# Stress in crops due to high temperatures

The environment has a direct influence on the productivity of crops. In fact, an increase in cases where biotic and abiotic factors determine the growth and productivity of plants is increasingly common. Also common is crop loss due to climate fluctuations to which crops are subjected as the seasons change and due to stress on account of high temperatures.

Plants, just like all living beings, receive external stimuli that unleash chemical and physiological responses in their behavior. All plants are affected to a greater or lesser degree by those stimuli, which serve as triggers for physiological responses of the organisms.

Changes in climate factors, as well as phenological and populational changes, can impose severe restrictions upon the growth and development of plants. These conditions are called stress situations. The concept of "stress" in plants implies the presence of an external factor, provoked by the changing environment, which adversely influences their growth and optimal development and thus negatively impacts agricultural production.

"Stress" is considered to consist of any environmental factor that acts on the plant, thus affecting its biochemical and physiological response, which can provoke damage or, occasionally, injuries. A change of the climate, transplanting, pruning, fertilization, fertigation, the soil itself, and tillage, are stress factors for crops, since they represent a change in their external system that produces changes in their organic development. A clear example of this is the commonly seen curvature of crops in response to high temperatures.

Temperature, either too high or too low, is the principal abiotic factor that generates stress in plants. When the source of stress is temperature that is too high, a plant can even undergo morphological, physiological, and biochemical changes. When the temperature rises above 104ºF, it can occasion burns in young shoots and leaves, leaf senescence, and abscission, damage to the fruits, and other harm both to the shoots and the root system.

**Symptoms**

High temperature stress can be quickly identified in crops. Its most common symptoms are:

- Withering plants

- Sickly appearance

- Sunburn

The symptoms start with an alteration of the plants' photosynthesis system, caused by cellular respiration problems on account of the prolonged high temperatures. Next, oxidative damage occurs and rotting of the tissues. This occasions a decrease in the length and quality of the plant's life as a function of its productive development.

Optimal temperatures for crops of a given species vary as a function of a plant's genetic loads. Nonetheless, there is a standard measure that contemplates a range between 73 to 92°F. In theory, this measurement covers a broad spectrum that can be well tolerated by a wide range of species.

**Risk Factors**

Each plant contains a pathogen that makes it more or less resistant to the temperature levels of the environment specified for the crop. A clear example of that is the severe adverse effects on plants that are not acclimated at temperatures ranging between 86-95°F and cell death when exposed to temperatures between 113-122°C.

Increases in temperatures above normal levels at which plants develop have caused deformations in their reproductive organs. In fact, observations have been made of the presence of double and even triple pistils in *Prunus avium* flowers.

As seen above, one of the abiotic factors with the most influence on the growth and production of a species is exposure to high temperatures, where the crops can suffer from hydric stress due to lack of water coupled with dehydration due to the temperature.

This represents a problem for the producer and places the crop's growth at risk. Indeed, during "heat waves," levels of enzymes and proteins in plants diminish due to mounting disequilibrium between the speed at which the plant is forming and the speed at which it is degrading, because the plant is degrading more quickly than it is forming.

**Consequences**

The principal risks, consequences, and challenges that must be dealt with for an agricultural production subjected to long periods of stress in response to high temperatures are:

- Thermal stress due to high temperatures (heat shock) induces the syntheses of a set of proteins present in unstressed cells, named "Heat Shock Proteins" (HSP's).

- The universal response to the high temperatures is production or induction HSP's, which make plants tolerant to heat shock.

- Some varieties adapt to thermal stress and might only experience a small reduction in their photosynthesis. Yet in other, less tolerant varieties, there might be a severe reduction in their photosynthesis of up to 65% or more.

- At high temperatures, a reduction in photosynthesis means that less of the nutrients absorbed will be directed towards plant growth or the generation or production of flowers.

- The lack of viable pollen —due to its scarce production on account of high temperatures and cell decomposition— is the principal cause of a poor fecundation, which translates into economic losses for the producer.

- There can also be a lack of dehiscence of the pollen sac (failure to release the pollen) caused by a damaged endothecium that fails to open correctly due to the heat waves.

- The ovules in the ovary can also be damaged by heat, which drastically affects fertilization and agricultural production.

- At temperatures in excess of 95-104°F a softening and darkening of plant's interior often occurs.

- Injuries are seen in the epidermis in the form of spots or sores, that suberize, lowering the fruit's quality and blemishing its appearance. This downgrades the fruit's quality, resulting in a lower sales price and diminished agricultural earnings.

- When the heat shock occurs at the time of maturation, massive amounts of fruit can fall off the plant, due to the premature formation of the abscission layer in the peduncles.

**Recommendations**

The control of high-temperature stress in crops is one of the principal challenges that all growers must contend with at some point in time. It is therefore important to put methods and strategies into practice that allow for a dual approach to handling the situation. This involves the implementation of systems aimed at controlling high temperatures, adapting them in order to maximize their effectiveness, as a function of crop needs and the producer's best judgment.

For such purposes, it is recommended to implement strategies for reinvesting resources. For example: to work towards attaining a better distribution of light within the crown in order to favor the quality of the fruits, based on better exposure to the sun.

It is also recommended to properly manage irrigation in order to avoid hydric stress.

In addition, it is recommended to maintain stable levels of sunlight, ranging between 600 to 800 micro-Einsteins. This allows photosynthesis to take place in a normal fashion, without jeopardizing production development.

