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CROPS VARIETIES UNDER CONSERVATION: STUDY CASE CULTIVATED *TRITICUM SSP.*

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Abstract

The dynamic of crops domestication and use of edible wild plant species is well documented worldwide. The diversity of plant species used for food, changed during humankind history and lot of researchers pointed out the danger of species erosion that may negatively impact food security. The trade of crops is regulated at the international level and as a secondary effect is the promotion of new breed varieties. Today the scientific community is talking about neglected species and old varieties not eligible for trade and consequently removed from the today diet without taking into consideration the fact that their presence in the same agro-ecosystem for more than 50 years, increases their capacity to adapt to climate change effects. Therefore, huge efforts should be done to re-assessing our conservation strategies for breeding crops. At the European level it is already recognized the term "varieties under conservation", that allows members states to maintain old varieties and landraces under specific conditions. The scope of this article is to evaluate the official status of conservation of Triticum ssp. in our country by taking into account the history of cultivation and breeding programmes. At least 6 edible fossilized wheat species were found in human settlements for more than 6,000 years (i.e.: T. aestivum, T. dicoccoides, T. dicoccum, T. durum, T. monococcum and T. spelta). If einkorn and emmer wheat were common between Neolithic and Middle Age, today they are almost absent. Only six varieties of bread wheat are today officially recognized as "varieties under conservation", a series of more than 50 old varieties breed after 1927 being not yet officially recorded.

Key words**:** *breeding programme, on farm conservation, PGRFA. Romania Triticum ssp, varieties under conservation, wild crops relatives.*

INTRODUCTION

During humankind wild plant species have been domesticated for more than 10,000 years ago and the process continues today [16]. The authors also recorded a historical dynamic of plant species domestication, such as the entering and loses of plant genetic resources for food and agriculture or PGRFA. Different archaeological studies revealed the presence of fossilised crop seeds that have been used in the archaic human settlements, all over the world [11; 13; 23; 26], including the present territory of Romania [9]. Such evidences become more relevant when considering new strategic directives for agriculture development that is today under myriad of pressure factors [18]. Moreover, by taking into account the history of ecosystems regarding crops cultivation and current pressures associated to climate changes (i.e. short heavy rains, long-term drying conditions, diseases and pests breakouts) it is relevant to take into consideration food security for the country [7; 8]. Thus, a specific agro-ecosystem may act today like a living-gene-bank, by preserving all relevant genes of the species for supporting their continuous adaptation to environmental factors [13; 25]. By accessing the diversity of PGRFA in hot-spots of agro-biodiversity may give relevant clues for breeding strategies on one hand and applied agricultural management on the other hand [19]. Romania developed the research infrastructure for crops breeding in between the World Wars for all three historical provinces (Transylvania, Moldova and Walachia) and cereals were among the main research subjects. A continuous development in cereal breeding was achieved in Romania starting with 1927. After the Second World War, cereal breeding recognized another step towards its development [6]. After 1989 breeding cereals suffered some losses, especially in terms of capacity building by weakening the national system for ensuring the long-term development of cereal breeding programmes. Attention today is oriented

towards "varieties under conservation" that are officially regulated for European Union countries such as the following: Directive 2008/62/EC (providing for certain derogations for acceptance of agricultural landraces and varieties which are naturally adapted to the local and regional conditions and threatened by genetic erosion and for marketing of seed and seed potatoes of those landraces and varieties), Directive 2009/145/EC (providing for certain derogations, for acceptance of vegetable landraces and varieties which have been traditionally grown in particular localities and regions and are threatened by genetic erosion and of vegetable varieties with no intrinsic value for commercial crop production but developed for growing under particular conditions and for marketing of seed of those landraces and varieties) and Directive 2010/60/EU (providing for certain derogations for marketing of fodder plant seed mixtures intended for use in the preservation of the natural environment). Under this term, it is regulated *on-farm* conservation of old crop varieties and landraces. This legal framework was developed as a direct result of crops erosion recording. Certain authors underlined the value of traditional crops for species genetic diversity and furthermore for their contribution to increasing biodiversity. Moreover, they recognized some 30 years ago the need to develop farmer's skills and capacity to manage in a dynamic manner the conservation of crops [25]. Such genetic resources will be essential for improving crops in a genomic era by ensuring the rapid access to the genome of a certain species associated to a country [17]. Thus, today in the European Union it is possible to promote both old crops as well as new breeds based on the implementation of Multilateral System under the Plant Treaty (i.e. International Treaty on Plant Genetic Resources for Food and Agriculture) as well as on official catalogues for plant varieties and hybrids. Romania started to publish such varieties after 2011 and by today there are listed six varieties for *Triticum* ssp. The scope of this article is to survey scientific and technical literature in order to evaluate the current relevance of wheat varieties recognized to be "under conservation" towards the future breeding programmes and for ensuring food security of the country.

