THE INFLUENCE OF SALT STRESS ON STOMATAL CONDUCTANCE OF BITTER CUCUMBER (*MOMORDICA CHARANTIA* L.)

Ștefănica OSTACI[1], Mihaela COVAȘĂ[1], Cristina SLABU[1], Alina Elena MARTA[1], Carmen Doina JITĂREANU[1]

e-mail: stefanaostaci@gmail.com

Abstract
Among the environmental stressors salinity is the main factor that calls into question the future of plant cultivation, be it agriculture, ornamental or medicinal plants. It currently affects almost a billion hectares of lands, of which 77 million hectares represent arable land. The intensification of stomatal conductance is directly correlated with the mechanical force involved in the opening of the stomata, which is influenced by the osmotic absorption of water, but also by the increase in hydrostatic pressure in the stomatal. This research was carried out in order to determine the bitter cucumber varieties with good resistance to salt stress. The materials used were represented by five varieties of bitter cucumber (*Momordica charantia*) of which: two Romanian varieties (Rodeo variety and Brâncusi variety) and three lines (Line 1, Line 3 and Line 4). The five varieties of bitter cucumber were subjected to salt stress for a 30 days period, during which they were constantly treated with saline solutions consisting of 100 mM and 200 mM concentration. Stomatal conductance was measured with SC-1 Leaf Porometer. The device is used to determine the flow of water vapor in and out of leaf stomata by inducing stomatal conductance.

Key words: bitter cucumber, salt stress, stomatal conductance

Among the environmental stressors, salinity is the main factor that calls into question the future of plant cultivation, be it agriculture, ornamental or medicinal plants. This affects almost a billion hectares of land, of which 7 million hectares are represented by arable land. (Flowers T.J., Hajibagheri M.A., 1991).

Increased salinity induces both hypertonic and hyperosmotic stress, which can lead to the death of the plant. Typically, stress is caused by high concentrations of Na^+ and Cl^- in the soil solution (Grigore M.N., 2008).

Transpiration is the process in which plants remove water in the form of vapors, having an important role in plant life. With the help of transpiration, plants regulate the suction force of their leaves, which determines the absorption and circulation of both water and mineral salts (Jităreanu C.D. *et al*, 2011).

Stomata are well-known plant structures that control transpiration and carbon dioxide absorption. They are responsible for the highest percentage of transpiration, the intensity varying in relation to the species, the age of the plant and also the environmental conditions (Toma L. D., Jităreanu C. D., 2007).

The average values of stomatal transpiration are between 10 – 250 g/h/m2 during the day, and 1 – 20 g/h/m2 during the night. Stomatal cells function as a hydraulic valve due to the uneven thickening of the cell walls. Due to this characteristic, when the cells absorb water and become turgid the stomata open, and when the cells lose water and become flaccid the stomata closes (Jităreanu C.D. *et al,* 2011).

The intensification of stomatal conductance is correlated directly with the mechanical force involved in stomatal opening, which is influenced by the osmotic absorption of water, but also by the increase in hydrostatic pressure in the stomatal cells. High stomatal conductance is influenced by the amount of water in the soil. Thus, in salinity conditions, it was found that the soil maintains a higher percentage of water at the level of colloidal particles, leading to the manifestation of physiological changes at the level of the plant.

As an adaptation, the root system develops more in order to cope with the higher amount of water from the soil, thus the root will pump a greater amount of water, and the plant, as an adaptation, will intensify its transpiration process.

Leaf gas exchange through the stomata is essential for the photosynthesis process due to the absorption of carbon dioxide (CO2) (Munns R., 2004; Bartha C. *et al*, 2012).

[1] Iasi University of Life Sciences, Romania

MATERIAL AND METHOD

The materials used were represented by 5 varieties of bitter cucumber (Momordica charantia) obtained from the Buzău Research Station, of which: two Romanian varieties (Rodeo variety and Brâncusi variety) and three lines (Line 1, Line 3 and Line 4).

The research was carried out under solar conditions in 2022, within the Vasile Adamachi Iași farm.

The bifactorial experiment was carried out in pots of vegetation in randomized blocks with 3 repetitions. The 5 bitter cucumber varieties were subjected to salt stress for a period of 30 days, during which they were constantly treated with saline solutions of 100 mM and 200 mM concentration. Stomatal conductance was measured with SC-1 Leaf Porometer. This device was used to determine the flow of water vapor in and out of leaf stomata, inducing the stomatal conductance (Bologa M. *et al*, 2016).

The use of the porometer provides information on the photosynthetic capacity of the plant, the gas exchange (CO_2/O_2) and the water stress to which the plant is subjected. Salt stress is closely related to water stress, the reason why the foliar porometer provides important data on the degree of adaptation of plants to salt stress.

