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# INTERACTIONS BETWEEN STRESS FACTORS

# STRESS FACTOR INTERACTIONS

- **The study of the interactions of stress factors is absolutely necessary**

**A**. In all natural ecosystems, even in crops, plants are subject to more than one stressors on a daily basis

**B**. The regulation of vital processes, such as photosynthesis, and consequently regulation of growth is accomplished through interactions of more than one stress factors

# STRESS FACTOR INTERACTIONS

- **The study of the interactions of stress factors is absolutely necessary**

**Γ.** Restrictions on the availability of certain resources affect the reactions of plants against other stressors

**Δ.** Capacity to compensate for more than one limiting factor is an important regulatory mechanism

# STRESS FACTOR INTERACTIONS

- **The study of the interactions of stress factors is absolutely necessary**

**E**. Anthropogenic stressors (e.g., pollutants) that were unknown in the history of plant evolution may have a synergistic or antagonistic effect against other, biotic and / or abiotic, stressors

# STRESS FACTOR INTERACTIONS

- **Optimization in resource allocation, through compensation, aims to rationalize plant processes**

  Restricting the availability of a natural resource (e.g. oxygen) is one of the forms of stress that inevitably leads to a fall in productivity or has a dramatic impact on the survival of a plant

# STRESS FACTOR INTERACTIONS

- **Optimization in resource allocation, through compensation, aims to rationalize plant processes**

  **Liebig's law of the minimum**

  **Theory of compensation**

# STRESS FACTOR INTERACTIONS

- **Liebig's law of the minimum**

The growth of a plant organism is determined by the factor with the lowest availability. Therefore, the growth of a plant is essentially limited by a single factor at any time. A second stress factor can only affect growth after removal of the first limiting factor

# STRESS FACTOR INTERACTIONS

- **Theory of compensation**

Plant organisms have developed mechanisms through evolution that enable them to appropriately allocate and compensate for the use of resources that are in a non-ideal availability in the natural environment. The growth of a plant may be equally restricted by all the limiting factors acting at the same time.

# STRESS FACTOR INTERACTIONS

- **Optimizing the allocation of available resources**

The ability to obtain resources and allocate them in such a way that the available resources are not spent on functions or structures that restrict growth or do not confer adaptive advantages under the particular environmental conditions.

Any **deviation** from this 'optimum' inevitably leads to **losses in net carbon gains** with a serious impact on growth

# STRESS FACTOR INTERACTIONS

- **The expression of certain genes is induced by more than one stressor and vice-versa**

  Transcription of genes involved in stress resistance is regulated by the interaction of regulatory proteins (**transcription factors**) acting on specific regulatory sequences of the corresponding gene promoters

# STRESS FACTOR INTERACTIONS

- **The expression of certain genes is induced by more than one stressor and vice-versa**

  In many cases there is induction of **different genes from the same stimulus** which is regulated by **common signal transduction mechanisms** that activate the **responsible promoters**

# STRESS FACTOR INTERACTIONS

- **The expression of certain genes is induced by more than one stressor and vice-versa**

  On the other hand, the **same gene** may include regulatory sequences which are **activated by different stress stimuli**

# STRESS FACTOR INTERACTIONS

- **The expression of certain genes is induced by more than one stressor and vice-versa**

The gene encoding **osmotin** is induced by at least 10 different stimuli: Salinity, dehydration, cold, injuries, viral and fungal infections, ethylene, ABA and IAA.