MATERIALS AND METHODS

This article is based on a SWOT analysis of monographic papers or books and the official catalogues of Romanian plant varieties and hybrids, published between 1956 and 2017, regarding the long history cultivation of six wheat species such as: *Triticum aestivum* L. (bread wheat), *T. dicoccoides* (Körn. ex Asch. & Graebn.) Aarons., *T. dicoccum* Schübl. (emmer wheat), *T. durum* Desf., *T. monococcum* L. (einkorn) and *T. spelta* L. (spelt) [21]. Surveying UPOV database [20] and Gene Bank of Suceava [1] completed the current study.

RESULTS AND DISCUSSIONS

The six species, belonging to *Triticum* genus (i.e. *T aestivum*, *T. dicoccoides*, *T. dicoccum*, *T. durum*, *T. monococcum* and *T. spelta*), have been cultivated for a long time on the current territory of Romania and all of them may become valuable genetic resources for the future wheat breeding programme aside other 45 wild wheat relatives: *T. amyleum* Ser., *T. armeniacum* (Stolet.) Nevski & Nevski, *T. arras* Hochst., *T. arvense* Schreb., *T. biflorum* Brign., *T. campestre* Nyman, *T. caninum* L., *T. cereale* Asch., *T. compactum* Host, *T. cristatum* Schreb., *T. cylindricum* Ces., Pass. & Gibelli, *T. dicoccon* Schrank, *T. elongatum* Host, *T. farrum* Bayle-Bar., *T. fragile* Link, *T. glaucum* Desf., *T. hordeiforme* Host, *T. hybernum* L., *T. imbricatum* M.Bieb., *T. intermedium* Host, *T. junceum* L., *T. laevissimum* Habl.vel Hall. ex Steud., *T. latronum* Godr., *T. maritimum* L., *T. ovatum* Raspail, *T. panarmitanum* Bertol., *T. pectinatum* M.Bieb., *T. pinnatum* Moench, *T. polonicum* L., *T. prostratum* L.f., *T. repens* L., *T. rigidum* Schrad., *T. sativum* Lam., *T. sativum var. compactum* Hack., *T. secale* Link, *T. sepium* Lam., *T. siculum* Roem. & Schult., *T. silvestre* Asch. & Graebn., *T. subulatum* Banks & Sol., *T. trichophorum* Link, *T. turgidum* L., *T. turgidum L. subsp.*

pyramidale (Percival) Valdés & H.Scholz, *T. vaillantianum* Wulfen & Schreb., *T. villosum* (L.) M.Bieb. and *T. vulgare* Vill.) [5].

Neolithic cultivation of wheat species

Archaeological evidences regarding wheat cultivation in the today territory of the country, were proved down the Starčevo-Criș, Vinča and Boian civilizations [11; 22] or about 6,000 years B.C. that changed the wild Neolithic landscape inside the Carpathian Arche [5]. Based on a series of archaeological excavations it was proved the cultivation of four primitive wheat species such as: *T. monococcum* (einkorn), *T. spelta* (spelt), *T. dicoccum* (emmer wheat) and *T. aestivum* (bread wheat) based on fossils analysis in archaic human settlements [8]. As examples in Miercurea Sibiului, Sibiu county, the presence of einkorn and emmer wheat was proved and furthermore in the western part of the country (i.e. Banat region) bread wheat fossils were recorded. The first two species continue to be frequently identified after 3,000 years down the Coțofeni civilization (i.e. 80% by emmer and 20% by einkorn based on statistical estimations conducted by Ciută in 2009 [8]). Based on this author, gradually the bread wheat is covering more the archaic landscapes in the inner Carpathian arch and *T. dicoccoides*, spelt and *T. sativum var. compactum* Hack. were also recorded in human settlements. As a concluding remark it can be considered that at least 5 different species of *Triticum* (i.e. exception is *T. durum*, that was introduced later) have a long and continuous history of cultivation in this territory which makes them relevant for their future conservation and use in national breeding programmes for ensuring food security of the country.

The cultivation of wheat species during middle-age.

During the middle-age continues the cultivation of different species of *Triticum* especially the winter and spring wheat, as primitive cultivars. The politics of 18th century in Transylvania were also interested in recording the wheat leaf rust, relevant for the economy of villages [14]. Fiscal conscription of Transylvania is an economic recording book of all settlements. However, not all localities were described in the same manner, and that may be due to different persons in charge for recoding data from the field. Many localities from Transylvania were officially recorded for the cultivation of bread wheat, excepting those located in mountains. Instead, most localities were cultivating autumn wheat which was some time replaced in certain hilly-mountain areas with spring wheat or other cereals due to harsh conditions (i.e. long winter season). Also, almost half of localities were using both bread wheat varieties, and the production recorded for autumn wheat being almost all the time higher compared to the spring wheat. In certain cases, the officials are mentioning the cultivation of einkorn, especially for hilly-mountain areas (i.e. Presaca and Metiș villages from Sibiu county). However, in the mountain villages, not appropriate for good wheat production, the fiscal office is using the common term of grains (this includes all above mentioned cereals and more). This fiscal conscription is among the first type of official communication method that supported the cultivation of productive species and in this case bread wheat.

