

# The Standard Characterization of the Romanian Onion Landrace 'Roşie de Făgăraş'

Maria Mihaela ANTOFIE<sup>1\*</sup>, Camelia SAND SAVA<sup>1</sup>

<sup>1</sup> Faculty of Agricultural Sciences, Food Industry and Environmental Protection, Department of Agricultural Sciences and Food Industry. University Lucian Blaga from Sibiu  
7-9 Dr. Ion Raţiu Str. 550012, Sibiu, Romania

\*)Corresponding author, e-mail: mihaela.antofie@ulbsibiu.ro

BulletinUASVM Horticulture 73(2) / 2016

Print ISSN 1843-5254, Electronic ISSN 1843-5394

DOI:10.15835/buasvmcn-hort:12227

---

## Abstract

'Roşie de Făgăraş' is a red onion landrace originating from the old region named Făgăraş Country situated in South East Transylvania. It was officially included in the National Official Catalogue for cultivars and hybrids in 1952, for almost 50 years, and erased before 2004 without applying *in situ* conservation measures. However, food security depends on the appropriate management of all genetic resources for food and agriculture (PGRFA). Thus they have to be conserved and sustainable used and efforts have to be done for the recognition of this landrace as a PGRFA and therefore to be maintained "under conservation" into the Official Catalogue. The study focused on analysing data from three localities recognized for cultivating 'Roşie de Făgăraş', in order to evaluate morphometric characteristics of mature onion bulbs according to the UPOV Standard TG/46/7, productivity, land cultivation and socio-economic vulnerabilities. The analysis of morphometric measurements results support that 'Roşie de Făgăraş' is a medium size red onion that may have the chance to enter the market place, at least at the small scale, according to the current regulatory framework of the European Union regarding the conservation of landraces and provided by: Directive 2008/62/EC, Directive 2009/145/EC and Directive 2010/60/EU. The analysis of productivity, and land cultivation revealed dramatic land use change associated with the decline of cultivated area as following: 76.27% in Mândra, 50% in Recea and 33.34% in Beclean. With an increasing ageing population, lack of political support for entering the market place, decrease of landowners cultivating 'Roşie de Făgăraş' for trade will increase vulnerability of traditional knowledge related to the conservation of this landrace.

**Keywords:** landrace, onion, Romania, Roşie de Făgăraş, 'UPOV Standard TG/46/7'

---

## INTRODUCTION

The conservation of all plant genetic resources for food and agriculture (PGRFA) became extremely important for political agenda upon the adoption of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) or Plant Treaty at the global level in 2001 (Maxted *et al.*, 2015). The need for applying *in situ* and *ex situ* conservation measures in an efficient manner for crops including landraces, is recently explained by their particular evolution of their inherited genetic traits that were developed into peculiar environment provided by specific agro-ecosystems conditions (Dwivedi *et al.*, 2016).

Today it is generally accepted the need for their official recognition in supporting biodiversity conservation as a whole for ensuring food security (Martin *et al.*, 2016). Romania became a Party to the Plant Treaty in 2005 (i.e. Law 42/2005) and based on the provisions of Art. 5 it will be compulsory to provide conservation measures to all PGRFA, including crop landraces as well as wild crops relatives (Jarvis *et al.*, 2015). However, such a goal will be difficult to be reached by any country, and a balance between *in situ* and *ex situ* conservation measures should be reached for cost efficiency of the process, in order to cover all potential PGRFAs (Negri *et al.*, 2015).

The onion (*Allium cepa* L.) domestication and use has a history of more than 5000 years (Gallina *et al.*, 2012). Thirty years ago, 40% of all European genetic resources for vegetables, including onion, were considered to be conserved (i.e. ready to be accessed as PGRFA), in the existing network of European gene banks (Maggioni, 2002). The European onion breed programmes, is based on the conservation for accessing these genetic resources for producing new varieties facing new demands for market production or challenges due to environmental factors (Maggioni *et al.*, 1997). Today the current onion breeding programme needs to access the entire genome (Duangjit *et al.*, 2013). Onion genome is huge, comprising 16.3 gigabases per 1C nucleus (Arumuganathan and Earle 1991), and it makes difficult the identification and use of molecular markers nowadays. In addition other characteristics such as the biennial generation time and severe inbreeding depression which slow the development of segregating families make more difficult the progress in onion breeding (Duangjit *et al.*, 2013). Therefore, it is imposed to ensure as much as possible a broader access to all potential genetic resources of onion (Porta *et al.*, 2014).

