PHYSIOLOGICAL RESEARCHES ON THE INFLUENCE OF SALT STRESS AT SOME LOCAL POPULATIONS OF BEANS (*PHASEOLUS VULGARIS* L.)

CERCETĂRI FIZIOLOGICE PRIVIND INFLUENŢA STRESULUI SALIN LA UNELE POPULAŢII LOCALE DE FASOLE (*PHASEOLUS VULGARIS* L.)

JITĂREANU Carmenica Doina[1], SLABU Cristina,[1]
MARTA Alina Elena[1]
e-mail: doinaj@uaiasi.ro

Abstract. *Saline stress affects seeds germination, reduces the chlorophyll content in the plant leaves and the photosynthesis activity, changes that have prompted the researchers around the world, also in Romania, to study this abiotic factor with interest.The success of the research could provide the extension of plant cultivation to areas affected by salinisation or as well as the possibility of using sea and ocean water, a vast resource, for irrigation of crops, and as a result, the increase in world biomass production. The present research investigated the influence of saline solutions (100 mM and 200 mM NaCl) on the chlorophyll pigments content in 10 local populations of common beans (Phaseolus vulgaris L.) grown in pots, in greenhouse conditions. The main objective of this study was to identify the salinity tolerant genotypes, knowing that this attribute is also conferred by a high chlorophylls concentration. Also tolerant genotypes could be used in plant breeding, as these local populations are adapted to the environmental conditions of the NE of Romania.*
Key words*:* salt stress, *Phaseolus vulgaris*, chlorophyll content

Rezumat. *Stresul salin afectează germinaţia semințelor, provoacă diminuarea conținutului de clorofilă din frunzele plantelor şi reducerea fotosintezei, modificări ce au determinat pe cercetătorii din România şi din întreaga lume să studieze cu interes acest factor abiotic. Reuşita cercetărilor ar putea însemna extinderea cultivării plantelor pe suprafeţele afectate de salinizare precum şi posibilitatea utilizării apei mărilor şi oceanelor, o resursă vastă, pentru irigarea culturilor, toate acestea având ca efect creşterea producţiei mondiale de biomasă. În lucrarea de faţă s-a urmărit studierea influenţei unor soluţii saline (100 mM şi 200 mM) asupra conţinutului de pigmenţi clorofilieni, la 10 populaţii locale de fasole comună (Phaseolus vulgaris L.) cultivate în condiţii de seră, la ghivece. Scopul principal a fost depistarea genotipurilor tolerante la salinitate, ştiindu-se faptul că această însuşire este conferită şi de un nivel ridicat al concentraţiei de pigmenţi clorofilieni. De asemenea, genotipurile tolerante ar putea fi folosite în ameliorare, populaţiile locale fiind adaptate condiţiilor de mediu din partea de NE a României.*
Cuvinte cheie: stres salin, *Phaseolus vulgaris*, conținut de clorofilă

[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

INTRODUCTION

Soil salinity currently represents an important limiting factor of agricultural crops productivity, in many regions of the world, being considered the main cause of desertification, which remains the worst form of soil degradation. Worldwide, the situation is quite worrying because arid or desert areas represent approx. 25% of the Earth's surface and one third of irrigated land is affected by salinity

Following the demographic growth and the pronounced expression of the greenhouse effect, considerable efforts have been made around the world to breeding salinity resistant agricultural plants, but so far only small progress was recorded for this purpose. It is a certainty that the food provision has always constituted a primary goal, which even now, in modern times, brings people to try, to seek, and to discover. For these reasons, the capitalization of genetic variability of the local plants populations, regarding salinity resistance, may be a first step in the works of improvingt the salinity tolerance of the cultivated species with the aim to increase the living standards and to fully exploit soil resources.

There are many concerns about salt tolerance of plants, their response to high salinity, the various aspects of saline stress, otherwise this being the most intensely studied type of abiotic stress on plants. All salts affect plant growth, but not all inhibit this process. Also, the interaction effect is manifested inside the plant, some of which are simple, while some are complex. Despite numerous published researches on mechanisms of plant adaptation for salinity tolerance, the exact elucidation of these biochemical and physiological mechanisms of metabolic adaptation to saline stress has not been achieved (Petcu, 2008).

The impact of saline excess on the productivity of several cultivated plants is sometimes disastrous, fact which determines the identification and creation of new plants genotypes, with osmotic stress tolerance. *Phaseolus vulgaris* L. is considered very sensitive to saline stress and the decreasing in the chlorophyll content under saline stress conditions is described as a phenomenon which diminishes the plant productivity, inhibits or alters their growth, distribution of dry matter, seed germination, photosynthesis and their yield (Galani, 2014).