The cultivation of wheat species between the World Wars.

Continuing this analysis, the presence of all wheat species, mentioned before were also recorded before the second World War [6; 12].

The cultivation of wheat species after the Second Wold War.

The history of wheat breeding in Romania after 1970 were published by agronomists [8; 14, 24] and the famous silvic engineer Alexandru Beldie [5]. 158 wheat varieties are recorded under UPOV for Romania starting with 1981, proving a high interest for wheat breeding [20]. A summary of officially recorded varieties will be described below based on the type of wheat varieties.

(a)The status of cultivation of *Triticum aestivum* L.

The group of T. aestivum L. var. erythrospermum (Körn.) Velican.

Under this wheat botanical group have been created and placed on the Romanian market at least 32 old varieties such as (in alphabetical

order): 'A15', 'Banat', 'București 1' (i.e. as a specific selection of hybrids resulted from 'Kanred' x 'C.906'), 'Cenad 117' (i.e. an old wheat variety described in 1921, and possible extinct), 'Cluj 11' (i.e. result of continuous selection of a local population), 'Cluj 650', 'Crimeea', 'Dacia' (i.e. placed on the market in 1967 as a variety based on the hybridization between 'București 1' and 'Skorospelska 3'), 'Excelsior' (i.e. placed on the market in 1966 as a variety based on the hybridization between 'București 1' and 'Skorospelska 3'), 'Favorit' (i.e. placed on the market in 1966 as a variety based on the hybridization between 'Odvos 241' and 'Bezostaia 4'), 'golden Romanian wheat', 'Harrach' (i.e. imported from Austria in 1958 as a hybridization based on the white wheat of 'Tisa' x 'Carman Red'), 'Moldova' (i.e. placed on the market in 1966 as a variety based on the hybridization between 'București 1' and 'Skorospelska 3'), 'Nr. 301' (i.e. imported from Bulgaria in 1954 based on a complex hybridization between 'Nr. 16', 'Noe', 'Nr. 2010' and 'A 741'), 'Ponca' (i.e. imported in 1957 based on a complex hybridization between 'Kawvale', 'Marquillo' and 'Tenmark'), 'Skorospelska 3' (i.e. imported in 1960 from Russia has in its history the hybridisation between 'Kanred Fulcaster 266286' and 'Klein 33'), 'Tisa', 'Triumph' (i.e. imported in 1957 from USA with a complex hybridisation history based on: 'Blackhull', 'Kanred' and 'Flovice'), 'Turda 195' (i.e. placed on the market in 1970 as a variety based on the hybridization between 'ICA 440' and 'Skorospelka 3b'). 'Delia' was obtained in 1997 from a complex hybridization between 'Fundulea 29', 'Lovrin 32' and 'Flamura 80'. Some results have been published by the National Agricultural Research and Development Institute (NARDI) Fundulea in 2010. Relevant wheat varieties such as 'Dacia', 'Excelsior', 'Favorit' and 'Fundulea 29' where considered as wheat height standard varieties [24]. Due to dryness of the climate after 1980 the breeding strategy was oriented to semi-dwarf varieties creation (i.e. 'Flamura 85', 'Fundulea 4' and 'Dropia') followed by other six cultivars: 'Ardeal', 'Boema', 'Delabrad', 'Faur', 'Glosa' and 'Gruia' [23].

The group of T. aestivum L. var. ferrugineum (Alef.) Velican

This group was cultivated mainly in Transylvania and Moldova, known under different toponymies. Relevant is 'Târgu Frumos 16' a cultivar for Moldova region [23].

The group of T. aestivum L. var. lutescens (Alef.) Velican,

This group was cultivated during 1970 as the following 10 varieties in alphabetical order: 'Aurora' (i.e. imported in 1968 from Russia as a variety based on the hybridization between 'Lutescens 314 h 147' and 'Bezostaia 1'), 'Bezostaia 1' (i.e. imported from Russia in 1960 and created by the former Krasnodar Agricultural Research Institute, currently the National Grain Center. P. P. Lukyanenko), 'Caracal 277' (i.e. placed on the market in 1969 as a variety based on the hybridization between 'Bezostaia 1' and 'Arnăut 048'), 'Kaukaz' (i.e. imported in 1968 from Russia as a variety based on the hybridization between 'Lutescens 314 h 147' and 'Bezostaia 1'), 'Lovrin 10' (i.e. placed on the market in 1969 as a variety based on complex hybridization between 'Abondanza', 'Triumph' and 'Bezostaia 1'), 'Lovrin 231' (i.e. placed on the market in 1969 as a variety based on the hybridization between 'Bezostaia 1' and 'Fiorello'), 'Măgurele 7' (i.e. placed on the market in 1970 as a variety based on the hybridization between 'Marquis' and 'Bankut 1201' as a winter wheat), 'Marquis' and 'Selkirk' [23]. It is added to this a local population 'Ulca' [5].

