

## ASSESSMENT OF PHENOTYPIC DIVERSITY FOR SOME RED ONION LANDRACES FROM TIMIȘ COUNTY

**SUMALAN R., DIANA ION, IOANA POPESCU , BRIGITTA SCHMIDT, SUMALAN RENATA, CAMEN D., CIULCA S.**

**Keywords:** red onion, landraces, bulbs traits.

### ABSTRACT

*The study's aim was to assess the phenotypic diversity of bulb traits (shape index, diameter, height and weight) in 15 red onion landraces grown in saline areas of south western Timiș County. In this region growers use mostly red onion landraces with a high adaptability to specific environmental conditions determined by the abiotic stress factors, including soil salinity.*

*The obtained results showed that significant differences in bulb traits were present between the landraces. This study found that the diversity of the studied red onion landraces was distributed within, as well as among landraces from the same location. Some of the landraces like Sânmartinu S. 18, Livezile 151, Peciu Nou 99 and Uivar 305 with favorable traits could be selected for further research and utilization.*

### INTRODUCTION

Red onions are low in calories and rich in fibers, which can make them suitable for a wide range of diets. Its traditional culture includes especially landraces, and to a lesser extent improved varieties.

Nowadays onions are cultivated almost worldwide at latitudes between 5-60° in both hemispheres. The crop includes hundreds of open-pollinated traditional and modern F1 hybrid varieties (Fritsch and Friesen, 2002). Genetic erosion is thought to have a major impact on the variation in this group, because of the widespread introduction of highly uniform and productive F1 hybrid varieties. Nonetheless, significant diversity can still be found (Astley et al., 1982; Bosch Serra and Currah, 2002).

Most landraces do not have the characteristics that determine the good quality and uniformity for the market (González et al. 2000). Nevertheless, landraces are well adapted to local edaphic and climatic conditions, resulting in high yields and better post-harvest storage ability in comparison with introduced cultivars. Landraces also have high genetic diversity and, consequently, are important raw material for plant breeding programs (Galván et al. 2005).

Onion landraces with high genetic diversity have potential in selection for development of cultivars with favorable agronomic and market traits, such as high number of skins and dark brown color of skin, round shaped bulbs, and high soluble solids and dry matter content (Porta et al., 2014).

This paper presents some of the results regarding the phenotypic diversity of some bulb traits of 15 red onion landraces collected from South-Western saline area of Timiș County.

### MATERIAL AND METHOD

The biological material was composed of 15 red onion landraces from localities of Timiș County with saline soils. The studied material was obtained from the work of a group of researchers from BUASVM Timișoara who have collected bulbs of red onion landraces from areas affected by salinity in Banat region, activity which was financed from the project "The screening of salinity tolerance of some local vegetable landraces in order to conserve the genetic potential and biodiversity" through PN-II-PT-PCCA-2011 program.

The experimental design was a randomized complete block (RCB) with three replicates. From each plot 20 bulbs were evaluated for the following traits: bulb height (Ib); bulb diameter (Db); bulb weight (Gb); shape index (If).

The data were analyzed by Jaccard similarity coefficients, UPGMA cluster analysis (Fielding, 2007), principal components, ANOVA (Ciulca, 2006). The significance of differences was expressed based on letters, variants marked with different letters being considered as significantly different. The distance matrix was used for cluster analysis using the unweighted pair-group method with arithmetic averages (UPGMA), with the Neighbor program of the Phylip package, version 3.5c. To make possible the display in a single graph of the performance of each genotype for each of the five traits, the basic principle of the biplot technique developed by Gabriel (1971) and GGE biplot method developed by Yan et. al. (2000) was used.

### RESULTS AND DISCUSSIONS

The height of bulbs in red onion landraces showed a middle-high (21.70%), ranging from 3.47 for Crai Nou and 8.13 for Livezile 151 landrace, under the conditions of 4.66 cm amplitude. Thus, Livezile 151 landrace showed a height of bulbs significantly superior to all other landraces. High values of this trait have been also observed in Grăniceri 25, Livezile, Sânmartinu Sârbesc 18, which have achieved significant increases compared to Uivar 305 and Crai Nou 82 landraces.