In Romania, the research on *Allium cepa* L. has developed after 1967 at the Research Institute for Vegetable and Flower Growing Vidra-Ilfov (Maggioni *et al.*, 1997). *Ex situ* collections in Romania for PGRFA are managed today by the Gene Bank from Suceava but the onion landrace conservation and use in our country is not yet documented. 'Roşie de Făgăraş' is a red onion landrace used for gardening and originating from South Eastern Transylvania for more than 300 years (Indrea *et al.*, 2007; Poşta, 2008; Gyémánt *et al.*, 2009), which was officially recognized for trade as a landrace since 1952. Later, before 2004, it was erased from the Romanian Official Catalogue of crop varieties without any conservation measures.

The scope of this article is to analyze morphometric measurements of mature onion bulbs of "Roşie de Făgăraş", ready for marketing, against 16 characteristics described in the "Guidelines for the Conduct of Tests for Distinctness, Uniformity and Stability, TG/46/7 (UPOV, 2009). Also it was evaluated the evolution of production and land cultivation, as well as, socio-economic vulnerabilities related to traditional knowledge.

## MATERIALS AND METHODS

**Studied area** Three landowners from each of the localities: Beclean (Lat. 45°50'00"; Long. 24°56'00"), Mândra (Lat 45°49'20"; Long 25°02'48") and Recea (Lat 45°43'52"; Long. 24°56'34"), have provided onion bulbs of the landrace 'Roşie de Făgăraş'. They are applying, the complete biennale technology, in the traditional way. All seeds are originating from their own production for more than three generations.

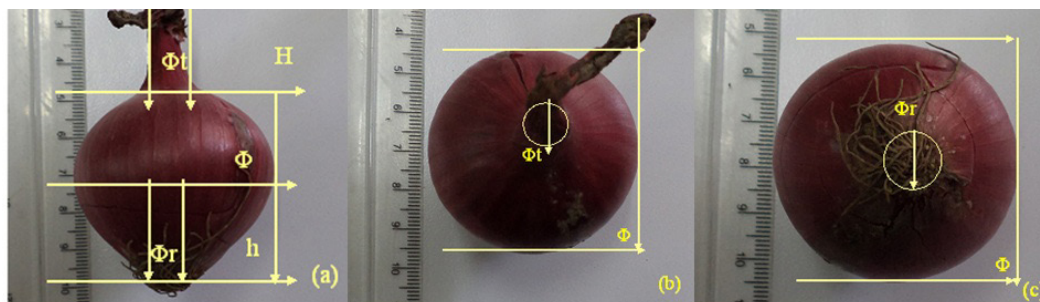
**Official data survey** regarding onion production and cultivated surface have been requested from the City Halls of Beclean, Mândra and Recea as well as from the National Institute for Statistics. City Halls have been requested for additional data regarding the land use change, aging and gender situation, level of education of the producers and ability to trade or only produce for subsistence.

**Official catalogues survey** for plant genetic varieties have been investigated for revealing the status of official landrace conservation, particularly regarding the situation of onion landraces in Romania.

**Ex situ conservation programmes survey** The Gene Bank from Suceava (i.e. the National Focal Point under the Plant Treaty), and the Research Institute for Vegetable and Flower Growing, Vidra-Ilfov were surveyed for the presence of the landrace 'Roşie de Făgăraş' as well as for other onion landraces or varieties.

**Plant material** Mature onion bulbs have been examined after their harvesting from three original locations during October, 2014 (i.e. 100 onion bulbs of each location have been purchased directly from their landowners). Thus, it was ensured that onion local populations used in this study have been produced in original conditions (Meier 1997; Engle, 1992; Krasteva *et al.*, 2009), for the evaluation of morphometric characteristics according to the UPOV Standard TG/46/7 as well as to the requirements of the current regulatory framework at the European Union supporting the conservation of crops landraces.

