THE BEHAVIOR OF SOME ONION (*ALLIUM CEPA* L.) LOCAL LANDRACES UNDER SALT STRESS

COMPORTAMENTUL UNOR POPULAȚII LOCALE DE CEAPĂ (*ALLIUM CEPA* L.) SUB INFLUENȚA STRESULUI SALIN

***SLABU Cristina*[1], *JITĂREANU Carmenica Doina*[1], *MARTA Alina Elena*[1], *BOLOGA (COVAŞĂ) Mihaela*[1]**
e-mail: cslabu@uaiasi.ro

Abstract. *Soil salinity is a very important ecological factor that affects the growth and the yield of cultivated plants, especially in arid and semi-arid regions. This decrease in land productivity due to salinization, come in contradiction with increased food need. In the effort to create plants resistant to salinity, exploitation of diverse sources of variability as local landraces is required. Onion (Allium cepa L.) is a very important vegetable crop considered salt sensitive. The aim of this work was to determinate the effect of salt stress of 11 landraces collected from NE Romania, in Iasi and Botosani districts in areas with saline excess. The results of research show that only some of the studied cultivars reacted to salt stress according to the biphasic model Munns. Only one of this local landraces presented a better salt resistance expressed by high chlorophyll content and a yield close to the control variant.*
Key words*: salt stress, Allium cepa, chlorophyll content*

Rezumat. *Salinitatea solului este un factor ecologic foarte important, care afecteaza cresterea si productivitatea plantelor cultivate, in special in regiunile aride si semi-aride. Aceasta reducere a productivitatii terenurilor salinizate vine in contradictie cu nevoia crescanda de hrana. In efortul de a crea plante rezistente la stres salin, se impune exploatarea tuturor surselor de variabilitate, de exemplu populatiile locale. Ceapa (Allium cepa L.) este o planta legumicola foarte importanta, considerata a fi sensibila la salinitate. Scopul lucrarii a fost de a determina efectul stresului salin asupra a 11 de populatii locale de ceapa, colectate din judetele Iasi si Botosani, din zone cu exces de salinitate. Rezultatele cercetarii arata ca doar o parte dintre cultivarele studiate a reactionat la stres salin conform modelului bifazic Munns. Numai unul dintre acestea a prezentat o rezistenta mai buna la salinitate, exprimata printr-un continut ridicat de clorofila si o productie apropiata de cea a variantei martor.*
Cuvinte cheie: *stres salin, Allium cepa, continut de clorofila*

INTRODUCTION

Soil salinization is a worldwide environmental problem with severe economic and social consequences (Sidike *et al.,* 2014). Salinity limits the plant growth and productivity around the world, especially in arid and semi-arid

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

regions. Currently, over 6 % of land and 20 % of irrigated areas are salt-affected (Munns, 2011). The decrease in land productivity due to salinization, come in contradiction with increased food need. Exponential growth in the ensuing 200 years resulted in the global population exceeding 7 billion, placing enormous demands on modern agriculture (McClung, 2014). The total size of the world population is likely to increase from its current 7 billion to 8–10 billion by 2050 (Lutz and Samir, 2010). In this context, a special attention should be paid to food security. It is necessary not only the quantitative but also the qualitative aspects of food to be considered.

Onion (*Allium cepa* L.) is a very important vegetable crop. Nowadays are cultivated almost worldwide at latitudes between 5-60° in both hemispheres (Sumalan el al., 2014). From 1995 to 2013, worldwide, both harvested area and production has registered a continuous increase, so that in 2013 the dry onions yield was estimated at around 85,78 Million tonnes, and from onions shallots green, at 4,2 Million tonnes (FAO, 2014).

The accumulation of salts in soil is harmful to plants because it increases the concentration of the soil solution, inhibits seeds germination, plants root system morphogenesis, disturb the root absorption and due to the toxic effect of excess ions accumulate in plants. During the last decades, the development of salt-resistant crops, has made very limited progress despite tremendous efforts (Schubert *et al.,* 2009) A reason could be that, the possible physiological, biochemical and molecular mechanisms behind the growth reduction of crops has not yet been adequately understood (Läuchli and Grattan, 2007).

On the other hand, in the effort to increase plant resistance to salinity, local plant landraces should not be overlooked. A first step in plant breeding for the improvement of salt tolerance of cultivated species should be the capitalization of salt tolerance variability in local landraces. In comparison with introduced cultivars, the onion landraces are well adapted to local edaphic and climatic conditions, resulting in high yields and better post-harvest storage ability (Sumalan *el al.,* 2014).

The aim of this work was to determinate the effect of salt stress of 11 landraces collected from NE Romania, in Iasi and Botosani districts in areas with saline excess to capitalize the variability of salt tolerance in local landraces.

