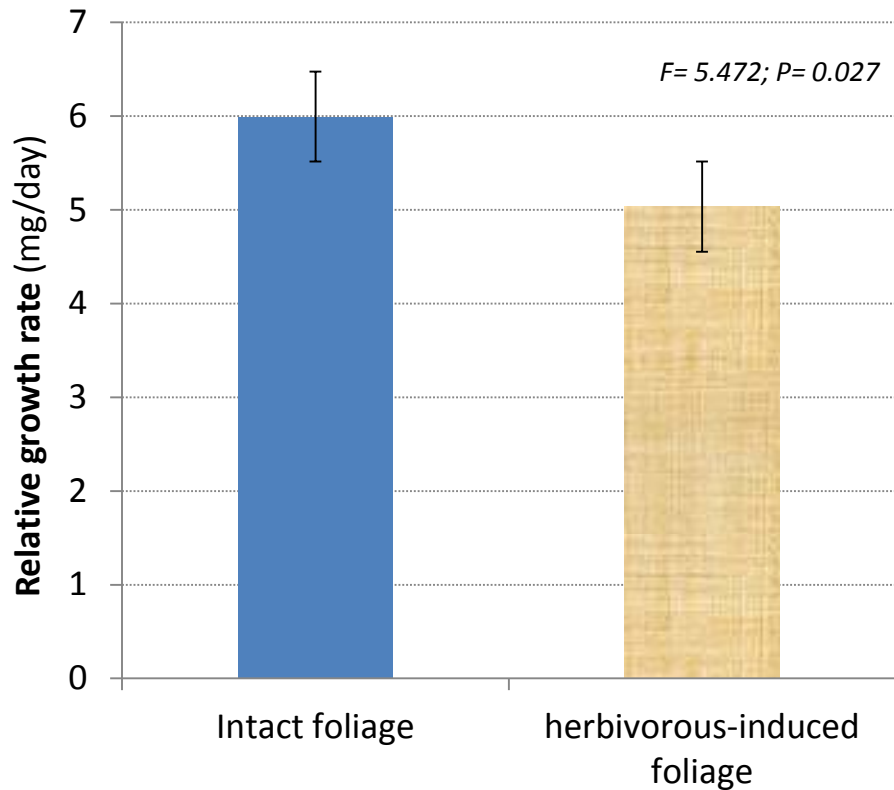
Growth rate of *S. litura* on damaged foliage



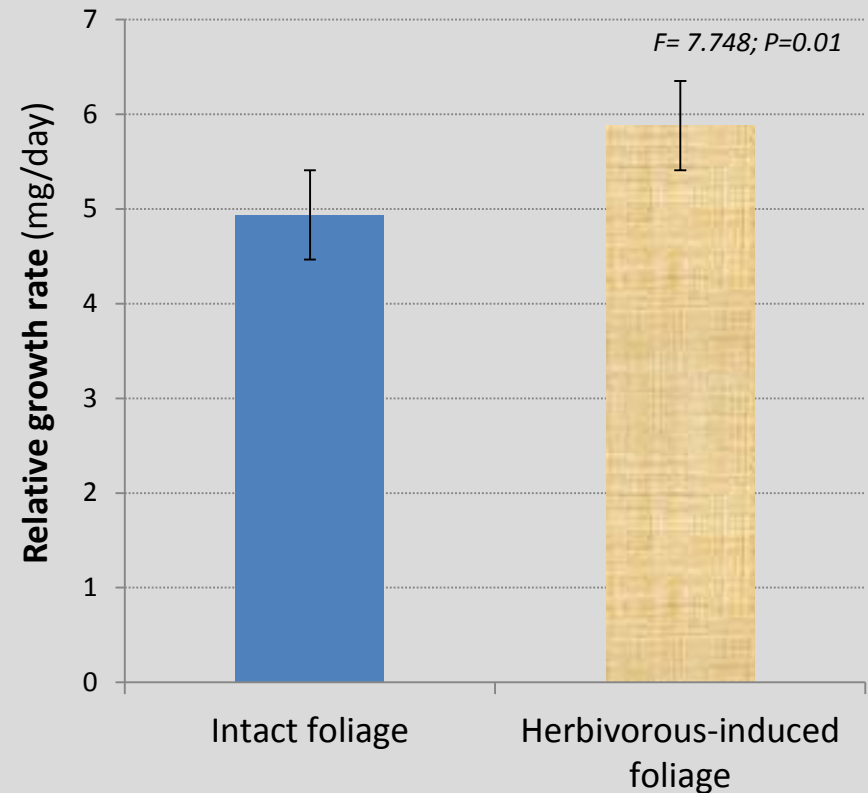
Relative growth rate of 2nd instars larvae of *S. litura* fed on 6th leaf