**Morphometric measurements** A lab ruler and a professional calliper have been used. For photographs a Canon camera was used at a fixed point of 30 cm under a light intensity of 10000 Lx. Measurements and observations were realized for longitudinal, top-down and bottom-up views of the onion bulbs (Fig 1), according to UPOV standard (UPOV, 2008). An analytical balance Bio-Rad and



**Fig. 1.** Longitudinal (a), top-down (b) and bottom-up (c) views of measurements for onion bulbs according to the Standard TG/46/7: height (H), position of maximum diameter (h), maximum diameter ( $\Phi$ ), wide of neck or stem base diameter ( $\Phi_t$ ) and root diameter ( $\Phi_r$ ).

an oven Froilabo AP60 were used for fresh weight and dry matter analysis.

**Onion bulbs preparation for analysis** The dry skins as well as the protruding parts of root disks were manually removed according to the standard method.

**Dry matter** All investigated onion bulbs have been cut in slices of less than 5 mm (Fig. 2c) placed in glass jars at 105°C for at least 2 h followed by 22 h at 65°C. After other 24 h, of maintaining in dry conditions all samples have been weight (Porta *et al.* 2014).

## RESULTS AND DISCUSSION

### Morphometric measurements and characteristics

**Degree of splitting into bulblets** Not very often (i.e. 17.33%) bulbs present two bulblets. According to the landowners such a characteristic may become more frequent due to weather conditions and even so, that characteristics can be considered as belonging to the second class according to the Standard characteristic no. 11.

**Bulb size** The average fresh weight of the 'Roşie de Făgăraş' (after removing the dry skin, roots and stems), was 61.48 g ranging between 46.5 and 98.35 g for all three onion landrace sources (Fig. 3a). However, 82.23% of the samples ranged between 60 and 80 g. According to the Standard characteristic 12.1 is a medium size onion.

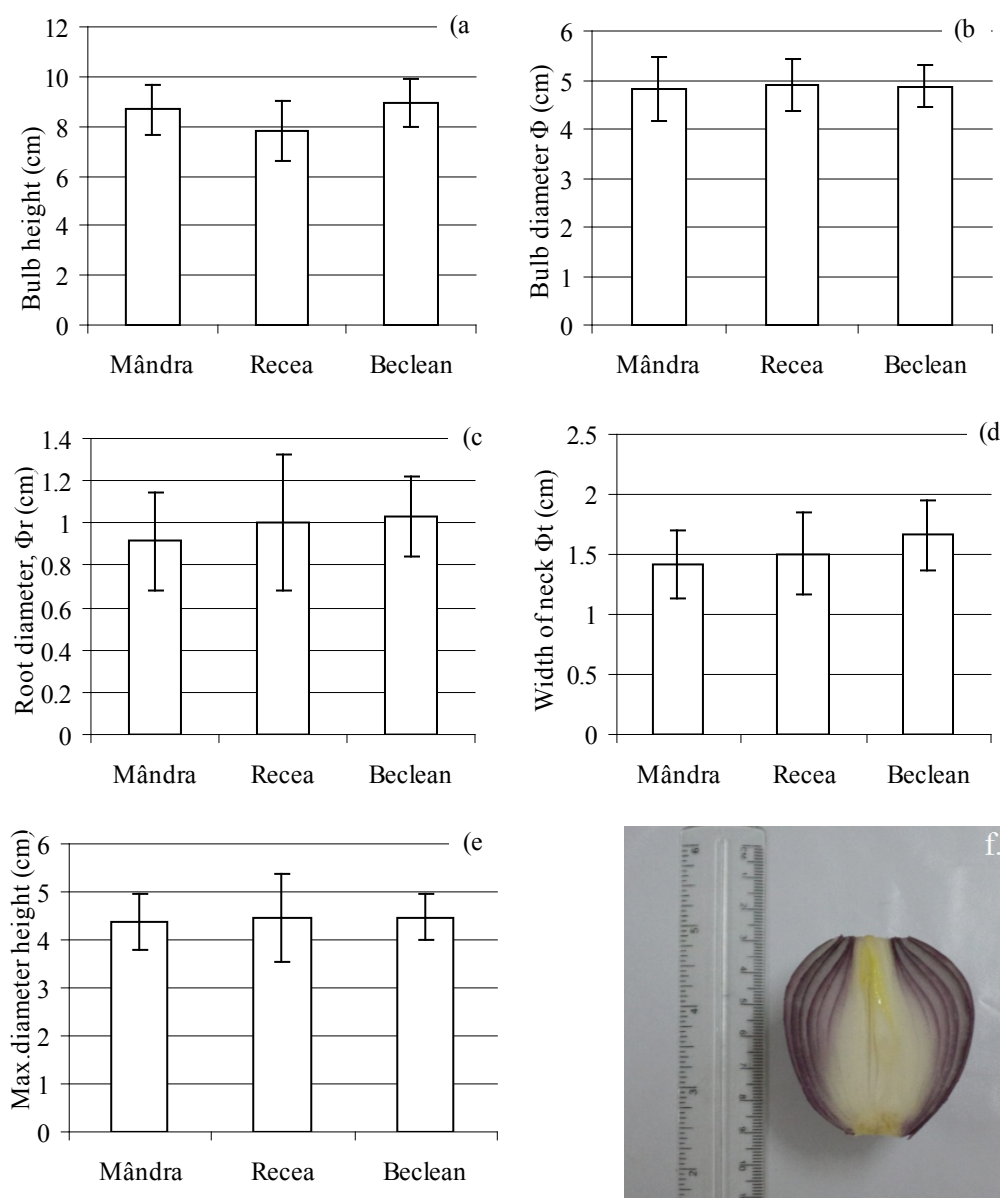
**Bulb height** The analysis of height measurement for the three different onion populations revealed that the onion bulb height ranges between 6.5 and 12 cm and over 78% of them (236 bulbs) are ranging between 7 and 10 cm. As a consequence the onion bulb height may be considered as medium according to the Standard characteristic

