ACTIONPIN
EFFECTIVE BY NATURE

HELIOPOLIS®

PHYSICAL THERMIC BARRIER

REFLEX SOLUTION AGAINST SUN DAMAGES

INTRODUCTION

WHAT IS THERMIC STRESS?

Sun is an essential factor for plant development

> Photosynthesis
> Photoperiod
> Optimum temperatures

but when in excess, it is a source of stress for plants. This stress is referred to as THERMIC STRESS and it covers 2 types of stress:

> High temperatures
> Excess UV rays

SYMPTOMS OF THERMIC STRESS

1 **Grapevine**

Solar burns at T° > 42°C
Partial leaf desiccation (browning then necrosis of the blade)
Red-brown lesion on the most exposed side of berries

2 **Cereals/Maize**

Leaf curling is a symptom of thermal stress

3 **Tree crops**

As a result of sunburn, a large brown spot appears on the skin of fruits in full growth, and the tissues become necrotic and rot.

4 **Vegetable**

When the temperature rises above 35°C without a protective sheet, small spots of discoloration or staining appear on the fruit. The fruit tissues then become soft and sometimes wrinkled. The exposed side then becomes whitish or brownish.

2 TYPES OF THERMIC STRESS:

EXCESS OF SOLAR RADIATION (UV)

The ultraviolet (UV) portion is the most "dangerous" one for plants (as it is for humans, especially UVB) since it may:

- damage the DNA of plant cells;
- cause the release of free radicals;
- hinder photosynthesis;
- impact growth.

- Visible damage to the plant and cell death
- Fruit quality and conservation issues (post-harvest)

EXCESS OF HEAT

The intensity of thermal stress depends on:

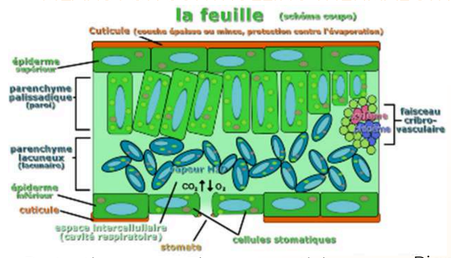
- the characteristics of the temperature rise (intensity, duration, rate of increase, contrast between day and night T°, etc.)

Thermal stress is particularly caused by:

- Sustained exposure to high temperatures
- Heat shock (= large thermal fluctuations)
- The characteristics of the plant depending on the species (C3 or C4 plant), the cultivar, the stage of development and the value of its optimum temperature.

EXCESS OF SOLAR RADIATION (UV)

MEANS FOR CONTROLLING THERMAL STRESS ESTABLISHED BY PLANTS



- Protective wax => The waxy cuticle on the surface of the fruit skin helps reduce water loss.

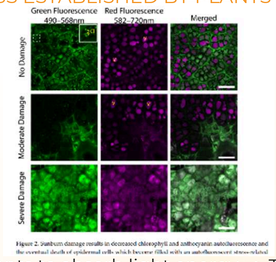


Figure 2. Sunburn damage results in decreased chlorophyll and anthocyanic autofluorescence and the eventual death of epidermal cells which become filled with an autofluorescent stress-related

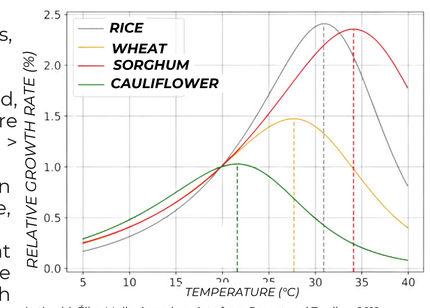
- Pigments to absorb light energy => These pigments (chlorophyll, anthocyanins and carotenoids) increase the fruit's light absorption, helping manage excess light energy.

EXCESS OF HEAT

TEMPERATURE IS A KEY FACTOR IN PLANT DEVELOPMENT.