MATERIAL AND METHOD

The biological material used in this research was represented by 10 local bean populations collected from saline soils in the Iasi and Botosani counties: Copălău 1, Coropceni 1, Coropceni 2, Iezer 4, Iezer 5, Moşna 3, Moşna 4, Săveni 1, Truşeşti 4 and Truşeşti 5.

The experiments were carried under greenhouse conditions in the Phytotron of the "Vasile Adamachi" Didactical Center, from University of Agricultural Sciences and Veterinary Medicine Iaşi. The *Phaseolus vulgaris* seeds were sowed in March 2016 in a 15-liter vegetation pot, in a mixture of garden soil and peat in a 1: 1 ratio.

The research was bifactorial, the first factor being the genotype, and the second the concentration of the saline solution applied to the plants. Thus, there were

3 experimental variants: 1. the control variant (V0) in which the bean plants were irrigated only with drinking water; 2. variant V1 - wherein the plants were watered with 100 mM NaCl solution; 3. Variant V2-irrigation with a 200 mM NaCl solution. Each experimental variant included 6 rehearsals.

RESULTS AND DISCUSSIONS

Influence of saline stress on the foliar pigments content. According to the literature data, it is highlighted that under saline stress conditions, the chloroplasts aggregation occurs in the leaves, and cell membranes become wrinkled and distorted. For many plant species, the photosynthesis is inhibited by NaCl concentration, and the chlorophyll pigments content decreases with increasing of saline concentrations (Khavari-Nejad and Mostofi, 1998).

The chlorophyll pigments analysis is an important tool to assess the effect of saline stress, because they play an important role in plant metabolism.
According to Abdel-Kader *et al*., (2008), the decrease in chlorophyll a and chlorophyll b is due to accelerating tissue and biochemical degradation under saline stress.

In our research, the spectrophotometric analysis performed 15 days after salt application, it resulted that **chlorophyll a 662-663 nm** had the lowest, but close, values in Copălău 1 populations (0.242 a.u., 0.148 a.u.; 0.217 a.u.) and Săveni 1 (0.517 a.u., 0.476 a.u., 0.530 a.u.), that indicated a low but not salty stressed photosynthetic intensity (fig. 1).

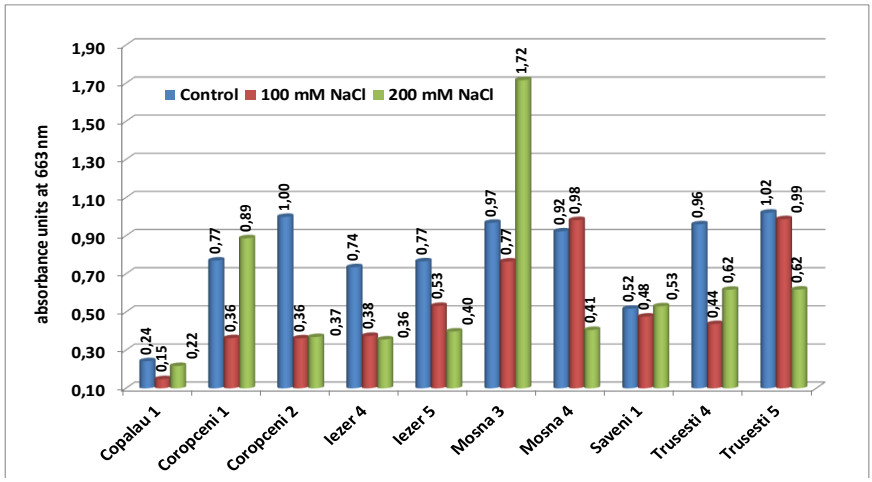

Fig. 1 The saline stress effect on the chlorophyll a 662-663 nm content

In the Coropceni 2 and Iezer 4 populations, approximately equal values were observed for the 100 and 200 mM NaCl treated variants, up to 1/3 of the control variant, indicating sensitive populations to this type of stress. The highest

values of the chlorophyll content of 662-663 nm in 100 mM NaCl variants were recorded at Moşna 4 (0.982 a.u.) and Truşeşti 5 (0.987 a.u.), showing resistance to lower salt concentrations and can be taken in consideration for medium or poorly leveled soils. High values of the analyzed parameter at high salt concentrations (200 mM NaCl) were observed in Coropceni 1 (0.887 a.u.) and especially in Moşna 3 (1.716 a.u.), both against the control and 100 mM NaCl, which shows us populations with good resistance to saline stress.