no 13.1. (Fig. 2a). In Recea, the average diameter is 7.80 cm, in Mândra 8.67 cm and in Beclean is 8.96 cm. However, there are not significant differences for this parameter between the three collected populations.

The onion *bulb diameter* ranged between 3.5 and 10 cm with no significant difference between the three sources of onion populations (Fig. 2b). However over 85% of the bulbs ranged  $\pm 0,5$  cm around 6.5 cm (i.e. between 6 and 7 cm) and according to the Standard characteristic no 14.1., it is a medium size onion bulb that can be recognized already as such. The difference among the extremes, between the smallest and the largest bulb, is reduced (i.e. 15%) and it is due to land fertility and cultivation conditions supporting the maintenance of genetic variability in bulb size inside the onion population according to other results (McCollum, 1968; Galmarini *et al.*, 2001; Balint and Poşta, 2015).

**Bulb ratio height/maximum diameter** ranges between 1.14 and 2.7 with a 76.5% of the population ranging between 1.35 and 2.05 supporting further these results for classifying this landrace as a medium size onion according to the Standard characteristic no. 15.1. with similarities of other cultivars described before (Magruder *et al.*, 1941). It is relevant to underline that such a ratio may further support the initial description of this landrace realized by Groza *et al.*, (1976) and that is not any-more an onion of large size.

**Bulb position of maximum diameter** Only 8 samples proved to have the maximum diameter displaced up to 5% above the half of the bulbs height of 300 samples (Fig. 2 e). This is a strong response of this red onion landrace regarding the position of the maximum diameter at the middle according to the Standard characteristic no. 16.