Table 1

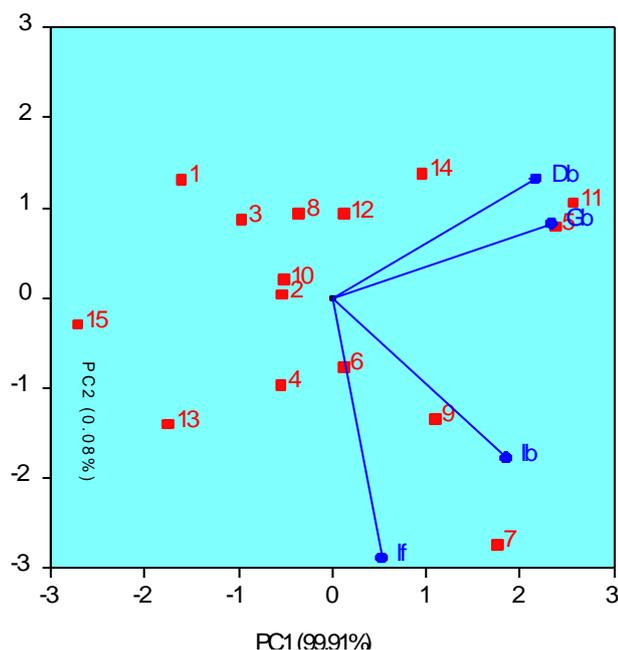
#### Mean values of the studied bulb traits in red onion landraces from Timiș County

Landraces	Height (cm)	Diameter(cm)	Weight (g)	Shape index
Crai Nou 82	3.47±0.61e	4.87±0.08cdef	48.80±10.12def	0.71±0.07d
Cruceni 111	4.87±0.21bcde	5.00±0.21cdef	61.83±4.64cdef	1.00±0.09bcd
Cruceni 249	4.10±0.10cde	5.05±0.45cde	59.40±10.29cdef	0.82±0.04cd
Cruceni 250	5.10±0.33bcde	4.70±0.08def	58.54±0.02cdef	1.27±0.04ab
Grăniceri 25	6.15±0.32b	6.55±0.04ab	135.97±4.22ab	0.94±0.04bcd
Livezile	5.75±0.75bc	4.90±0.10cdef	75.57±12.40cdef	1.17±0.09abc
Livezile 151	8.13±0.30a	5.17±0.33bcde	87.40±6.46bcde	1.58±0.04a
Livezile 498	4.43±0.30bcde	5.40±0.21abcd	72.16±2.75cdef	0.83±0.05bcd
Peciu Nou 99	5.40±0.48bcd	5.75±0.36abcd	94.46±7.41abcd	1.59±0.07a
Rudna 304	4.73±0.39bcde	4.93±0.30cdef	69.53±6.05cdef	0.97±0.06bcd
Sânmartin S.18	6.00±1.00bc	6.65±0.35a	147.46±13.09a	0.91±0.14bcd
Toager 80	4.85±0.37bcde	5.60±0.16abcd	81.16±12.25bcde	0.82±0.03cd
Toager 207	4.83±0.44bcde	3.80±0.20ef	32.25±3.82ef	1.27±0.03ab
Toager 209	4.50±0.32bcde	6.20±0.15abc	111.86±10.35abc	0.87±0.04bcd
Uivar 305	3.60±0.06de	3.60±0.21f	23.04±3.90f	1.01±0.03bcd
Exper. mean	5.06±0.30	5.21±0.22	77.30±8.93	1.05±0.07
LSD <sub>5%</sub>	1.93	1.45	57.91	0.45
LSD <sub>1%</sub>	2.60	1.95	77.97	0.61
LSD <sub>0.1%</sub>	3.46	2.60	103.67	0.81

Regarding the bulbs diameter, the red onion landraces recorded a variation amplitude of 2.85 cm with the limits between 3.60 for Uivar 305 and 6.65 cm in Sânmartinu Sârbesc 18, amid a medium inter genotypic variability. A frequency of 40% of the landraces showed a bulb diameter below 5 cm, while six landraces achieved values between 5 and 6 cm, and for three landraces the bulbs diameter exceeding 6 cm. The landraces Sânmartinu Sârbesc 18, Grăniceri and Toager 209 showed the highest values of this trait and significant increases compared to landraces: Uivar 305, Toager 207, Grăniceri 250.

Regarding to the bulbs weight, it is noted that the studied landraces showed a very high variability (39.85%), associated with amplitude of 115.21 g, with the limits between 23.04 g in Uivar 305 and 147.46 g in Sânmartinu Sârbesc 18. This trait has a Gaussian distribution, given that 20% of the landraces achieved a bulb weight below 50 g, 60 % of the landraces registered values between 50 and 100 g, and 20 % exceeded 100 g. Like the bulb diameter, the landraces Sânmartinu Sârbesc 18, Grăniceri 25 and Toager 209, who achieved values over 100 g, where significantly superior to Uivar 305 and Crai Nou 82 landraces.