$CO_2 = 450$ ppm



$CO_2 = 900$ ppm



Closing note

elevated CO₂ condition showed

1. The *better performance* in foliage fresh and dry weight but
2. The *reduce the nitrogen* as proteinous nutritional value.
3. The trend of *reduced defensive compounds* in context of
 - intact plants (constitutive resistance)
 - damage foliage (induced-resistance)



The performance of *Spodoptera litura*

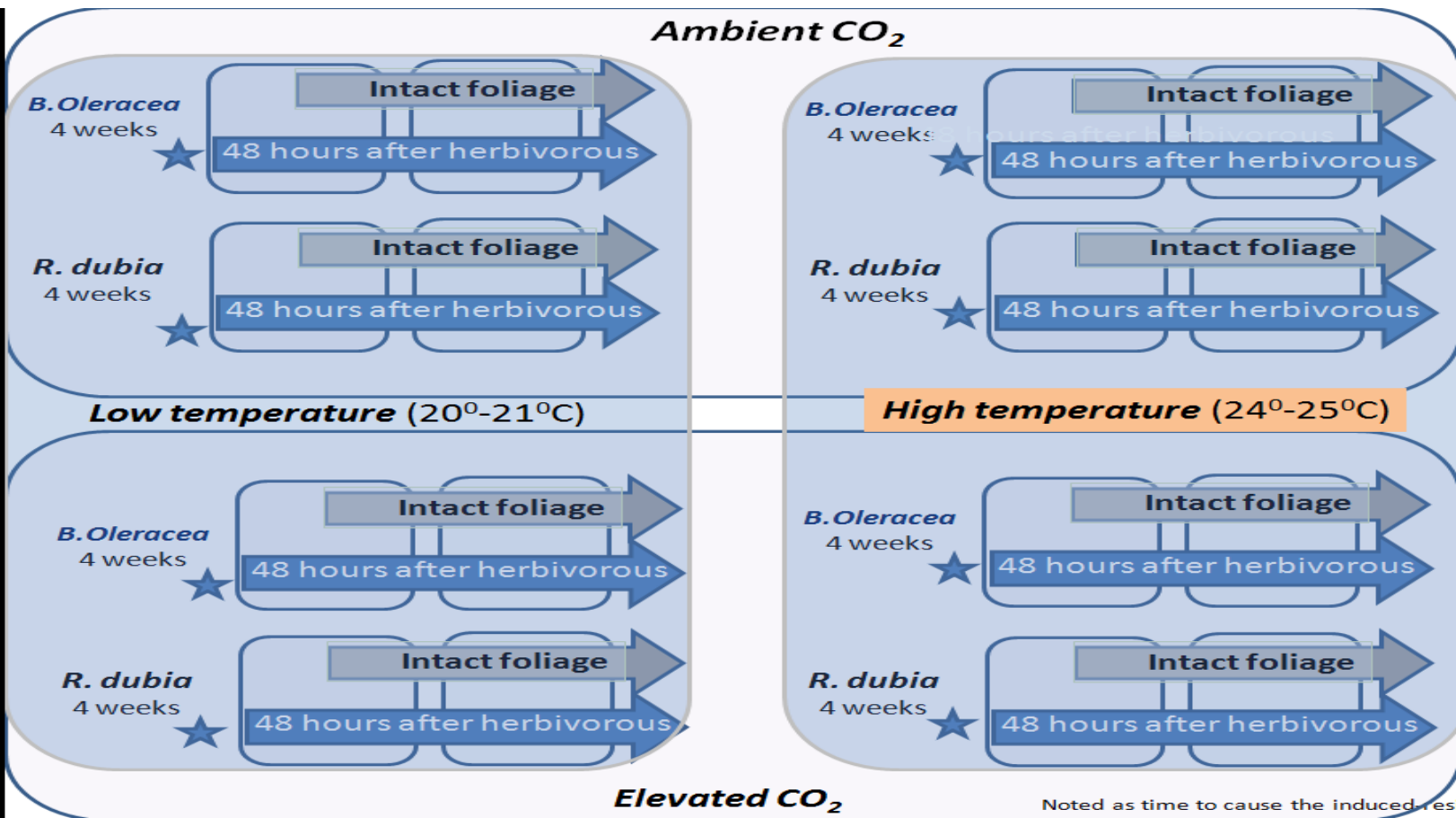


	constitutive resistance	induced-resistance
Elevated CO ₂	Decreasing	Increasing
Ambient CO ₂	Control	Control

- Projection: **outbreak of insect** population can be occur by plant **reduce resistance** in elevated CO₂

Ongoing research

- CO₂ + temperature →
 - Plant performance
 - insect performance



Analyzing

1. foliage's allelochemicals
2. the RGR of 2nd instars larvae of *S. litura* feeding on intact/induced-resistance foliage

Noted as time to cause the induced resistance by herbivorous

Thank you for listening
see you in Taiwan