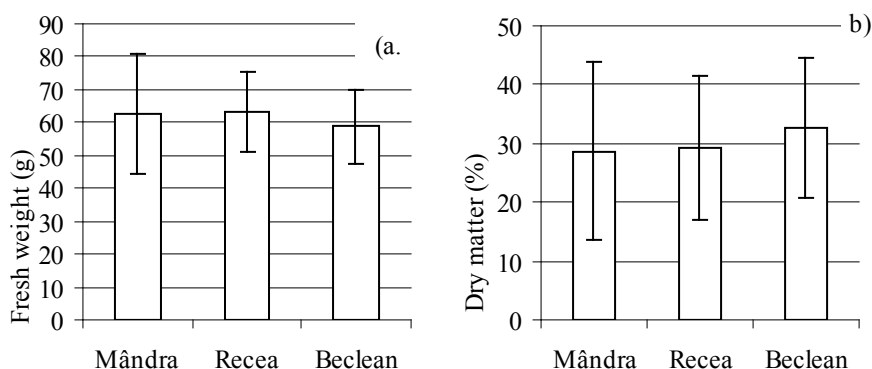


**Fig. 2.** Bulb measurements for red onion landrace “Roşie de Făgăraş”: a) bulb height (cm); b) bulb maximum diameter (cm); c) root diameter  $\phi_r$  (cm); d) width of neck  $\phi_t$  (cm); e) height of the maximum diameter (cm); f) bulb shape in longitudinal section.

The width of neck may range between 1 and 2.5 cm depending on the maximum size of the bulb diameter (Fig. 2 d). The ratio between the bulb size and width of neck may vary between 6 to 1 or between 20% to 50%, from the smallest to the largest onion bulb. Over 65% of the recorded bulbs exhibit a width neck of  $1.5 \pm 0.2$  cm and it can be concluded that this red onion population may be classified as presenting a narrow neck according to the Standard characteristic no. 17.

*Bulb shape* (longitudinal section) Two main shapes have been identified such as broad elliptic (85.66%) (Fig. 2 f) and circular (14.33%) with small differences between the three investigated localities: Recea (i.e. 87% broad elliptic), Mândra (i.e. 86% broad elliptic) and Beclean (i.e. 84% broad elliptic). It can be considered that ‘Roşie of Făgăraş’ may present a broad elliptic shape according to the Standard characteristic no. 18. The circular shape may be due to the different environmental factors.





**Fig. 3.** Fresh weight (a) and dry matter (b) for the three onion landrace 'Roşie de Făgăraş'.

*Bulb shape of stem end* proved to be rounded and slightly sloping that is similar as a ratio compared to the bulb shape (Fig 1a). According to the to the Standard characteristic no. 19, 85.66% of onion bulbs are rounded and 14.33% are slightly sloping and it can be considered that the bulb shape of stem end is rounded.

*Bulb shape of root end* proved to be only round shape for all three sources (Fig. 1a) according to the Standard characteristic no. 20. The root *diameter* ranged tight around 1 cm such as following: 0.91 cm for Mândra, 1 cm for Recea and 1.03 cm for Beclean (Fig. 2 c). However the differences between all samples are minor and positively correlated with the onion size supported by an average ratio between bulb diameter and root diameter of 5.12.

*Bulb adherence of dry skin after harvest* (Standard characteristic 21) and *Bulb thickness of dry skin* (Standard characteristic 22) are medium for all investigated bulbs without exception. *The base colour of dry skin* is dark red without exception for all investigated bulb (Fig. 2 f) and therefore "Roşie de Făgăraş" belongs to class 7 according to the Standard characteristic no.23. *Bulb intensity of base colour of dry skin* is dark for all investigated bulbs according to (Standard characteristic 24). *Hue of colour of dry skin* (in addition to base colour) is purplish (Fig. 2 f), according to the Standard characteristic no. 25 and is explaining the use of it in the traditional dyeing of Easter eggs or textile fibres (i.e. wool, flax and hemp).

*Dry matter* The dry matter ranged between 28.66% (Recea) to 29.41% (Mândra) and 32.73% (Beclean) (Fig. 3b). Very tight differences between all sources are supporting that these might be due

to climatic conditions. With an average dry matter content, ranging between 28.66% and 32.73%, according to the Standard characteristic no. 29, the 'Roşie de Făgăraş' belongs to the medium class. However, considering the description of Groza *et al.*, (1976) it should be underlined that only by accident, in local conditions, may reach 250 g per bulb. If before it was considered as a large size bulb onion due to these characteristics, the current results are placing this landrace in the medium size onion for bulbs.