Compared to controls, the other analyzed populations obtained much lower values of chlorophyll a 662-663 nm in the variants subjected to osmotic stress, which proves more sensitivity to the action of NaCl that has multiple negative effects, causing toxic actions on the protoplasm, manifested by deregulation of submicroscopic structure of chloroplasts.

The content of **chlorophyll b 453-454 nm,** the main component of the reaction center in the photosynthetic systems, also had oscillating values from one population to another. The lowest content was recorded in the Copălău 1 populations (0.223 a.u., 0.376 a.u.) and Săveni 1 (0.624 a.u., 0.716 a.u.), but the values were close to the control variant, indicating genotypes with low chlorophyll concentrations and reduced photosynthetic intensity. At Coropceni 2 and Iezer 4 we have noticed much lower levels of chlorophyll b 453-454 in the variants treated with NaCl compared to the control variant, proving a susceptibility to saline stress. The highest content of chlorophyll b in variants treated with 100 mM NaCl have registered Moşna 3 (1.11 a.u.), Moşna 4 (1.516 a.u.) and Truşeşti 5 (1.360 a.u.) (fig. 2).

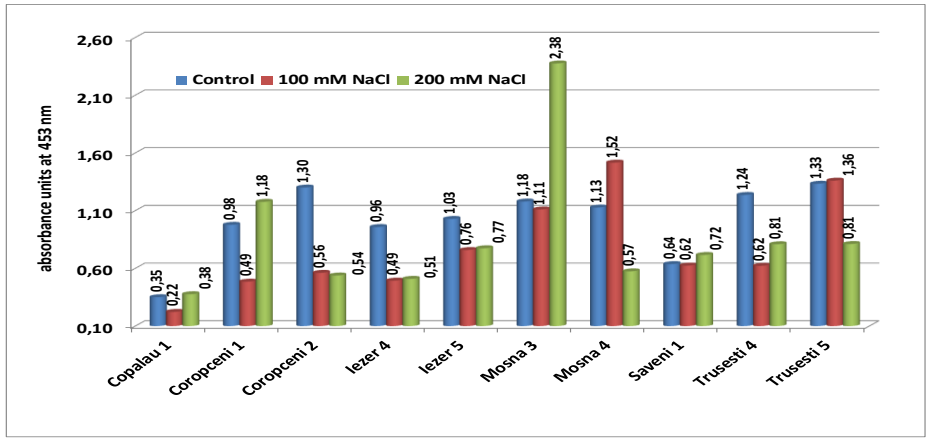

Fig. 2 The saline stress effect on the chlorophyll b 453-454 nm content

In versions treated with 200 mM NaCl, Coropceni 1 (1.176 a.u.) and Moşna 3 (2,375 a.u.) stood out, even surpassing the control, demonstrating good resistance to osmotic stress.

The other experimental populations recorded significantly lower values than the control variant, with a marked sensitivity to osmotic stress, which had disastrous effects on plants, in addition to reducing the chlorophyll content, causing reduced photosynthesis, decreased production and crop yield.

Analysis of chlorophyll content with maximum absorption at **434 - 435 nm** (AIV) reveals similar behaviors to other types of chlorophyll. Thus, among all analyzed variants, the lowest content is noted in the local population Copălău, the minimum values being of 0.299 a.u. to the variant treated with 100 mM NaCl and 0.331 a.u. to the variant treated with 200 mM NaCl (fig. 3)

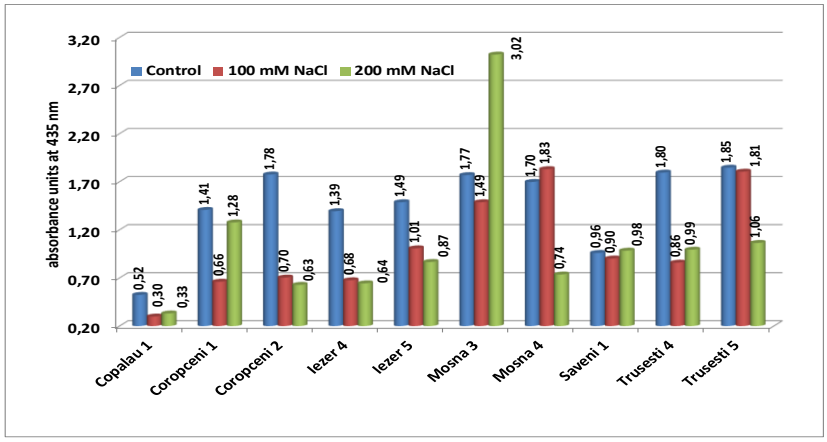

Fig. 3 The saline stress effect on the chlorophyll b 434-435 nm content

At 200 mM, a maximum content is observed at Moşna 3 (3.022 a.u.), followed by Coropceni 1 (1.277 a.u.), which demonstrated the best resistance to high concentrations of NaCl and could be grown on salt-rich terrains. In the case of osmotic stress sensitive populations, NaCl produced a decrease in chlorophyll a and b, saline stress also producing both a fresh and dry bean weight reduction due to decreased photosynthesis intensity.