RESULTS AND DISCUSSIONS

The regulation of the physiological phenomenon of stomatal closing and opening is strongly affected by both water and salt stress. The decrease in the ability to close the stomata, or even the total lack of it, is attributed to the sensitivity of some plants to the concentration of salinity in the soil (Sharma S.K., Gupta I.C., 1986).

In the efectuated experiment, the readings were performed 10 days after the application of the treatments, respectively the 10th, 20th and 30th days of the month. As it can be seen in the following graphs, the plants have created a specific adaptation to salt stress conditions, thus modifying their stomatal opening with closing movements.

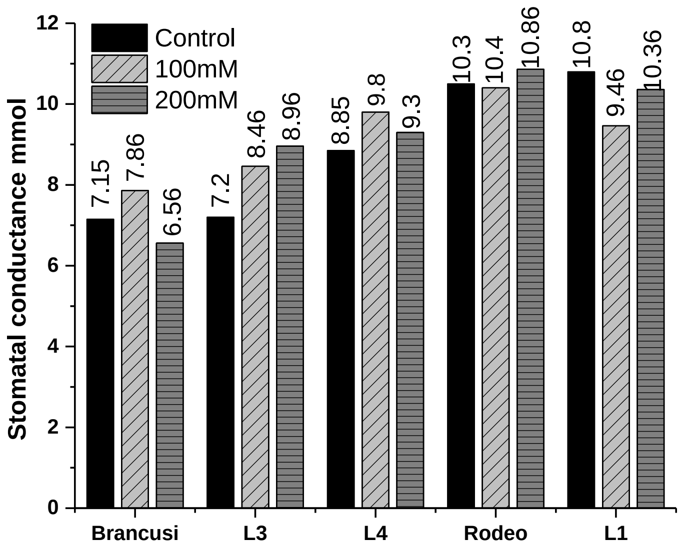

Figure 1 **The effect of saline stress on stomatal conductance in bitter cucumber (Momordica charantia) 10 days after the start of the treatments**

According to *figure 1*, 10 days after the start of the treatments, the Brâncusi variety shows, in the case of the control sample, a stomatal conductance of 7.15 mmol compared to the plants watered with 100 mM saline and a value of 7.86 mmol was recorded. In the case of Line 3, a higher stomatal conductance is observed where plants treated with saline solution of 200 mM concentration had the recorded value of 6.63 mmol compared to the control which presented a value of 6.3 mmol.

Line 4 shows a progressive increase in stomatal conductance, the lowest value being recorded in the control: 5.25 mmol; at 100 mM concentration the conductance is 5.9 mmol and at 200 mM concentration the conductance is 6.26 mmol. This rise in the conductance values might represent a good adaptation of the plants of this line to saline stress. Unlike Line 4, the Rodeo variety shows increasing values of stomatal conductance; thus, the control has the highest conductance value: 6.95 mmol and the lowest value is recorded for plants treated with the 200 mM saline solution where the recorded value is 6.3 mmol. In the case of Line 1, the situation is similar to that of the Rodeo variety plants, the difference being the control plants showing a higher stomatal conductance, compared to the plants treated with the two saline solutions. Thus, the control shows a value of 8.85 mmol, while the plants treated with saline solution of 200 mM concentration had a conductance value of 7.36 mmol.

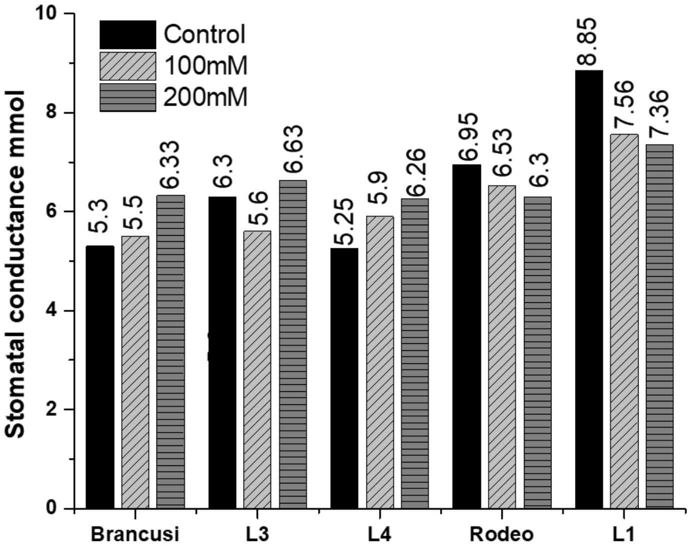

Figure 2 **The effect of saline stress on stomatal conductance in bitter cucumber (Momordica charantia) 20 days after the start of the treatments**

Figure 2 represents the stomatal conductance values read 20 days after starting saline treatments.