#### Onion production and socio-economic vulnerabilities

*Cultivated area and production* In Beclean the cultivated area with onion dropped during 25 years of monitoring from 15 ha (between 1990 and 2000) to 10 ha up today (2015). The average production decreased accordingly from 10 t (between 1990 and 2000) to 8 t (after 2000). Today it was registered a production of 0.8 t/ha that it is associated with the traditional cultivation of the red onion similar with organic agriculture. It is relevant to mention the low fertility of the soil and that the farmers are adding only manure during autumn before frost. In Mândra it was recorded the worse situation: the cultivated surface decreased during the last 25 years from 118 ha (from 1990 to 2000) to 28 ha (after 2000). The onion production dropped from a total of 180 t to 80 t or 2.85 t/ha that is the highest productivity supported by a more fertile land applying the same traditional practices for red onion cultivation. Recea is a village located near the foot of the Făgăraş Mountain and therefore the cultivated area is smaller. Yet the cultivated area decreased in the last 25 years from 8 ha (from

1990 to 2000) to 4 ha (after 2000). Today the maximum onion production is 3.5 t compared to 8 t (before 2000), or 0.87 t/ha that is a comparable with that recorded for Beclean.

*Land use change* Another barrier is due to land use change due to an unsustainable urban planning in the region recognized at the City Halls. Thus large surfaces of arable land have been excluded from arable land and registered for urban area in the same way like in all Transylvania (Fischer *et al.*, 2012). Only in Mândra locality 50 of 118 has arable land, have been changed for urban area. Such land use change will have a tremendous impact on the future sustainable development of these localities (Smith, 2008).

*Socio-economic vulnerabilities* The interviews with farmers and mayors revealed a common barrier in the trade of onion as commodity, that is essential for the maintenance of this landrace. Thus, for example taxes are too high in Făgăraş city (i.e. less than 20 km distance from each of the three localities) for placing on the market the entire production (i.e. 91.5 t for 2014). In addition, taxes for storage or renting a market place, also according to officials, may rise up to 648 lei/month (i.e. 144 Euros/month). The entering on the market place of large retailers is highly supported. They sold the onion during the winter of 2015 with 3 lei/kg (i.e. 0.67 Euros/kg) compared to the locals valuing 4.5 lei/kg (i.e. 1 Euro/kg). This price is imposed by the high taxes for entering the market of city of Făgăraş. It can be concluded that there is a lack of commitment for local marketing policy.

*Ageing and poor population* The active population is represented by 57% as a total for all three localities, almost half of the population being retired. Among these over 72% is represented by women. The level of education is as following: gymnasium 69% and only 3% have university studies. However 87% of the landowners cultivating onion are practising mainly subsistence agriculture and only 13% are involved in the onion trade, respecting the whole technical requirements, for producing 'Roşie de Făgăraş'. Considering these vulnerabilities it can be concluded that the traditional knowledge related to the cultivation of Roşie de Făgăraş is vulnerable.

### **The official situation of onion landraces in Romania**

The investigation is based on the survey of Official Catalogues of Romania starting with 1976 (Ministerial Order of the Ministry of Agriculture and Food Industry no. 7/1976). Two onion landraces belonging to *Allium cepa* have been officially recognized starting with 1952: 'De Ţibucani' and 'Roşie de Făgăraş' (e.g. together with 'De Turda' and 'De Arieş', for the same position). In 1960 two new authorized cultivars have been recognized: 'De Măcău' and 'De Zittauer'. Three importing cultivars have been authorized in 1965 such as the following 'Spaniolă', 'De Stuttgart' and 'Wolska'. In 1970 other two bred varieties have been authorized (i.e. 'Yellow Globe' and 'Ewer Green') followed in 1971 by the authorization of a Romanian bred onion variety (i.e. 'Aurie de Buzău') and in 1972 by a Romanian landrace (e.g. 'De Cluj'). In 1973 entered the market place other two bred varieties: 'Degydrator' and 'Dehysó'. The ratio between the Romanian and foreign cultivars was balanced in favour of national varieties. Thus, and it can be considered that onion landraces have been promoted for their cultivation at the official level. After 1988 only 6 cultivars were registered into the National Official Catalogue (e.g. 'Aurie de Buzău', 'De Stuttgart', 'Diamant', 'Roşie de Făgăraş', 'Roşie de Turda' and 'Wolska'. Based on the Official Catalogue published in 2005 the Romanian cultivar 'Diamant', as a Romanian bred onion cultivar, first homologated in 1977, was no longer homologated and after 2015. The cultivar "De Buzău" needs to be homologated again and 'De Arieş' was erased starting with 2012. After 1988 Roşie de Făgăraş was erased from the Official Catalogues. It can be concluded that the Romanian onion landraces or bred cultivars currently are not officially recognized as "under conservation" as today it is recommended by the European Union regulatory framework in this domain (i.e. Directive 2008/62/EC; Directive 2009/145/EC and Directive 2010/60/EC).