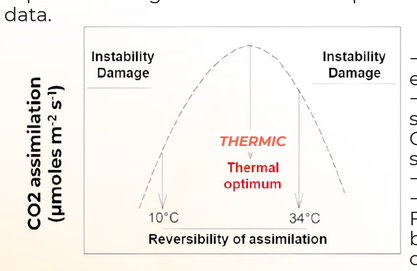
Temperature
–influences the intensity of photosynthesis,
–is involved in cell biochemical reactions,
–conditions the activity of many enzymes until a thermal optimum is reached, beyond which an increase in temperature adversely affects the same reactions = > thermal stress.

Figure 4 - Relative growth depending on temperature for various crop species (rice, wheat, sorghum and cauliflower)
The reference corresponds to growth at 20°C. The dotted lines indicate the temperature corresponding to growth optimum. The curves correspond to a temperature response model fitted to experimental growth and development data.



Author(s): Élise Muller based on data from Parent and Tardieu. 2012
License: CC-BY-SA
Source: New Phytologist

THE THERMIC OPTIMUM IS THE TEMPERATURE OR TEMPERATURE RANGE AT WHICH CO2 ASSIMILATION IS AT ITS MAXIMUM.



–is based on the average temperature of the environment
–can vary according to the sensitivity of the species to heat or cold, the type of plants in C3 or C4 (generally lower in C3), the cultivars and the stage of development of a plant.
–depends on the CO2 content of the ambient air
–depends on the state of hydration of the leaf
For plants from temperate regions (generally C3): between 15°C and 25°C. For plants of tropical origin (generally C4): between 30 and 45°C.

AT CELLULAR LEVEL

IMPACT OF THERMIC STRESS

High temperatures

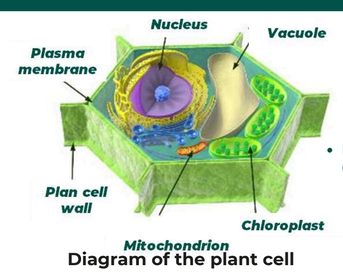


Diagram of the plant cell

MOLECULAR ALTERATION

- **DESTRUCTURED CYTOSKELETON**
- **DISRUPTED IONIC CONCENTRATIONS AND FLOWS**

THERMIC STRESS

DECREASED ENZYME ACTIVITY (IN THE MITOCHONDRIA & CHLOROPLASTS)

- **INCREASED PHOTORESPIRATION**
- **DECREASED PHOTOSYNTHESIS**

BUT STOMATA REMAIN OPEN
=> REDUCED YIELD

WHEAT EXAMPLE

ABOVE 35°C

- Difficult for plants to absorb water and control evapotranspiration
- Sudden heating of tissues exposed to the sun
- Possible immediate and permanent cessation of plant function
- Irreversible yield loss

30 OR EVEN 35°C

- Disrupted cell multiplication
- Long-term effect on photosynthesis
- Damage to reproductive organs

FROM 25 TO 30°C

- The impact on metabolism is low,
- But the filling time (in calendar days) shortens more than the accumulation of sugars in the grains,
- Leading to a TGW loss.

HELIOPOLIS® TECHNOLOGY

MODE OF ACTION AND BENEFITS

SUN PROTECTOR

PINE TERPENES TECHNOLOGY
+β -carotène

- **HELIOPOLIS® is formulated with pine terpenes technology, which provides the following properties:**

1. **Easy to use: liquid formulation, mixing, application**
2. **Reduced leaching**
3. **Lasts for 2 to 3 weeks**
4. **Does not mark the fruit**

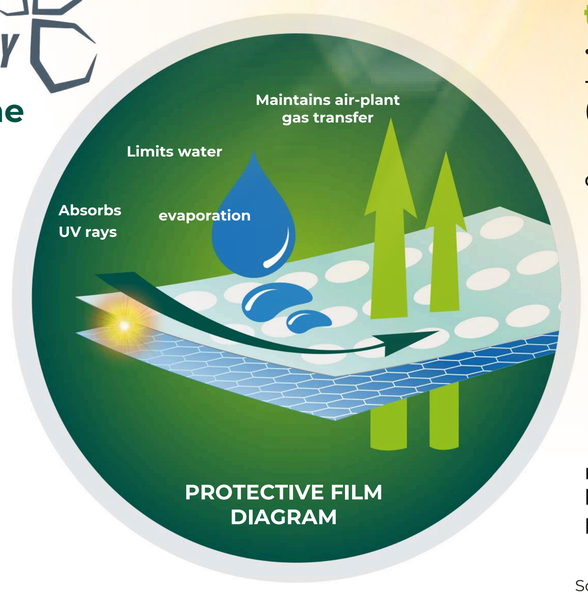
Creation of a protective film reducing water evapotranspiration