MATERIAL AND METHOD

A pot experiment with factorial arrangements on the bases of randomized complete block with three replications was conducted in 2015 to investigate the salinity tolerance at 11 onion local landraces. These local landraces have been selected from 20 collected landraces after a previous investigation of sets germination capacity under salt stress. The cultivars were collected from NE Romania Iasi and Botosani districts from areas with saline excess. Three sets of each cultivar with a diameter of 15 mm and a mean weight of 3,2 g were planted in garden soil, in 10 kg pots. The pots were placed in the greenhouse at a temperature between17- 25ºC. Two weeks after emergence, the plants were exposed to salt stress. Experimental

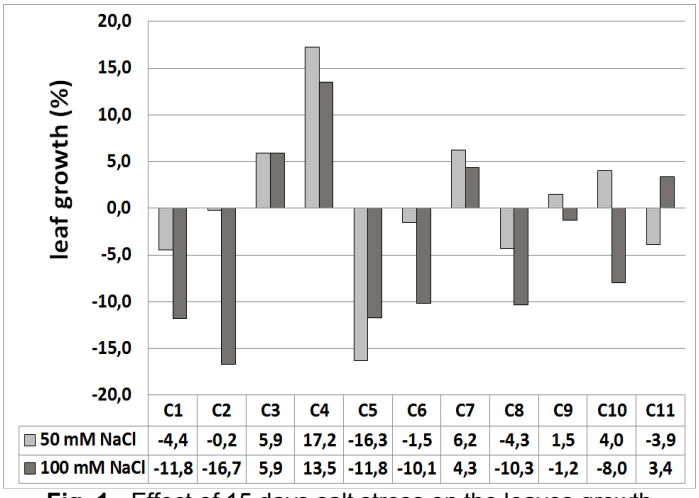
variants: V1 – control, watered with water only; V2 - watered with 1 liter 50 mM NaCl solution for each watering; V3 - watered with 1 liter 100 mM NaCl solution for each watering. Plants were grown to full maturity. Measured were: leaf growth, onion bulb weight and chlorophyll content as chlorophyll content index. The chlorophyll content index was measured in each plot by using a portable chlorophyll content meter (CCM-200, Opti-Sciences Inc., NH, USA).

RESULTS AND DISCUSSIONS

The growth of crop plants suffering from salt stress can be described by the biphasic model, originally proposed by Munns in 1993 and modified by Munns and Tester in 2008 and Schubert in 2011 (Hütsch *et al.,* 2014). According to the two-phase model of growth response to salt stress by Munns, two major physiological problems may limit crop performance under saline conditions. In a first phase, osmotic problems reduce extension growth so that plants show stunted growth and look dark-green in colour. In a second phase, ion toxicity develops and growth of sensitive plants is severely inhibited (Schubert *et al.,* 2009).

The behaviour of the studied landraces was according to this model evaluated. After 15 days salt treatment only two of the studied landraces (C1 and C8) have responded according to this model, by a reducing of foliar growth and increasing of chlorophyll content (Fig. 1 and 2).

Any other three landraces (C3, C4 and C7) showed a significantly better growth (fig. 1) and a higher chlorophyll content compared with the control variant (Fig. 2).

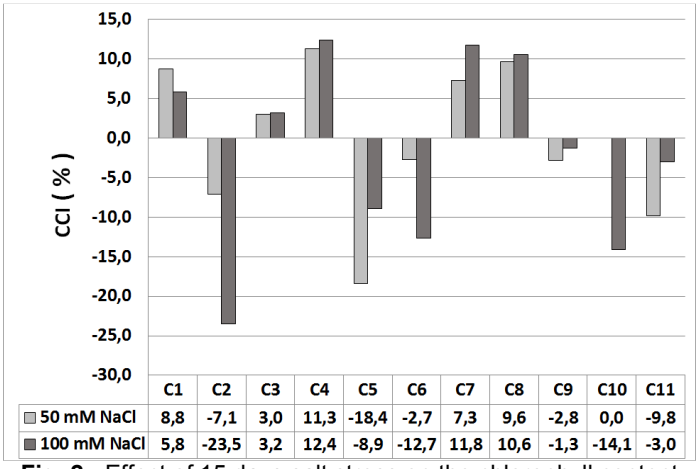


	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
50 mM NaCl	-4,4	-0,2	5,9	17,2	-16,3	-1,5	6,2	-4,3	1,5	4,0	-3,9
100 mM NaCl	-11,8	-16,7	5,9	13,5	-11,8	-10,1	4,3	-10,3	-1,2	-8,0	3,4

Fig. 1 - Effect of 15 days salt stress on the leaves growth (percentage difference to the control variants)

In this case, NaCl promoted the growth. This behaviour can be explained by the fact that onions have a high requirement for Cl, The reason is related to stomates, which regulate movement of gases in and out of plant leaves (Randle, 2004).