The content of **flavonoid pigments** responsible for the protection of plants under stress conditions proved to be particularly great in the control variant.

In particular, the Moşna 3 and Truşeşti 5 populations, which recorded high values for all analyzed variants: control, 100 mM and 200 mM NaCl (fig. 4).

In 100 mM-treated variants, maximum values were observed for Coropceni 1, Iezer 5 and Săveni 1 genotypes, while in the 200 mM wet variants only the

Moşna 4 population were found to be high. The lowest values of 100 mM flavonoids are noted in Copălău 1, Coropceni 2, Iezer 4, Iezer 5 and Truşeşti 4, which proves a poor protection against their osmotic stress.

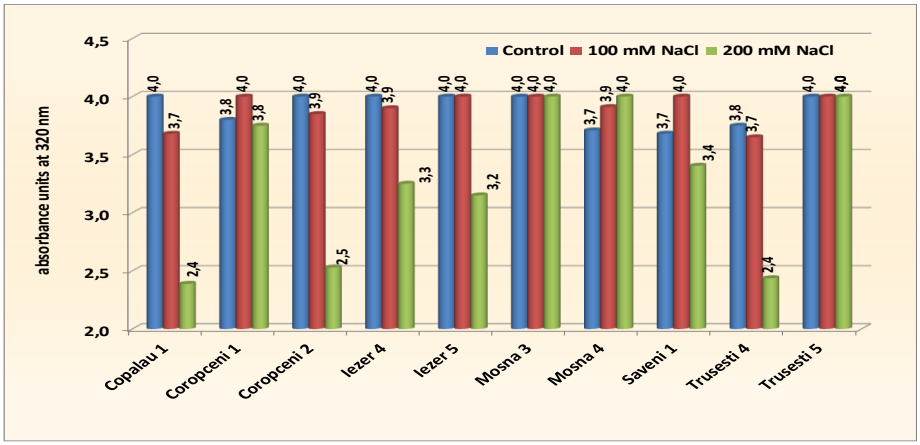

Fig. 4. The saline stress effect on the flavonoid pigments content

CONCLUSIONS

1. The chlorophyll content of 662-663 was found to be higher in the local populations of Moşna 4 and Truşeşti 5 at saline concentrations of 100 mM NaCl and Coropceni 1 and Moşna 3 to 200 mM NaCl, which denotes resistance to saline stress.

2. The main component of the reaction center, chlorophyll b 453-454 nm, recorded high values in the 100 mM NaCl variant at Moşna 3, Moşna 4 and Truşeşti 5 and at 200 mM NaCl at Coropceni 1 and Moşna 3.

3. The maximum content of chlorophyll pigments at the 200 mM concentration recorded in the local populations of Moşna 3 and Coropceni 1 demonstrates their better resistance to saline stress and recommends these local populations in culture on saline soils and their use in amelioration.

REFERENCES

1. **Abdel Kader A F., Aronsson H., Solymosi K., Bela Boddi, Sundqvist C., 2008** - *Chlorophyll accumulation, protochlorophyllide formation and prolamellar body conversion are held back in wheat leaves exposed to high salt stress*, Photosynthesis. Energy from the Sun, 1133-1136.
2. **Galani (Neculai) D., 2014** – Managementul conservării biodiversității. Stresul abiotic la plante. USAMVB. https://www.academia.edu/7728524/Stresul salin la salat *Lactuca sativa*
3. **Khavari-Nejad R.A., Mostofi Y., 1998** – *Effects of NaCl on photosynthetic pigments, saccharides and chloroplast ultrastructure in leaveas of tomato cultivares*. Photosyntetica, 35:151-154.
4. **Petcu Elena, Ţerbea Maria, Lazăr C., 2007** - Cercetări *în domeniul fiziologiei plantelor de câmp la Fundulea*, An. I.N.C.D.A. Fundulea, vol. LXXV:431-458.