• A protective film forming around the plant's organs provides the following benefits:

- Strengthens the protective wax, which limits
-water evapotranspiration,
- Fruit shattering ("exoskeleton") wilting,
- Limits the rise in T° at plant level.

• Without interfering with the fruit's normal ripening and colouring processes.

• By remaining completely permeable to gaseous and liquid transfer at the plant-air interface.



Absorption of UV radiations thanks to β-carotene

• Carotenoids:

- Absorb light in part of the UV spectrum (Solovchenko and Merzlyak, 2008; Joubert et al., 2016).

- Protect photosynthetic organisms under stress conditions (Hashimoto et al., 2016).

> Explanations: Carotenoids play an important role in eliminating excess light energy. When a leaf is exposed to full sunlight, it receives a large amount of energy which, if not managed correctly, can damage the photosynthetic machinery. Carotenoids contained in chloroplasts help absorb excess energy and dissipate it in the form of heat.

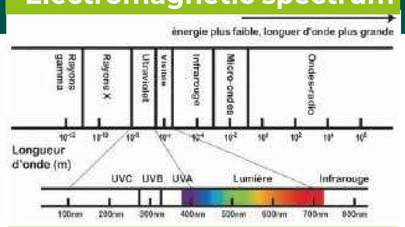
• As a result:

- The protective film of HELIOPOLIS® absorbs UV radiation (particularly UVB rays, which are the most harmful ones) thanks to the presence of β-carotene pigment.

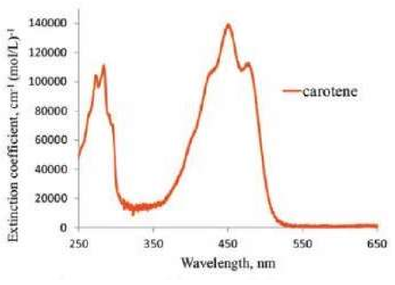
- Less sunburn on plant organs.

Source: Hashimoto et al., H. Hashimoto, C. Uragami, R.J. Cogdell. Carotenoids and photosynthesis. C. Stange (Ed.), Carotenoids in Nature. Subcellular Biochemistry 79, Springer, Cham (2016)

Electromagnetic spectrum



Absorption spectrum of beta-carotene



Spectrum of beta-carotene extinction coefficient in the range of 250-650 nm (60)

SCIENTIFIC EVIDENCE

HIGH PERFORMANCE

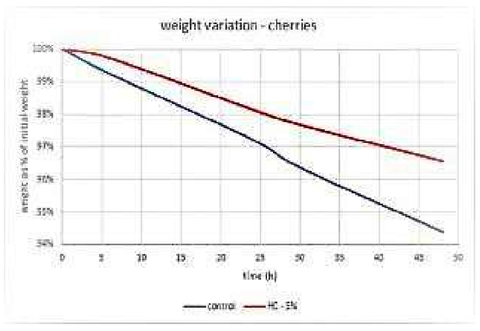
SCIENTIFIC EVIDENCE

REDUCES WATER LOSS BY 40%

LIMITS WATER EVAPOTRANSPIRATION

LABORATORY TRIAL ON CHERRIES

• PROTOCOL
-Cherries placed in an oven: 25°C
-The weight of the cherries is measured every 12 hours for 48 hours



RESULTS
Weight loss in cherries is linked to water loss through water evapotranspiration.
HELIOPOLIS® slows down this loss.