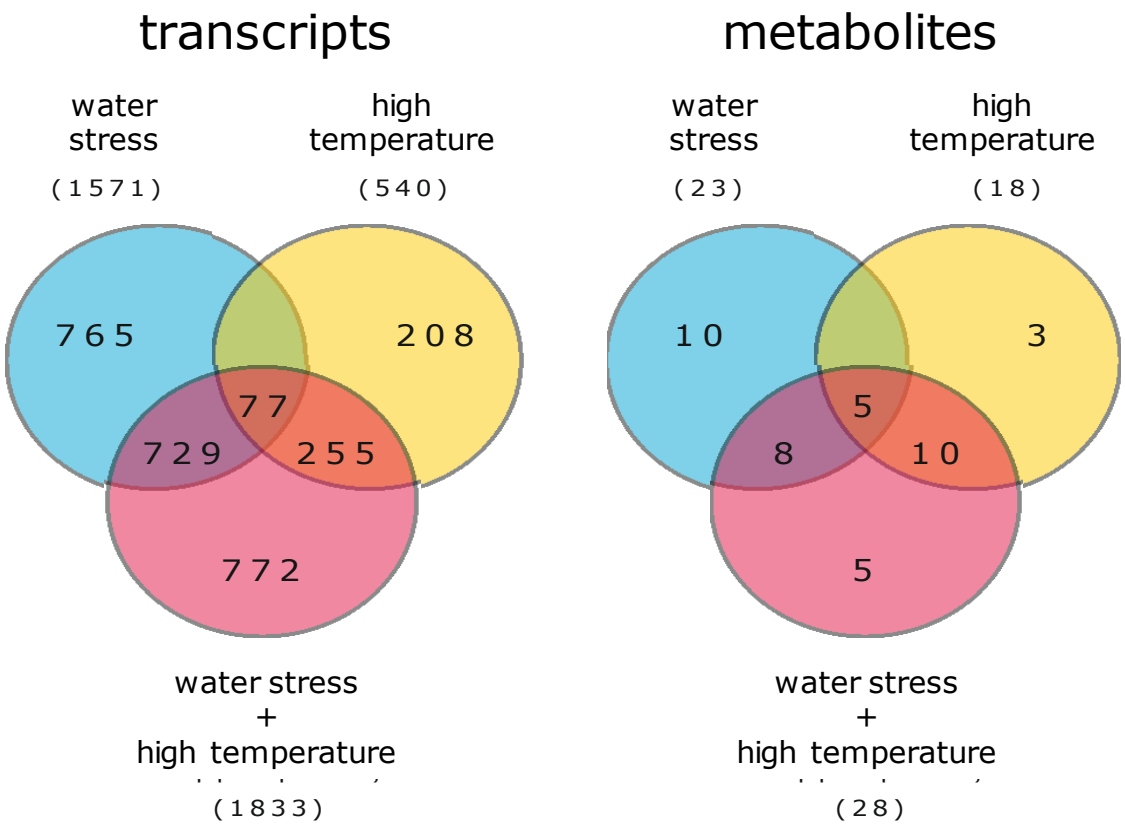
It seems that the common point between these stimuli is the loss of cell turgor. Loss of turgor can occur e.g. due to water or osmotic stress, but also due to cell lysis when attacked by pathogens

# STRESS FACTOR INTERACTIONS

- **The interaction of two or more stressors is a totally new stress condition**

  The reaction of a plant when **two or more abiotic stressors interact is unique** and can not be predicted based on the reaction of the plant against each stressor separately

# STRESS FACTOR INTERACTIONS




The unique transcriptional and metabolic characteristics of plants under combined water and thermal stress. The common and different transcripts and metabolites under water stress, thermal stress or under the combination of the two stressors are shown.

# STRESS FACTOR INTERACTIONS

- **The interaction of stress factors can be synergistic or antagonistic**

  If the interaction results in the enhancement of the damaging effect of a stressor in the presence of a second stressor, it is called **synergistic**

  In the **antagonistic** interaction, the presence of a stressor results in lowering the damaging effect of a second stressor. This phenomenon is also referred as **cross-resistance**