**Stress Management in Crops**

- The crop wiring can be shaken to help release the pollen and facilitate pollination.

- Implementation of bursts of air at intervals to release pollen that has adhered to the plants due to levels of dampness and heat.

- Electrics vibrators that shake the flowers and allow the grains of pollen to be released and potentially fall that onto the stigma.

- Bumblebees are not very sensitive to extreme temperatures and can help in attaining better results. They should even be used under conditions of very high temperatures.

**Crop Treatments for High Temperatures**

Treatments and strategies to be implemented for controlling and minimizing the effects caused of high temperatures include a wide array of approaches to reduce the effects of high temperatures on crops. These are principally grouped into two types of treatments: a) the use of biochemical factors that improve the plants' own resistance and 2) implementation of strategies that mitigate climatic conditions for the crop, as a function crop needs.

**Biochemical Treatments**

Among the treatments most recommended is the implementation of Screen Duo. Screen Duo was created with a unique composition, formed by a base of terpenoids + hydrolyzed kaolinite in micro-particulate form that help protect against heatwaves from the sun and contribute to keeping the fruit clean in packing (60-75 kilos/hectare per season), as well as contributing to the caliber, yield, soluble solids, fruit skin quality, plant vigor, and to greater efficiency in the use of water and environmental moisture, in addition to sustained increased yields over time.

Use of terpenoids is very common for strengthening the activity of the chloroplasts, preventing oxidation of the plant, and protecting the internal conditions of plants and fruits.

There is a synergy between the terpenoids and the refined kaolinite, which improves and strengthens photosynthesis, a key factor when analyzing the results and the crop's earnings; "a greater total yield and better earnings are direct results of a better and more prevalent photosynthesis and proper functionality of the plant as a whole"

Currently, the implementation of Photon WG is quite popular among dicarboxylic acid-based products. It functions as a type of anti-stressor, activating in reaction to climate-stress cycles in the plant.

**Organic Treatments**

- Cover the soil with plant remains in order to protect the pads, keep soil temperature low, and conserve moisture.

- Minimize the effects of high temperatures by keeping the crop free of hydric stress. Cooling of the crop by transpiration can bring the crop's temperature down to more than 9°F below the temperature of the air.

- Sprinkler Irrigation: use this type of irrigation during the night to lower the temperature of the soil.

- Select the optimal time for planting, avoiding high temperatures during the plant's flowering period and the filling of the grain.

- Chose a variety that is as well adapted as possible to the climate conditions of the place in order to avoid high temperatures during the plant's flowering period and the filling of the grain.

- Nebulization: This is a technique used in order to reduce and manage high-temperature stress in crops grown in greenhouses. It has two forms: 1) high-pressure nebulization and 2) low-pressure nebulization.

- In high-pressure nebulization, the high pressure used and the small size of the nebulizer orifice cause a drop to be created whose diameter is very small. This makes the drop very light weight, and it therefore floats in the greenhouse atmosphere for a longer period of time. This technique is excellent, although one must weigh its high economic cost and use a very good quality water.

- In low-pressure nebulization, the size of the drop is much larger than when high-pressure nebulization is used. The drop thus weighs more and falls quickly onto the crop, on account of which it is less effective in lowering the soil temperature.

**Prevention**

There are many ways to prevent and control high-temperature stress in crops, with the aim of preventing production losses and low-quality products. The development of greenhouses with padding or wet cooling walls is a strategy used to reduce the effect of heat on crops.

Thermal curtains can be used to regulate the greenhouse's internal temperature, aimed at reproducing the ideal temperature for the crop and minimizing the effect of major heat waves.

Likewise, the full development of the plant's transpiration is the prime determinant of its capacity to cope with high temperatures.

Other methods and strategies that can be implemented to prevent high-temperature stress include:

- Planting in soils that are on slopes or in foothills.

- Avoiding soils filled with weeds or the sowing of pastures or grain crops near a fruit orchard.

- Avoiding overworking the soil.

- Keeping the crops well fertilized.

- Applying bactericides, antibiotics, or other such products to the foliage.

- Use of covered structures (tunnels and greenhouses).

- Inverting of the air layers (use of fans).

- Heating of the air (burners).

- Increasing soil moisture.

It is important to constantly check on how crops are being affected by the sun's radiation and high temperatures. These drastically alter the crop's quality, production levels, and profitability, thus adversely impacting the economic and financial development of an agricultural enterprise.

**Crop Nutritional Monitoring**

At **AGQ Labs** we have been working for more than 25 years in the continual monitoring of plant needs at any given time. In a practical and dynamic manner, throughout the growing season, we monitor the crop's needs for water and nutrients, in order to adjust the irrigation and fertilizer regime to that demand.

Moreover, with such monitoring we achieve a sustainable agricultural practice, because there is no leaching that contaminates the aquifers or harm the soil structure. The result is:

- **Minimization of environmental impacts**
- **Optimization of nutritive irrigation**
- **Better quality product**
- **Important savings in fertilizer costs**
- **Greater productivity and larger yields**

To accomplish this, we have developed an internal Crop Nutritional Monitoring procedure, based on analyzing soil solutions extracted using our patented suction probes.

At all times, our guarantee is based on the know-how gained by AGQ Labs over the course of our history. Through our continual efforts, we have reached optimal reference values for the major crops. Our agronomists from around the world are experts in the interpretation of all this information, thus contributing the greatest value in matters of irrigation and nutrition.

Feel free to contact our Agronomist department for more information.