In the case of Brâncusi variety, the increasing of the stomatal conductance values is observed. The control plants show the lowest value: 5.3 mmol, the plants treated with 100 mM saline solution have a higher stomatal conductance (5.5 mmol), and the plants treated with 200 mM the highest value (6.33 mmol). This increase in stomatal conductance values, directly proportional to the increase in the concentration of saline solutions, indicates a good adaptation capacity of the variety to saline stress conditions.

In the case of Line 3, the control plants showed a conductance of 6.3 mmol, while the plants exposed to the maximum concentration of the saline solution showed a value of 6.63 mmol, fact that may imply the attempt of the plants trying to adapt to the new abiotic conditions. Line 4 showed increasing values of stomatal conductance directly proportional to the applied saline solutions. As in the first graph, the stomatal conductance values of the Rodeo cultivar and Line 1 were inversely proportional to the increase in applied saline solutions.

In the case of the Rodeo variety, the control showed a stomatal conductance with a value of 6.95 mmol, and the plants that were treated with the saline solution of 200 mM concentration had a value of 6.3 mmol. Line 1 showed a significant difference between control plants and plants treated with the two saline solutions. The control had a stomatal conductance value of 8.85 mmol and the plants treated with the 200 mM saline solution presented a conductance value of 7.36 mmol.

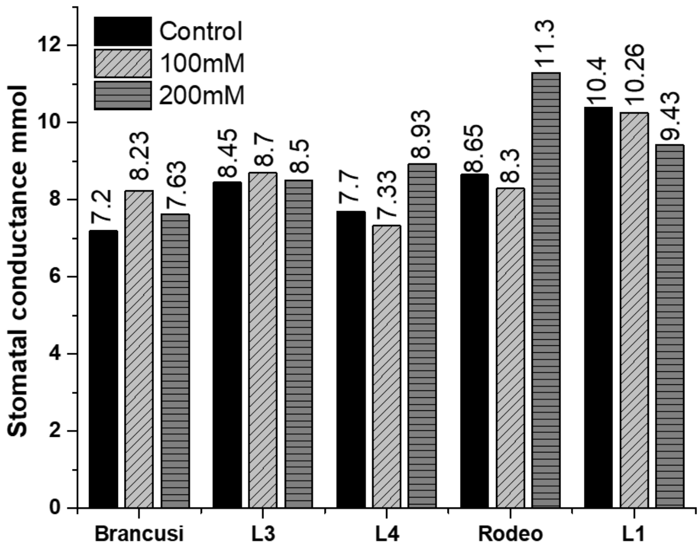

Figure 3 **The effect of salt stress on stomatal conductance in bitter cucumber 30 days after the start of the treatments**

Figure 3 represents the adaptation of plants to saline stress after 30 days from the start of the treatments with saline solutions. In the case of the Brâncusi variety, the plants managed to adapt to the salt stress, thus the control had the lowest conductivity value of 7.2 mmol, the highest value being recorded for the plants treated with 100 mM concentration solution, where the conductance value was of 8.23 mmol. In the case of the plants treated with 200 mM concentration solution, the value was 7.63 mmol, thus exceeding the control. Line 3 also seemed to have an adaptation to abiotic conditions. However, the differences between the control plants and of those treated with saline solutions were not very significant. The control values recorded for conductance were of 8.45 mmol, and the plants treated with 200 mM concentration solution presented a value of 8.5 mmol.

Line 4 had a conductance value in the control plants of 7.7 mmol and in the plants treated with 200 mM a value of 8.93 mM. In the case of the Rodeo variety, after 30 days from the start of the treatment with saline solutions, the control plants had a stomatal conductance value of 8.65 mmol, and the plants watered with a saline solution of 200 mM concentration presented a conductance value of 11.3; the highest stomatal conductance value recorded during the 30-day period for all 5 variants was taken into account. In the case of Line 1, as in the previous cases, the stomatal conductance was inversely proportional to the concentration of the used solutions. Therefore, after 30 days from the start of the treatments, the plants of this line presented the lowest stomatal conductance values.

CONCLUSIONS

Salt stress significantly affects stomatal conductance and stomatal movements. Plants that fail to adapt to salt stress will not be able to coordinate the balanced flow of water from the roots to the leaves. As a result, the stomatal conductance will register low values, and the plant will show a series of visible deficiencies.

The five varieties of bitter cucumber (*Momordica charantia*) studied presented different degrees of stomatal conductance, which can be interpreted as a more pronounced or weaker adaptation to saline stress.

Stomatal conductance values underwent changes during the 30 days, which implies that the time required to adapt the studied variants to abiotic stress conditions is different. Line 1 is the variant that presents the lowest stomatal conductance values compared to the control plants throughout the studied period.

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