

## UNIVARIATE AND MULTIVARIATE ANALYSIS OF SOME GARLIC LANDRACES FOR BULBS TRAITS

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**Keywords:** garlic, landraces, bulbs traits.

### ABSTRACT

*The objectives of this paper were to evaluate 12 garlic landraces collected from South-Western saline area of Timis County regarding the bulbs traits and interrelationship among them, with a view to exploiting some of these landraces directly in the crop or using these landraces in breeding program. In this region growers use mostly garlic landraces with a high adaptability to specific environmental conditions, like soil salinity.*

*The results prove the existence of a large phenotypic diversity of bulb traits, even between landraces from the same location (Livezile, Sanmartin, Foeni) which suggests that the adaptation to specific environmental conditions have been associated with different morphological features of bulbs. The height followed by the diameter of bulbs has a significant contribution to the achievement of their weight.*

### INTRODUCTION

Despite its asexual reproduction, garlic (*Allium sativum* L.) exhibits wide diversity for morphological and agronomic characters due to accumulation of mutations (Mohammadi et al., 2014). On the other hand, although mutations may be a source of variability, they are rather limited; therefore, breeding using this strategy has not resulted in significant progress (Etoh and Simon, 2002). The lack of sexuality in garlic limits the increase of variability that is useful for breeding for economically important traits, such as tolerance to biotic and abiotic stress, earliness, yield and quality (Kamenetsky, 2007).

Garlic yield is the integration of many variables that affect plant growth during the growing period. The knowledge of genetic association between garlic yield and its components would improve the efficiency of breeding programs by identifying appropriate indices for selecting garlic varieties (Singh, et al., 2011). Bulb diameter was reported by many researchers as the most closely variable related to yield per unit area and was often used in selecting high yielding garlic (Rahman and Das, 1985; Kohli and Nutan, 1993; Singh and Singh, 1999). Because garlic is highly adaptive to its growth environment, yields remain consistent or may improve when bulbs are replanted in similar conditions in which they were produced (Volk and Stern, 2009).

As garlic being a vegetative propagated crop, genetic variability is maintained mainly between rather than within populations. Therefore, a low number of individuals from each population may be sufficient to represent the genetic variability within and between genotypes (De Bustos et al. 1998).

Saline soils affect around 15% of the agricultural lands in Timis county. There are two main geographical areas affected by soil salinity: the South-Western area – represented by Livezile, Cruceni, Foeni, Uivar, Cenei, Săcălaz, Peciu-Nou Ciacova, and the North-Western area - Dudestii-Vechi, Beba-Veche, Cenad, Sînicolaul-Mare, Sînpetru-Mare and Teremia Mare villages (Camen et al. 2012).

The objectives of this paper were to evaluate 12 garlic landraces collected from South-Western saline area, regarding the bulbs traits and interrelationship among them, with a view to exploiting some of these landraces directly in the crop or using these landraces in breeding program.

## MATERIAL AND METHOD

The biological material was composed of 12 garlic 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 biological material was planted in autumn using 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 interrelationships between the bulbs traits were analyzed using multiple regressions (Ciulca, 2006).

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 bulbs height of garlic landraces showed a medium inter genotypic variability (10,56 %), with values from 3,15 in Foieni 375 and 4,30 cm in Livezile 333 landraces, under the conditions of a variation amplitude of 1.15 cm. Livezile 333 landrace showed a significantly superior bulbs height towards the landraces: Sanmartin S. 180b, Foieni 375; Crai Nou 82 și Cruceni 249. High values of this trait, of over 4 cm were also recorded by Livezile 498 and Sânmartinu S. 180a landraces.