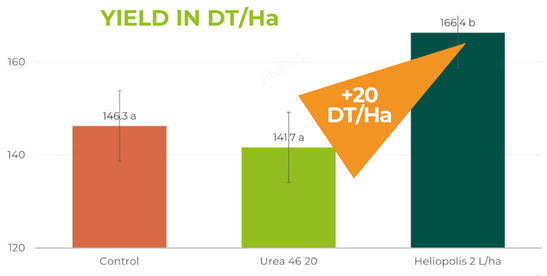
RESULTS OF AGRONOMIC TRIALS

MAIZE (EXCEPTIONAL)

• PROTOCOL
Location: East France (distributor)
Evaluation of yield

TREATMENTS
1. Control
2. Urea 46, +20 units, 5-leaf stage, 07/06/23
3. HELIOPOLIS® 2 L/ha 5-leaf stage, 07/06/23

YIELD IN DT/Ha



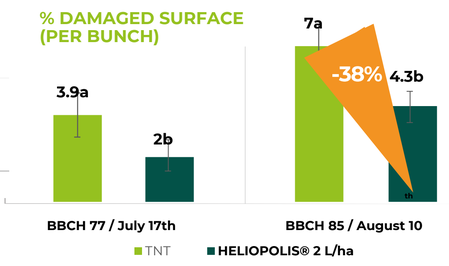
RESULTS
Applying **HELIOPOLIS®** at 5-6 leaf stage = ideal stage to protect the maize plant against thermic stress. In the case of this distribution trial, the yield gain was exceptional: **+20 dT/ha** compared with applying urea at 5-leaf stage, a practice considered to optimise maize yield.

GRAPEVINE

• PROTOCOL
Location: Italy
Evaluation of 50 bunches
Spray volume: 100 L/ha

TREATMENTS
1. Control
2. HELIOPOLIS® 2 L/ha
2 applications:
▪ 17/07 - BBCH 77
▪ 10/08 - BBCH 85

% DAMAGED SURFACE (PER BUNCH)



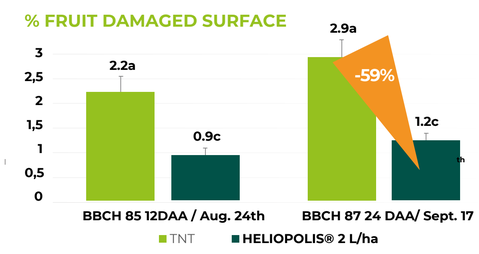
RESULTS
The 2 applications of **HELIOPOLIS®** at indicated stages will protect the plant against sunburn.
In this trial carried out in Italy, the surface damaged by sunburn was reduced by **38%**.

APPLE TREE

• PROTOCOL
Location: Greece
Evaluation on 50 apples
Spray volume: 1000 L/ha

TREATMENTS
1. Control
2. HELIOPOLIS® 2 L/ha
3 applications:
T1 29/07 – BBCH 81
T2 12/08 – BBCH 85
T3 24/08 – BBCH 85
2 observations: ▪ 24/08 > T2 + 12 days ▪ 17/09 > T3 + 24 days

% FRUIT DAMAGED SURFACE



RESULTS
HELIOPOLIS® reduces by **59%** the percentage of damaged surface on apples at BBCH 87.

ROI CALCULATION

CROP	NO OF TRIALS	DOSE APPLIED	YIELD GAIN dt/Ha
WHEAT	6	2 L/ha	+4,2
MAIZE	3	2 L/ha	+10
POTATO	3	2 L/ha	+18
SOYABEAN	2	2 L/ha	+20
SUNFLOWER	3	2 L/ha	+24

CROP	FARMER SELLING PRICE	GROSS ROI €/t	NET ROI €/t
WHEAT	225	94,5	62,1
MAIZE	200	200	167,6
POTATO	350	630	597,6
SOYABEAN	500	100	67,6
SUNFLOWER	350	84	51,6

WARNING.
EUH401 Follow instructions for use to avoid risks to humans and the environment.
H315 causes skin irritation.

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