In terms of bulb shape, the landraces are grouped into two categories with close frequencies, amid a general slightly elongated shape. Thus the most elongated bulbs were recorded for Peciu Nou 99 and Livezile 151 landraces, while at Crai Nou 82, Toager 209 and Cruceni 249 landraces the bulbs have had a more round shape.

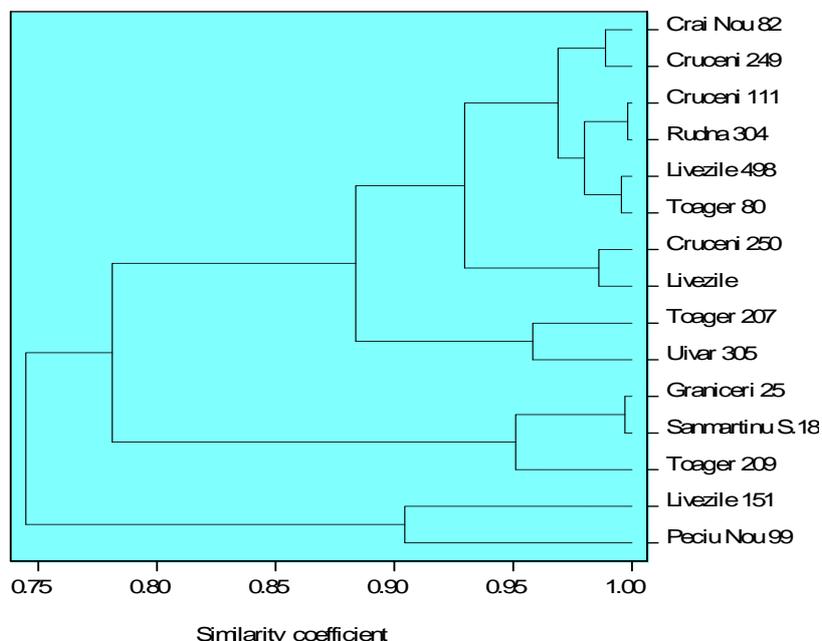


**Fig. 1. Biplot for the studied red onion landraces and bulb traits**

The biplot based on the first two principal components express 99.99% of the variability for red onion landraces (Figure 1). Also, it is noted that at Grăniceri 25, Sânmartinu Sârbesc 18 and Toager 209 landraces, the higher values of bulb diameter are associated with high weight. For Liveziile 151 and Peciu Nou 99, increased values of the bulb height are associated with an elongated shape and a weight close to the experience mean. Regarding the cosine of the angle between the vectors related to different traits,

assumptions about the correlations between these can be made. Thus, it is observed that the bulb height has a high influence on its shape.

The highest phenotypic similarity in terms of analyzed traits was recorded between landraces: Cruceni 111-Rudna 104 (99.84%); Grăniceri 25-Sânmartinu Sârbesc 18 (99.70%); Cruceni 249-Livezile 498 (99.28%). A high phenotypic diversity was registered between landraces: Sânmartinu Sârbesc 18-Uivar 305 (56.96%); Grăniceri 25-Uivar 305 (51.63%); Crai Nou 82-Livezile 151 (52.23%).



**Fig. 2. UPGMA clustering of red onion landraces from Timiș County for bulb traits**

Based on the phenotypic similarity for the studied traits, the red onion landraces were grouped into two main clusters (Figure 2). The first cluster is composed from Livezile 151 and Peciu Nou 99 landraces which manifests a phenotypic diversity of 9.57%.

*Table 2*

**Analysis of variance for red onion landraces concerning the bulb traits**

Landraces	Between groups		Within groups		F Test
	SS	DF	SS	DF	
Crai Nou 82	1572.09	1	8.96	2	350.87**
Cruceni 111	2541.01	1	10.33	2	491.90**
Cruceni 249	2358.44	1	9.85	2	478.81**
Cruceni 250	2256.51	1	8.88	2	507.95**
Grăniceri 25	12954.07	1	19.59	2	1322.37**
Livezile	3848.14	1	11.87	2	648.34**
Livezile 151	5097.27	1	21.52	2	473.78**

Livezile 498	3530.16	1	11.60	2	608.89**
Peciu Nou 99	6103.96	1	10.66	2	1144.92**
Rudna 304	3265.68	1	9.95	2	656.20**
Sânmartin S18	15323.88	1	19.76	2	1551.06**
Toager 80	4493.46	1	13.22	2	679.94**
Toager 207	628.58	1	6.71	2	187.30**
Toager 209	8748.56	1	14.83	2	1180.02**
Uivar 305	309.17	1	4.47	2	138.27**

The second cluster consists of several sub-clusters which exhibit different levels of the phenotypic similarity. The first sub-cluster includes the landraces: Crai Nou 82, Cruceni 249, Cruceni 111, Rudna 304, Livezile 498, Toager 80, between which there is an average similarity of approximately 97%. Cruceni 250 and Livezile landraces compose the second sub-cluster, showing an average diversity of about 93% to the landraces of the first subgroup. The third sub-cluster is composed of two landraces, Toager 207 and Uivar 305 respectively, showing a similarity of approximately 89% compared to the landraces of previous sub-clusters. The last sub-cluster is composed of Grăniceri 25, Sânmartinu Sârbesc 18 and Toager 209 landraces between which there is a similarity of 95.5% and presented high bulb size.