Table 1

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

| No. | Landrace           | Height (cm)   | Diameter(cm) | Weight (g)     | Shape index   |
|-----|--------------------|---------------|--------------|----------------|---------------|
| 1   | Crai Nou 82        | 3,37±0,09 bc  | 4,17±0,27 b  | 27,62±3,21 bc  | 0,81±0,03abc  |
| 2   | Cruceni 249        | 3,30±0,10 bc  | 4,95±0,15 ab | 56,49±14,40 ab | 0,67±0,05d    |
| 3   | Foieni 284         | 3,47±0,03 abc | 5,10±0,21 ab | 40,50±3,70 abc | 0,68±0,02d    |
| 4   | Foieni 343         | 3,93±0,34 abc | 4,67±0,55 ab | 47,92±3,92 abc | 0,86±0,09a    |
| 5   | Foieni 375         | 3,15±0,05 c   | 4,55±0,35 ab | 27,00±7,18 c   | 0,70±0,04d    |
| 6   | Livezile 151       | 3,50±0,15 abc | 4,83±0,34 ab | 43,70±6,63 abc | 0,73±0,02bcd  |
| 7   | Livezile 333       | 4,30±0,32 a   | 5,17±0,33 ab | 58,74±5,01a    | 0,83±0,02ab   |
| 8   | Livezile 498       | 4,17±0,19 ab  | 5,80±0,15 a  | 61,66±2,86 a   | 0,72±0,04cd   |
| 9   | Periam 48          | 3,93±0,09 abc | 5,20±0,06 ab | 55,71±1,65 abc | 0,76±0,01abcd |
| 10  | Sânmartinu S, 180a | 4,00±0,12 abc | 5,70±0,15 a  | 66,38±2,09 a   | 0,70±0,04d    |
| 11  | Sânmartinu S, 180b | 3,23±0,03 c   | 4,30±0,15 b  | 28,42±0,51 bc  | 0,75±0,03bcd  |
| 12  | Toager 44          | 3,73±0,09 abc | 5,63±0,20 a  | 66,67±5,24 a   | 0,67±0,04d    |
|     | Exper. mean.       | 3,61±0,15 abc | 4,89±0,21 ab | 47,16±4,98 abc | 0,75±0,02bcd  |
|     | LSD <sub>5%</sub>  | 0,88          | 1,26         | 29,45          | 0,11          |



this regression model, this results are relevant considering also the value of adjusted coefficient of determination. The bulbs height showed the highest influence (56.04 %) on their weight. Also, the bulbs diameter has a significant contribution (28.30) to the achievement of their weight, while the bulbs shape has a small (2.30 %) and statistically uninsured influence.

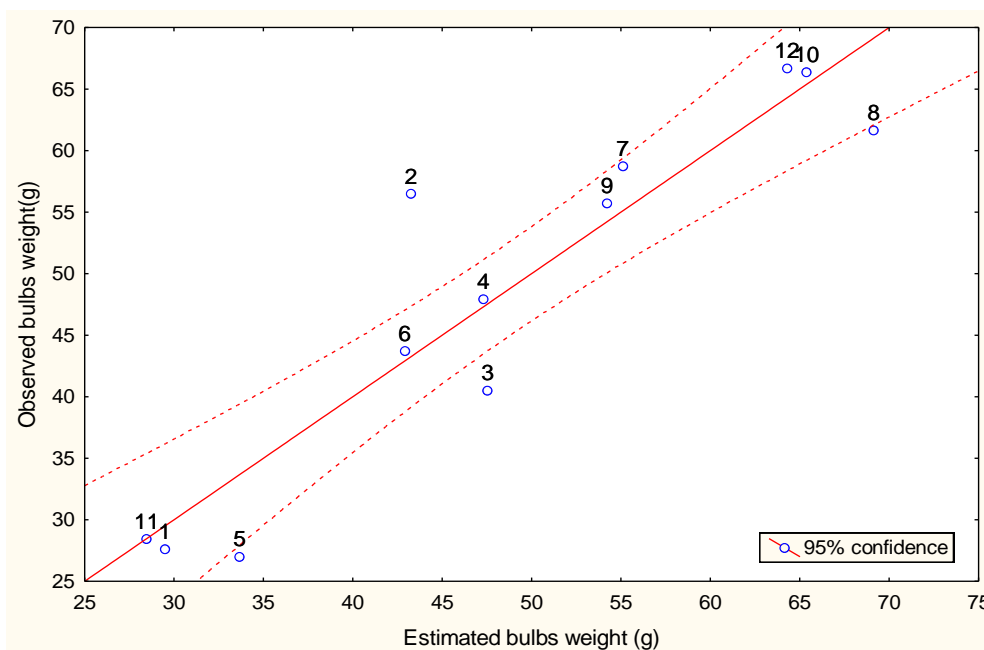
Table 2

**Variance components of multiple regression between bulbs weight and other bulbs traits for garlic landraces**

| Variability source      | SS      | DF | MS      | F       |
|-------------------------|---------|----|---------|---------|
| Regression              | 2080.80 | 3  | 693.60  | 15.78** |
| Bulbs height ( $x_1$ )  | 1363.24 | 1  | 1363.24 | 31.02** |
| Bulb diameter ( $x_2$ ) | 688.47  | 1  | 688.47  | 15.66** |
| Shape index ( $x_3$ )   | 29.10   | 1  | 29.10   | 0.66    |
| Residual                | 351.60  | 8  | 43.95   |         |
| Total                   | 2432.40 | 11 |         |         |

$$y = -4,776 + 0,005x_1 + 0,092x_2 + 0,179x_3; R^2 = 0,8554; R_a^2 = 0,8012; SDE = 6.63 \text{ g}; DW=2,92$$

The regression model allows a meaningful assessment of bulbs weight with an error of  $\pm 6.63$  g. Given that the Durbin-Watson index is greater than 1.4, it follows that the errors which accompany the experimental results are not auto correlated, and the order of traits in the equation of regression does not influence the estimated values of bulbs weight for these garlic landraces.



