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Grapevine adaptation to drought stress

The terms stress and resistance to stress are used for plants in the same way they refer to animals and humans. Stress basically means a state of tension and shows the effects of a negative charge on the body. It is caused by the involvement of external factors (stressors), which lead either to damage or to a reduction in metabolism and growth. Stress factors can be biotic (ie due to other organisms) or abiotic (resulting from extreme environmental conditions outside the plant). One factor that can cause strain to plants is water. The flooding of the soil with water results in the pores of the soil being saturated and thus can cause lack of oxygen, which is necessary for the respiration of the roots of plant organisms, resulting in the latter suffering from anoxia.

On the contrary, the lack of soil water can cause a reduction in growth in mild conditions until the plant dries out intensely. In general, dehydration refers to a condition in which the water capacity and cell density are reduced to such an extent that normal functions are affected. Plants in order to cope with water stress conditions develop various mechanisms and thus ensure their survival.

Grapevines' responses to water scarcity are complex and can be either stress-adaptive or harmful. Under field conditions, these reactions can be cooperative or competitive, modified by the simultaneous action of other stresses. The reactions of vines in order to face drought involve a set of stress avoidance or tolerance mechanisms that vary depending on the genotype. This complexity is well illustrated in Mediterranean-type ecosystems where plants predominate.

Drought avoidance reactions (such as the deep root system).

Rapid reactions to water stress help in immediate survival, while acclimatization, which refers to new metabolic and structural properties, is achieved by altering gene expression. This helps to improve the functionality of vines under water stress.

These reactions include:

• Stress tolerance (vines tolerate stress without major damage).

• Protection against the stress factor through appropriate protective mechanisms. Reversing the effects of stress through repairing the damage caused. Vine is a plant that is resistant to water stress. This resilience is due to anatomical and physiological changes in the whole plant, which aim in reducing its water needs and its losses through evaporation and transpiration.

A. Anatomical changes.

The vine, like many other plant species, develops various anatomical features in order to cope with dry environmental conditions such as in the Mediterranean. These characteristics may be more pronounced or less pronounced d**ep**ending on the environmental conditions. Some characteristic changes are:

- Increasing the resistance of the root to the movement of water.

In conditions of water stress the epidermis of the root is covered with cork, in order to protect the organ from complete dehydration. However, cork is an additive resistance to water movement.

- Embolism formation

The creation of embolism ie the breaking of the water column in the xylem vessels and the interruption of its continuity, results in the increase of the resistances to the flow of water in the transport system. Specifically, when the continuum of transpiration current is interrupted, then air bubbles form inside the vascular system of the plant, which expand to fill the entire system. However, the expanding bubbles cannot easily penetrate the small pores of the membranes that exist at the junction of the trachea. This contributes to the lateral movement of the resulting water increasing the resistances to the movement of water through it vascular system.

- Reduction of the size of the vascular system.

Even in controlled water stress the size of the vessels can be reduced and consequently the hydraulic conductivity of the xylem tissue.

- Changes in the level of the leaf (Leaf Area Index-LAI)

The most important are:

●Reduction of the size and increase of the thickness of the leaf.

The thickness of the leaf and the amount of tissues of the mesophyll affect water relations between the leaf and their ability to continue photosynthesis, due to high resistance to the movement of water vapor and consequently the reduction of respiratory losses.

● Disposal of strongly developed schlerenchyma tissues.

The involvement of schlerenchyma tissues in the leaves seems to be associated with the prevention of the collapse mechanism in conditions of intense dehydration. In cells with inelastic walls the change in cell volume relative to sparse loss is much smaller than in cells with rubber walls.

●Thick protective tissues and hairs.

They help to reduce water vapor losses and to reflect sunlight from the surface of the tissues of the plants they cover. For the same reason they develop many small stomata.

B. Physiological changes.

1. Stomatal operation.

As species have been reported the lack of water causes closure of the stomata in order to reduce respiratory losses. It is known that the width of the oral cavity is regulated through changes in tidal pressure mainly of guard cells.

These changes can be:

- Passive.

The passive changes are due to the immediate loss of water from the guard cells due to evaporation. Passive closure of the stomata is favored in an atmospheric environment with low relative humidity, when the rate of vapor loss from the guard cells. The concentration gradient of water vapor is about a hundred times that of CO_2, meaning that water can diffuse out of a leaf a hundred times faster than CO_2 can diffuse in when the stomata

are open e cells is higher than that with which they are replenished through the adjacent epidermal occlusive (guard) cells.

- Active.

The active changes are due to a mechanism, which is activated through specialized stimuli and is due to the modification of the metabolic activity of the guard cells. The stomatal closure occurs due to the release of certain cations from the guard cells, resulting in the loss of their stretching.

In this procedure also hormones like abscissic acid, regulates the stomatal opening to conserve water during times of stress.