Based on the imposed requirements for onion recognition on the common market regulated by the Regulation 1508/2001 it can be considered that the landrace Roşie de Făgăraş do not comply such a standard but it can be recognized as a variety "under conservation" according to the European Union framework for the conservation of plant varieties. Italy is among the first European Union countries officially recognizing the value of landraces for food security in their regions

(Spataro and Negri, 2013) and Romania also may further develop conservation measures for all PGRFA in the support of food security.

In the national programme for *ex situ* conservation belonging to the Gene Bank Suceava, four accessions of onion landraces are available as following: SVGB-14925 (i.e. onion landrace from Bistrița Bârgăului, Bistrița Năsăud County), SVGB-16404 (i.e. onion landrace from Colțești, Alba county), SVGB-18622 (i.e. onion landrace from Pădureni, Botoșani county) and SVGB-13735 (i.e. onion landrace from Vadul Izei, Maramureș county). The Research Institute for Vegetable and Flower Growing (RIVFG), Vidra-Ilfov, comprises at least 8 onion cultivars of 126 accessions for all *Allium* species, that are not available *on line* (i.e. 'L123/2006', 'Haltedon', 'Andrada', 'Ovation', 'Hiberna', 'Regaso', 'Briliant' and 'Delicioasa'). However, today landraces such as 'Roşie de Făgăraş', 'De Turda' are not included in the current national programme for *ex situ* conservation.

## CONCLUSION

Currently crop landraces are not included into a coherent national programme for their conservation and as a consequence, such PGRFA that historically proved to be valuable for local communities, becoming part of heir traditional knowledge in small regions, may become lost. 'Roşie de Făgăraş', is a medium size onion landrace with a history of over three centuries in the region. Vulnerabilities such as the decrease of cultivated area, the lack of a marketing policy, a decrease of interest in continuing the implementation of full technology, will negatively influence traditional knowledge conservation that will fuel food insecurity in the region. These results further support the need for official recognition as a landrace for *on farm* conservation that is missing in our country.

*Acknowledgments.* This research was supported by the Research Center for Agricultural Sciences and Environmental Protection of the University Lucian Blaga from Sibiu for 2014-2020.