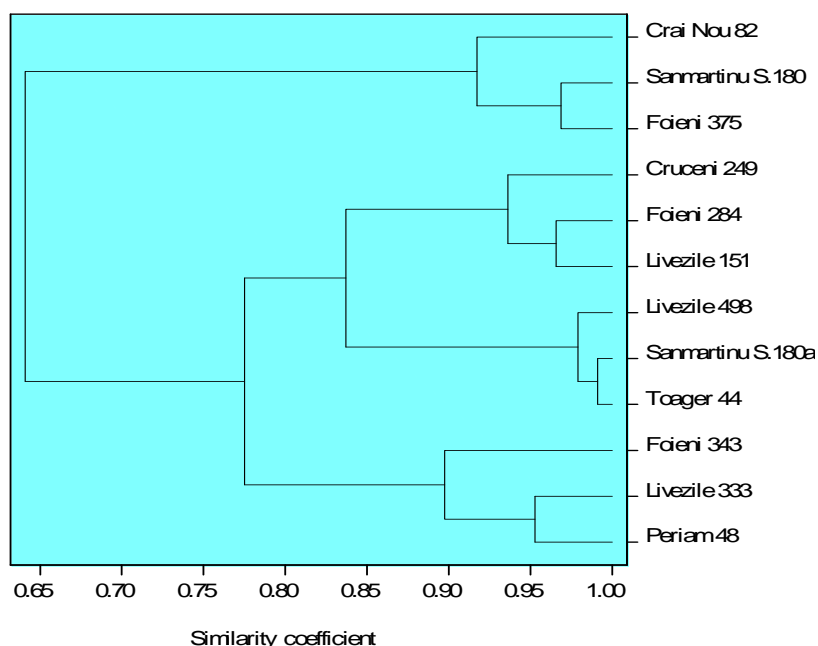
**Fig. 2. Observed and estimated values of bulbs weight based on multiple regression model for garlic landraces**

Based on the Figure 2 it is noted that generally there are no significant differences between the observed values and the estimated bulbs weight through the regression, as such the contribution of different traits to the variability of bulbs weight is relevant for 10 of the 12 garlic landraces. Thus, at Cruceni 249 landrace, the experimentally observed weight of bulbs is significantly higher to the estimated one, while at Foieni 384 the mass bulbs appreciated based on the other three traits is significantly lower than the real one.

The highest phenotypic similarity in terms of analyzed traits was recorded between landraces: Livezile 498-Sânmartinu S. 180a (99,30 %); Foieni 284-Livezile 151 (97,91 %);

Cruceni 249-Foieni 284 (97,50 %); Crai Nou 82-Sânmartinu S. 180b (97,30). The highest diversity under the aspect of these four traits was observed between landraces: Foieni 375-Sânmartinu S. 180a (68,07%); Foieni 375-Toager 44 (64,70 %); Foieni 375-Livezile 333 (61,01 %).

Having regard to the phenotypic similarity of the 12 garlic landraces, the dendrogram (Figure 3) was made using cluster (groups) average method. This dendrogram shows two main clusters, among which there is a phenotypic diversity of about 29%. The first cluster is composed from the landraces with small bulbs, like: Crai Nou 82, Sânmartinu S. 180b and Foieni 375, among which there is a phenotypic similarity of about 87%.



**Fig. 3. UPGMA clustering of garlic landraces from Timiș County for bulb traits**

The second cluster consists of two sub clusters; seven landraces showing an average similarity of approx. 93% are located in the first sub clusters, respectively. A second sub cluster is composed of Livezile 333 and Foieni 343 landraces between which there is a similarity of approximately 96.5%, and which have high values of the bulbs height, slightly more elongated than at the other landraces.

*Table 3*

**Analysis of variance for garlic landraces concerning the bulb traits**

| Landraces    | Between groups |    | Within groups |    | F Test   |
|--------------|----------------|----|---------------|----|----------|
|              | SS             | DF | SS            | DF |          |
| Crai Nou 82  | 462,64         | 1  | 6,16          | 2  | 150,18** |
| Cruceni 249  | 2148,03        | 1  | 9,32          | 2  | 460,98** |
| Foieni 284   | 1050,01        | 1  | 9,99          | 2  | 210,16** |
| Foieni 343   | 1503,04        | 1  | 8,16          | 2  | 368,27** |
| Foieni 375   | 74,40          | 1  | 3,09          | 2  | 48,09*   |
| Livezile 151 | 1241,15        | 1  | 8,75          | 2  | 283,67** |

|              |         |   |       |   |          |
|--------------|---------|---|-------|---|----------|
| Livezile 333 | 2294,12 | 1 | 10,54 | 2 | 435,14** |
| Livezile 498 | 2531,42 | 1 | 13,46 | 2 | 376,27** |
| Periam 48    | 2060,37 | 1 | 10,46 | 2 | 394,01** |
| Sânmartinu S | 2968,57 | 1 | 12,93 | 2 | 459,29** |
| Sânmartinu S | 493,83  | 1 | 6,63  | 2 | 148,91** |
| Toager 44    | 3007,70 | 1 | 12,52 | 2 | 480,28** |