Regarding the analysis of variance for red onion landraces in terms of bulbs traits (Table 2), higher values of variance were recorded for the landraces: Sânmartinu Sârbesc 18, Grăniceri 25 and Toager 209, which showed high values of the bulb size. A reduced variability of the analyzed traits was observed at Uivar 305 and Toager 207 landraces. The greatest contribution to the diversity within groups (clusters) was observed in Liveziile 151, Sânmartinu Sârbesc 18 and Grăniceri 25 landraces, while the variability of traits at Uivar 305 landrace does not influence the diversity between the landraces of the second cluster.

Table 3

### Analysis of variance for bulb traits of red onion landraces

Trait	Between groups		Within groups		F Test
	SS	DF	SS	DF	
Bulbs height	0.90	1	17.73	13	0.66
Bulbs diameter	5.91	1	4.62	13	16.62**
Bulbs weight	11125.36	1	5632.35	13	25.68**
Shape index	0.08	1	0.95	13	1.06

Given the results presented in Table 3, it is noted that the bulb weight, generate the largest difference between landraces, having high contributions to the total variability. The lowest contribution to the diversity between the landraces of the two clusters was observed for shape index. The bulbs weight, followed by the bulb height generates a high diversity between the landraces of the same group.

## CONCLUSIONS

The results showed that significant differences in bulb traits were present between the landraces. The landraces: Sânmartinu Sârbesc 18, Grăniceri 25 and Toager 209, which showed high values of the bulbs size have had a high contribution to the total diversity. Also a reduced variability of the analyzed traits was observed at Uivar 305 and Toager 207 landraces.

This study found that the diversity of the studied red onion landraces was distributed within, as well as among landraces from the same location. Some of the landraces like Sânmartinu S. 18, Livezile 151, Peciu Nou 99 and Uivar 305 with favorable traits could be selected for further research and utilization.

## ACKNOWLEDGEMENT

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. Special thanks to all persons from villages which were very kind to let us visit their gardens and supplied us with the necessary plant material.

## REFERENCES

- Astley D., Innes N.L., Van der Meer, Q.P.** 1982 - *Genetic Resources of Allium Species*, IBPGR secretariat, Rome, Italy, pp. 38;
- Bosch Serra, A.-D., Currah L.** 2002 - *Agronomy of onions*, in: *Allium Crop Science: Recent Advances*, H.D. Rabinowitch, and L. Currah, eds., CABI Publ., Wallingford, UK, pp. 187-232;
- Ciulca S.** 2006 - *Metodologii de experimentare în agricultură și biologie*. Ed. Agroprint, Timișoara;
- Fielding A.H.** 2007 - *Cluster and classification techniques for the biosciences*. Cambridge University Press;
- Fritsch R.M., Friesen N.** 2002 - *Evolution, domestication and taxonomy*, in: *Allium Crop Science: Recent Advances*, H.D. Rabinowitch, and L. Currah, eds., CABI Publ., Wallingford, UK, pp. 5-30;
- Gabriel K.R.** 1971 - *The biplot graphic display of matrices with application to principal component analysis*. *Biometrika*, 58: p. 453-467;
- Galván G., González H., Vilaró F.** 2005 - *Estado actual de la investigación en poblaciones locales de hortalizas en Uruguay y su utilización en el mejoramiento*. *Agrociencia* 9: 115-122;
- González H., Zaccari F., Suarez C.** 2000 - *Conservación de bulbos de poblaciones locales de cebolla. En: Presentación de resultados experimentales de ajo y cebolla*. INIA Serie actividades de difusión 223: 41-46;
- Porta Bettina, Rivas Mercedes, Gutiérrez Lucía, Galván G.A.** 2014 - *Variability, heritability, and correlations of agronomic traits in an onion landrace and derived S1 lines*. *Crop Breeding and Applied Biotechnology* 14: 29-35;
- Yan W., Hunt L.A., Sheng Q., Szlavnic Z.** 2000- *Cultivar evaluation and mega-environment investigation based on the GGE biplot*. *Crop. Sci.*, 40, 597-605.