# STRESS FACTOR INTERACTIONS

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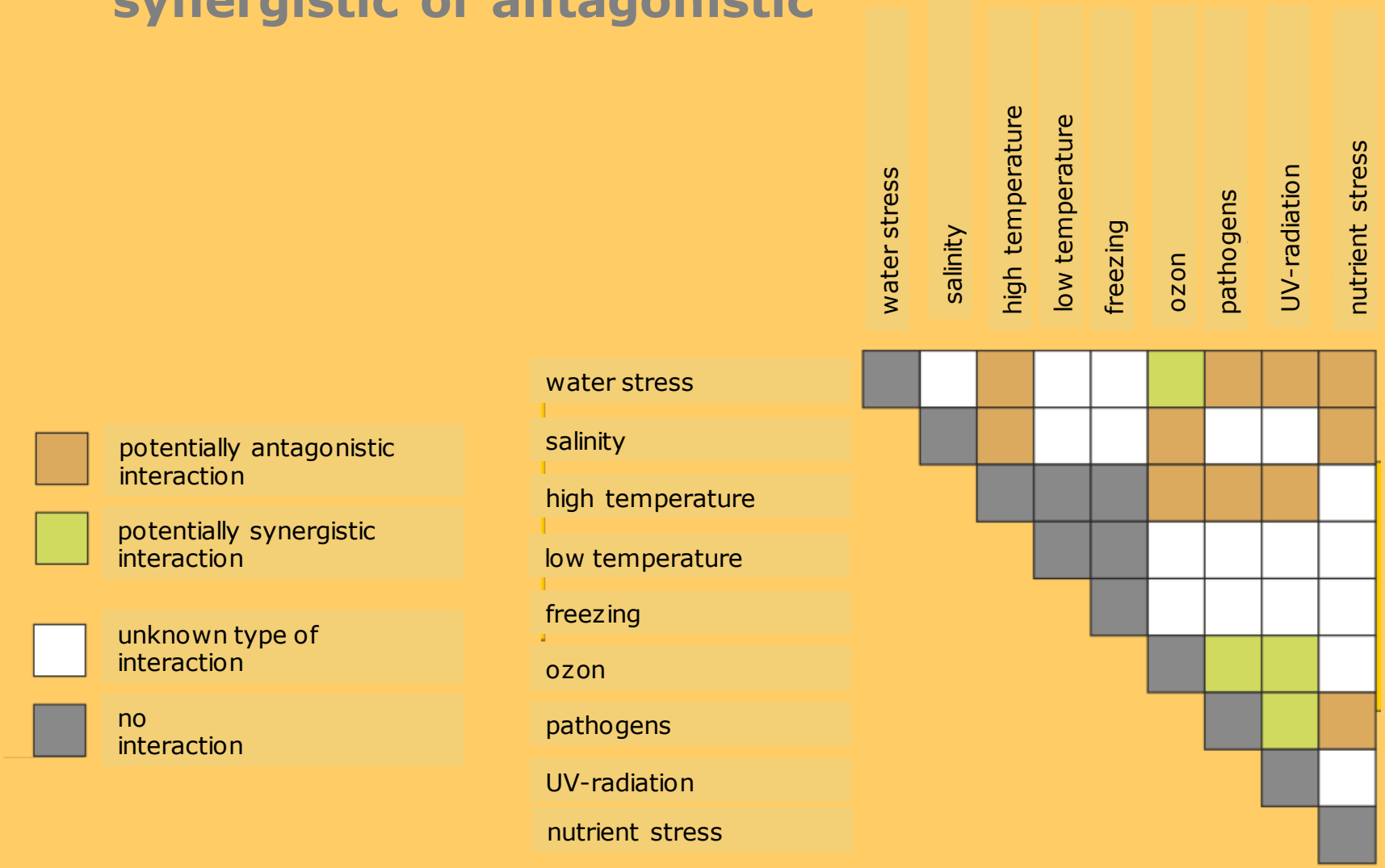
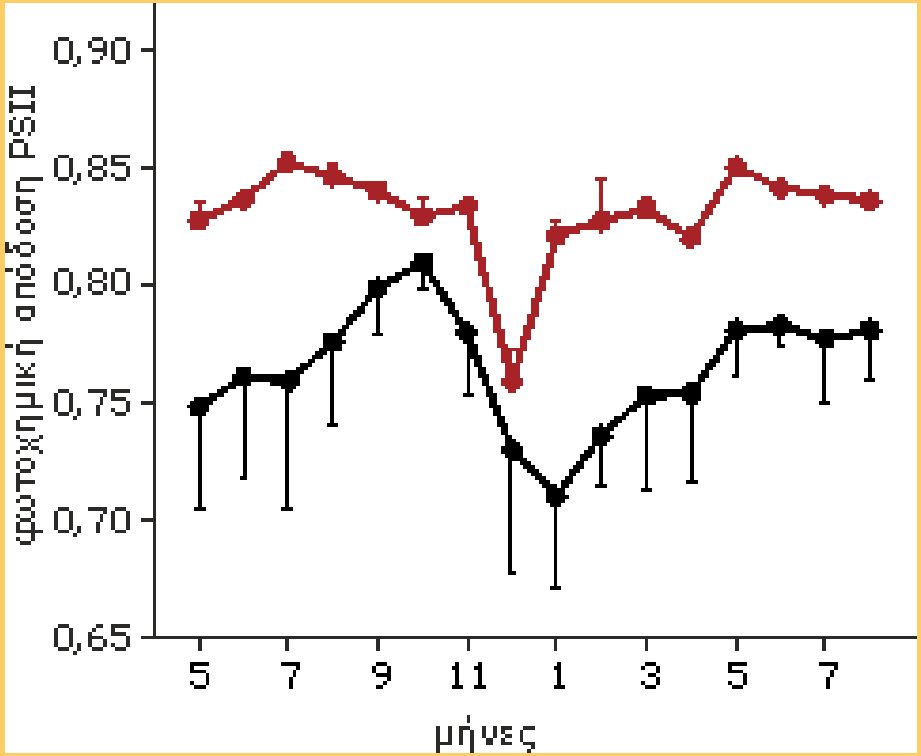


# STRESS FACTOR INTERACTIONS

- **The interaction of stress factors can be synergistic or antagonistic**

High light stress-low temperature stress-**Synergistic**



# STRESS FACTOR INTERACTIONS

- **The interaction of stress factors can be synergistic or antagonistic**

High light stress-water stress-**Synergistic**

# STRESS FACTOR INTERACTIONS

- **The interaction of stress factors can be synergistic or antagonistic**

Salinity stress-hypoxia-**Synergistic**

# STRESS FACTOR INTERACTIONS

- **The interaction of stress factors can be synergistic or antagonistic**

Water stress-high temperature stress-**Antagonistic**

# STRESS FACTOR INTERACTIONS

- **The interaction of stress factors can be synergistic or antagonistic**

Mechanical stress-water stress-**Antagonistic**

# STRESS FACTOR INTERACTIONS

- **The defensive potential of plant tissues against biotic stressors is affected by the abiotic environment**

  The qualitative and quantitative composition in secondary metabolites of plant tissues (and hence their **defense potential**) is affected by the **concentration of nutrients** in the soil

# STRESS FACTOR INTERACTIONS

- **The defensive potential of plant tissues against biotic stressors is affected by the abiotic environment**

  **Water stress** and **high light intensities** also positively influence **the synthesis of secondary metabolites**