Table 4

### Analysis of variance for bulb traits of garlic landraces

| Trait          | Between groups |    | Within groups |    | F Test  |
|----------------|----------------|----|---------------|----|---------|
|                | SS             | DF | SS            | DF |         |
| Bulbs height   | 1,46           | 1  | 1,49          | 10 | 9,77*   |
| Bulbs diameter | 2,95           | 1  | 3,08          | 10 | 9,56*   |
| Bulbs weight   | 2400,60        | 1  | 874,46        | 10 | 27,45** |
| Shape index    | 0,01           | 1  | 0,04          | 10 | 0,03    |

Regarding the analysis of variance for the traits studied in these landraces, it is noted that for bulb weight high and distinctly significant values of the variance were recorded (Table 4). Thus, this trait manifests a high capacity to differentiate both between the landraces of the same cluster as well as between those from different clusters. The lowest variability between landraces was observed for the bulbs shape.

### CONCLUSIONS

The results prove the existence of a large phenotypic diversity of bulb traits, even between landraces from the same location (Livezile, Sanmartin, Foieni) which suggests that the adaptation to specific environmental conditions have been associated with different morphological features of bulbs. The height followed by the diameter of bulbs has a significant contribution to the achievement of their weight. Some of these landraces are valuable resources for plant breeding programs as a source of salinity tolerant genes that were lost during the selection process of commercial varieties.

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### REFERENCES

Camen D, Suci Laura, Popescu Ioana, Schmidt Brigitta, Beinsan Carmen, Ciulca S, Gaspar S, Sumalan R. 2012- *Phenotypic diversity evaluation of some bulb characters of local shallot (Allium Ascalonicum) landraces from saline soils in Banat area*. In Annales of University of Craiova, Biology, Horticulture, Food Produce Processing Technology, Environmental Engineering, Issue XVII, 2012/2, Biology & Environmental Engineering, 565-570;

- Ciulca S.** 2006 - *Metodologii de experimentare în agricultură și biologie*. Ed. Agroprint, Timișoara;
- De Bustos A, Casanova C, Soler C, Jouve N.** 1998 - *RAPD variation in wild populations of four species of the genus *Hordeum* (Poaceae)*. Theor Appl Genet 96:101–111;
- Etoh, T., Simon, P. W.** 2002 - *Diversity, Fertility and Seed Production of Garlic*. In: Allium Crop Sciences: Recent Advances , Rabinowitch, H. D., & Currah, L., Eds., pp. 101-117, CAB International, Wallingford, U. K;
- Fielding A.H.** 2007 -*Cluster and classification techniques for the biosciences*. Cambridge University Press;
- Gabriel K.R.** 1971 - *The biplot graphic display of matrices with application to principal component analysis*. Biometrika, 58: p. 453-467;
- Kamenetsky, R.** 2007 - *Garlic: Botany and Horticulture*. Hort. Rev. , Vol. 33, pp. 123-171;
- Kohli U.K., Nutan M.** 1993. *Yield performance and correlation studies in garlic - A note*. Haryana Journal of Horticultural Sci., 22(2): 163-165;
- Mohammadi B., Khodadadi M., Karami E., Shaaf S.** 2014 -*Variation in Agromorphological Characters in Iranian Garlic Landraces* International Journal of Vegetable Science Vol. 20, Issue 3, 202-215;
- Rahman A.K., Das M.K.** 1985 - *Correlation and path analysis in garlic*. Bangladesh J. Agric. Research, 10: 50-54;
- Singh J.P., Singh S.B.** 1999 - *Evaluation of different selections/varieties of garlic for yield and some yield contributing parameters*, Crop Research, 18(2): 216-217;
- Singh R.K., Dubey B.K., Bhonde S.R., Gupta R.P.** 2011 - *Correlation and path coefficient studies in garlic (*Allium sativum* L.)*, Journal of Spices and Aromatic Crops, 20(2): 81-85;
- Volk G.M., Stern D.** 2009 - *Phenotypic Characteristics of Ten Garlic Cultivars Grown at Different North American Locations*. Hort Science 44(5):1238–1247;
- Yan W., Hunt L.A., Sheng Q., Szlavnicz Z.** 2000- *Cultivar evaluation and mega-environment investigation based on the GGE biplot*. Crop. Sci., 40, 597-605.