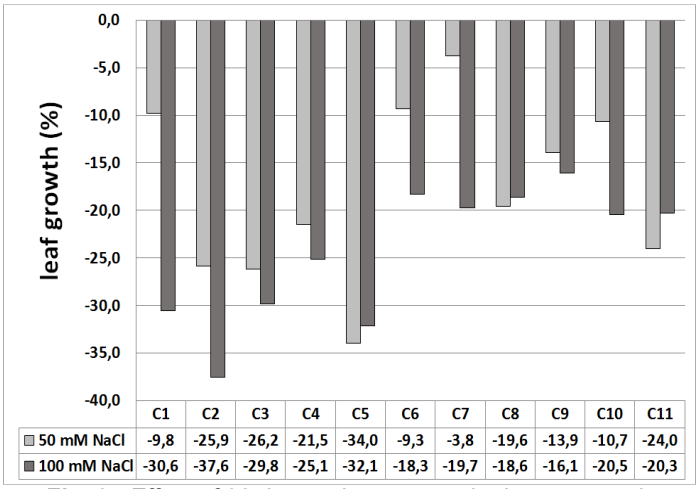
On the other hand, onion is considered to be salt sensitive more to sulphate and excluders of both Na and Cl (Shannon et Grieve, 1999).



	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
50 mM NaCl	8,8	-7,1	3,0	11,3	-18,4	-2,7	7,3	9,6	-2,8	0,0	-9,8
100 mM NaCl	5,8	-23,5	3,2	12,4	-8,9	-12,7	11,8	10,6	-1,3	-14,1	-3,0

Fig. 2 - Effect of 15 days salt stress on the chlorophyll content (percentage difference to the control variants)

After 30 days salt stress, leaf growth content were reduced in the both variants (Fig. 3): after the 50 mM NaCl treatment between 3,8 % (C7) and 34,0 (C5), and after 100 mM treatment between 16,1% (C9) and 37.6% (C2).

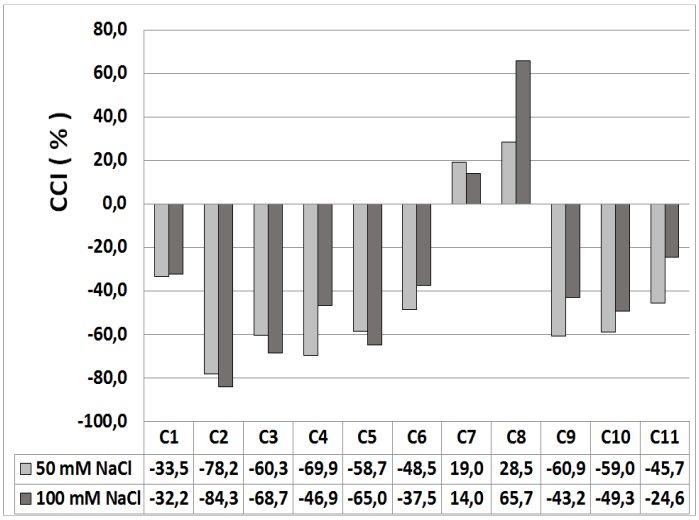


	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
50 mM NaCl	-9,8	-25,9	-26,2	-21,5	-34,0	-9,3	-3,8	-19,6	-13,9	-10,7	-24,0
100 mM NaCl	-30,6	-37,6	-29,8	-25,1	-32,1	-18,3	-19,7	-18,6	-16,1	-20,5	-20,3

Fig. 3 - Effect of 30 days salt stress on the leaves growth (percentage difference to the control variants)

Also, after 30 days of exposure to salt stress, the leaves chlorophyll content, has registered a significant decrease in case of 9 local landraces compared with untreated control variants. An increase in chlorophyll content was measured at the

landraces 7 and 8. At the first, the increase was at 14% after the 100 mM NaCl treatment and 19% after 50 mM treatment and at the second, the increase was between 28.5 and 65.7% (Fig. 4). Several studies have shown that salinity decreased bulb diameter, bulb weight, root growth, plant height, and number of leaves per plant (Shannon et Grieve, 1999).



	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
50 mM NaCl	-33,5	-78,2	-60,3	-69,9	-58,7	-48,5	19,0	28,5	-60,9	-59,0	-45,7
100 mM NaCl	-32,2	-84,3	-68,7	-46,9	-65,0	-37,5	14,0	65,7	-43,2	-49,3	-24,6

Fig. 4. Effect of 30 days salt stress on the chlorophyll content (percentage difference to the control variants)

Also in this study the onion yield was reduced at 8 until 58% of the control variant under 50 mM NaCl treatment and at 4.0% until 40.7% under 100 mM NaCl treatment (Fig. 5). A best behaviour under NaCl excess manifested landrace 7 with a loss of production from 23% in the 50 mM NaCl variant and from 35 % in 100 mM NaCl variant, which proves a better salinity resistance compared to all of the studied cultivars.