The group of T. aestivum L. var. milturum (Alef.) Velica

Varieties belonging to this group are not very often cultivated in Romania. However, 'Libelulla' was imported in 1970 from Italy as a variety based on the complex hybridization between 'Tevere', 'Giuliari', '1482-54-3' and 'San Pastore' [23].

T. aestivum as varieties under conservation for 2017

By analysing the Official catalogue for 2017 six varieties of *Triticum ssp*. have been officially recognized for their importance as conservation varieties. 'Beti PI' belongs to *T.*

aestivum L. var. *erythrospermum* and it was obtained after a complex hybridization based on varieties 'PI-2433-89' and 'F-141', being placed on the market in 2004 [15]. Since 2009 it is recorded as a conservation variety. This variety is developed in Iași as a winter wheat [15] and appropriate for bread production [10]. 'Eliana' is another autumn wheat variety that belongs to the same group of varieties, recommended for the southern part of Moldavia [2] (i.e. dry weather conditions) aside 'Gasparom', 'Pădureni', 'Romulus LV' and 'Șimnic 30'.

(b)The status of cultivation of *Triticum diccocoides* (Körn. ex Asch. & Graebn.) Aarons. The presence of this species is recorded from Neolithic up to last century and appears to disappear after 1960 [5]. There is no varieties or local populations officially registered as variety under conservation

(c)The status of cultivation of *Triticum dicoccum* Schübl. Different local populations were recorded to be cultivated in all our country after the 50th but disappeared after 1960 [5]. There is no varieties or local populations officially registered as variety under conservation.

(d)The status of cultivation of *Triticum durum* Desf. This species was not extensively cultivated currently and based on the UPOV data base there are officially registered 8 varieties starting with 'Pandur' in 1996 [20]. Varieties of this species are cultivated mainly in the South and East part of the country. It is not present into the collections of Gene Bank of Suceava [1] and either as varieties under conservation.

(e)The status of cultivation of *Triticum monococcum* L. The distribution of this species before 1950 was mainly recorded in Transylvania being cultivated in small plots in hilly-mountain areas of the following counties: Maramureș, Bistrița-Năsăud, Mureș, Sălaj, Bihor, Cluj, Alba, Hunedoara and Sibiu being highly resistant against wheat leaf rust and powdery mildew. [6]. There is no varieties or local populations registered as variety under conservation.

(f)The status of cultivation of *Triticum spelta* L. Different local populations were cultivated up 1950 and officially disappeared after 1960. Today it is used as a demonstrative field crop in the research stations together with *T. polonicum* and present in the grasslands [5].

Wheat species into national ex situ collections

The Genebank Suceava covers 153 entries for *T aestivum*, 27 of *T monococcum* and 4 of *T turgidum* [1]. However, there are no denominations regarding potential variety similarities.

Ex situ collections exists in several research stations (i.e. Agricultural Research and Development Institute Fundulea, Agricultural Research and Development Station Turda, Agricultural Research and Development Station Suceava, Agricultural Research and Development Station Simnic, Agricultural Research and Development Station Podu Iloaie and Banatului University of Timișoara) but there is not direct connectivity to the portal of Multilateral System for fully ensuring the access to genetic resources.

CONCLUSIONS

Varieties under conservation are meant to maintain their *on-farm* cultivation based on legal requirements. Their *on-farm* maintenance will contribute to traditional knowledge development (i.e. regarding seeds selection, cultivation, storage and use). Romania is a very rich country in terms of agro-biodiversity habitats and therefore the number of varieties under conservation should fit this diversity.

In this article over 50 varieties are described as relevant for our country history in cultivating *Triticum ssp.* Theoretically, all of them may represent a living-genetic-library that incorporates important heredity features for future breeding programmes. Some of the mentioned varieties are extinct or may become extinct (e.g. Cenad varieties) [4]. For others it was proved that they are key varieties for wheat breeding programme for their resistance towards diseases or pests, or productivity or nutritional values. Only six officially recognized varieties under conservation will not support the maintenance *on-farm* of wheat species germplasm. Moreover, by preserving these varieties they

should be available for being accessed into the Multilateral System too. The national wheat breeding programme needs for the future to take into consideration *ex situ* and *on-farm* collections as well as crops wild relatives.

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