## REFERENCES

- Arumuganathan K, Earle ED (1991). Nuclear DNA content of some important plant species. *Plant Mol Biol Rep.* 9: 208-218.
- Balint M, Poșta Gh. (2015). Research on the interaction genotype x technological factors in some morphological features in Macău onion bulbs cultivated in the vegetable basin Belinț (Romania). *Journal of Horticulture, Forestry and Biotechnology* 19(2): 125- 135.
- Duangjit J, Bohanec B, Chan AP, Town CD, Havey MJ (2013). Transcriptome sequencing to produce SNP-based genetic maps of onion. *Theoretical and Applied Genetics* 126(8): 2093-2101.
- Dwivedi SL, Ceccarelli S, Blair MW, Upadhyaya HD, Are AK, Ortiz R (2016). Landrace germplasm for improving yield and abiotic stress adaptation. *Trends in plant science* 21(1): 31-42.
- Engle LM (1992). Introduction to concepts of germplasm conservation. Chadna ML; Anzad Hossain AMK; Monowar Hossain SM, comps. *Germplasm collection, evaluation, documentation, and conservation.* 11-17.
- Fischer J, Hartel T, Kuemmerle T (2012). Conservation policy in traditional farming landscapes. *Conservation Letters* 5(3): 167-175.
- Gallina PM, Cabassi G, Maggioni A, Natalini A, Ferrante A (2012). Changes in the pyruvic acid content correlates with phenotype traits in onion clones. *Australian Journal of Crop Science* 6(1): 36-41.
- Galmarini CR, Goldman IL, Havey MJ (2001). Genetic analyses of correlated solids, Xavor, and health-enhancing traits in onion (*Allium cepa* L.). *Mol Genet Genomics* 265: 543-551.
- Groza T, Voinea M, Lăzărescu V (1976). *Legume, pomi și viță de vie pe lângă casă*, Ed Ceres, București, 121.
- Gyémánt L, Câmpeanu R, Dörner AE, Mureșan FV (2009). Conscripția fiscală a Transilvaniei din anul 1750: Descrierea localităților conscrie. *Editura Enciclopedică Cluj Napoca.*
- Indrea D, Apahidean SA, Apahidean M, Maniutiu DN, Apahidean M, Sima R (2007). *Cultura legumelor.* Ed. CERES București, 380 p.
- Jarvis S, Fielder H, Hopkins J, Maxted N, Smart S (2015). Distribution of crop wild relatives of conservation priority in the UK landscape. *Biological Conservation* 191: 444-451.
- Krasteva L, Stoilova T, Varbanova K, Neykov S (2009) Bulgarian Landrace inventory–Significance and use. *European landraces on-farm conservation, management and use.* 15-53.
- Maggioni L (2002). Conservation and use of vegetable genetic resources: a European perspective. In XXVI International Horticultural Congress: Advances in Vegetable Breeding. 13-30.
- Maggioni L, Astley D, Rabinowitch H, Keller J, Lipman E (1997). Report of a Working Group on Allium. In Sixth meeting. 23-25.
- Magruder R, Webster RE, Jones HA, Randall TE, Snyder GB, Brown HD, Hawthorn LR, Wilson AL (1941). *Descriptions and Types of Principal American Varieties of Onion.* USDA, Miscellaneous Publication No. 435, Washington DC. 93.
- Martin A, Coolsaet B, Corbera E, Dawson NM, Fraser JA, Lehman I, Rodriguez I (2016). Justice and conservation:

- The need to incorporate recognition. *Biological Conservation* 197: 254-261.
18. Maxted N, Avagyan A, Frese L, Iriondo JM, Magos Brehm J, Singer A, Kell SP (2015). ECPGR Concept for *in situ* conservation of crop wild relatives in Europe. Wild Species Conservation in Genetic Reserves Working Group, European Cooperative Programme for Plant Genetic Resources.
  19. McCollum GD (1968). Heritability and genetic correlation of soluble solids, bulb size and shape in white sweet Spanish onion. *Canadian journal of genetics and cytology* 10(3): 508-514.
  20. Meier U (1997). Growth stages of mono and dicotyledonous plants - BBCH Monograph, 2 Edition 2001, Eds. Meier U, Blackwell Wissenschafts-Verlag. pp. 111-114.
  21. Negri V, Freudenthaler P, Gasi F, Maxted N, Moreira PM, Străjeru S, Weibull J (2016). 26 A European *In situ* (On-farm) Conservation and Management Strategy for Landraces. Enhancing Crop Genepool Use: Capturing Wild Relative and Landrace Diversity for Crop Improvement: 297.
  22. Porta B, Rivas M, Gutiérrez L, Galván GA (2014). Variability, heritability, and correlations of agronomic traits in an onion landrace and derived S1 lines. *Crop Breeding and Applied Biotechnology* 14(1): 29-35.
  23. Poșta Gh (2008). *Legumicultură*. Ed. Mirton, Timișoara, 83p.
  24. Smith P (2008). Land use change and soil organic carbon dynamics. *Nutrient Cycling in Agroecosystems* 81(2): 169-178.
  25. Spataro G, Negri V (2013). The European seed legislation on conservation varieties: focus, implementation, present and future impact on landrace on farm conservation. *Genetic resources and crop evolution* 60(8): 2421-2430.
  26. UPOV (2008). Guidelines for the Conduct of Tests for Distinctness, Uniformity and Stability, TG/46/7, onion, echalion; shallot; grey shallot (Geneva 2009). <http://www.upov.int/edocs/tgdocs/en/tg046.pdf>