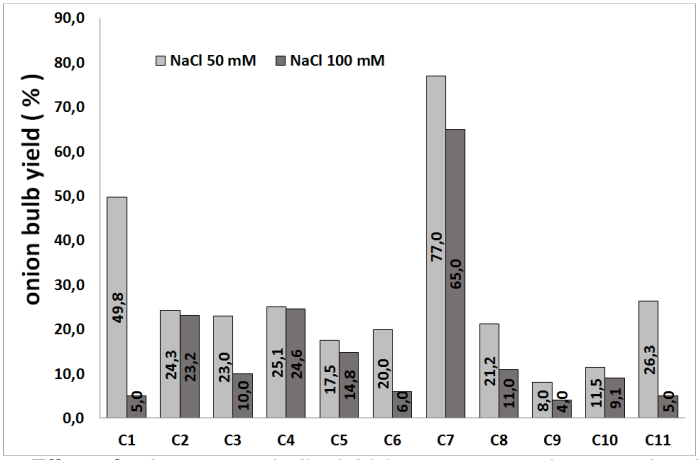


Fig. 5 - Effect of salt stress on bulb yield (percentage to the control variants)

CONCLUSIONS

1. The analysis of physiological reactions of local landraces of onions to salt stress, according to the biphasic model of Munns, has clearly indicated that not all cultivars follow this model.

2. After 30 days of exposure, salt stress caused a decrease in plant height in all of the cultivars analysed. A decrease in chlorophyll content was observed for nine cultivars.

3. Compared to the control variants under salt stress, the bulb yield was reduced in all of the cultivars analysed.

4. Best tolerance to salt stress, compared to all of the other local landraces studied, was observed for landrace 7, which has been collected in Iasi County. Notably, the lowest decrease in bulb yield was recorded for this particular cultivar, compared to the control.

Acknowledgements: *This work was supported by a grant of the Romanian National Authority for Scientific Research, CNDI-UEFISCDI, project number PN-II-PT-PCCA-2011-3.1-0965.*

REFERENCES

1. Hütsch B. W., Jung S., Schubert S., 2015 . – *Comparison of Salt and Drought-Stress Effects on Maize Growth and Yield Formation with Regard to Acid Invertase Activity in the Kernels.* Journal of Agronomy and Crop Science. Journal of Agronomy and Crop Science Vol. 201(5): 353–367.

2. Läuchli A, Grattan S.R., 2007- *Plant growth and development under salinity stress.* In: Advances in Molecular Breeding Toward Drought and Salt Tolerant Crops (eds. Jenks MA, Hasegawa PM, Jain SM), Springer, Dordrecht, Netherlands, p. 285-315.

3. Lutz W., Samir. KC., 2010 - *Dimensions of global population projections: What do we know about future population trends and structures?* Phil. Trans. R. Soc. B 365.

4. McClung C. R., 2014 - *Making Hunger Yield*. Science, 344(6185): 699-700.

5. Munns R., Tester M., 2008 - *Mechanisms of Salinity Tolerance*. Annual Review of Plant Biology, 59: 651-681.

6. Munns R., 2011 - *Plant adaptations to salt and water stress: differences an commonalities*. Adv. Bot. Res., 57: 1–32.

7. Randle W. M., 2004 - *Chloride Requirements in onion: clarifying a widespread misunderstandin*g. Better Crops Plant Food, 88(4):10-11.

8. Shannon M.C., Grieve C.M., 1999 - *Tolerance of vegetable crops to salinity*. Scientia Horticulturae 78: 5-38.

9. Schubert S., Anja Neubert, Antje Schierholt, Ali Sümer, Christian Zörb, 2009 - *Development of salt-resistant maize hybrids: The combination of physiological strategies using conventional breeding methods*. Plant Science 177:196–202.

10. Sidike A., Zhao S., Wen Y., 2014 - *Estimating soil salinity in Pingluo County of China using QuickBird data and soil reflectance spectra*. International Journal of Applied Earth Observation and Geoinformation, 26: 156-175.

11. Sumalan R., Ion D., Popescu I., Schmidt B., Sumalan R., Camen D., Ciulca S., 2014 - *Assessment of phenotypic diversity for some red onion landraces from Timis county*. Annals of the University of Craiova-Agriculture, Montanology, Cadastre Vol. 44(1):262-267.

12. ***FAO, 2014, http://faostat3.fao.org/compare/E,