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Fruit Genetic Resources in Republika Srpska

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Abstract: Republika Srpska is located in the northern, eastern and south-eastern parts of Bosnia and Herzegovina. Owing to its geographical position, there are two types of climate: continental in the north and east, and Mediterranean in the south. This area has been exposed to different civilizations and cultures throughout history, becoming very rich in biological diversity as the civilizations and climates mixed.

There were only a few studies on the inventory and collection of fruit genetic resources in the past. The most comprehensive one was conducted during 1989 - 1991 within the Plant Gene Bank of Yugoslavia project. Due to war, these activities were cancelled for more than ten years. Documentation was saved only for some inventories, including MCPDs (Multi Crops Passport Descriptors) for the accessions: *Malus × domestica* Borkh. (11), *Prunus domestica* L. (6), *Pyrus communis* L. (11), *Prunus avium* L. (4), *Prunus cerasus* L. (2), *Prunus persica* (L) Batch. (2), *Prunus armeniaca* L. (1), *Prunus cerasifera* Ehrh. (6) and *Juglans regia* L. (4).

PGR activities have restarted through the project »South Eastern European Network on Plant Genetic Resources 2004 - 2014« with the University of Banjaluka as a partner for SEEDNet implementation in Republika Srpska. This project has enabled the inventory and collection activities to be resumed and has supported capacity building for the establishment

of both the Gene Bank and the national PGR programme. The inventory and collection activities have been implemented through the Republic Working Group on Fruits and *Vitis* established according to the project proposal as well as through regional activities. Since 2004, the following accessions have been either inventoried or collected: *Pyrus communis* L. (91), *Malus* × *domestica* Borkh. (64), *Prunus avium* L. (44), *Prunus domestica* L. (20), *Ficus carica* L. (11), *Vitis vinifera* L. (11) *Corylus avellana* L. (5), *Prunus cerasus* L. (3), *Prunus cerasifera* L. (2), *Prunus persica* L. (1), *Cydonia oblonga* (1) and *Sorbus domestica* (1). These accessions have been documented via collection forms and MCPDs. Conservation work is being conducted *ex situ* in a collection orchard 20 km south of Banjaluka and on farms at two locations.

Key words: fruit germplasm, SEEDNet, MCPDs, *ex situ* collection, on-farm conservation.

Introduction

Biological diversity, defined as a variation within species, between species and between ecosystems, is decreasing very fast. The overall diversity of plant genetic resources is decreasing due to breeding and selection activities and farmers' tendency to use cultivars and hybrids that are giving higher yields and ensuring the highest quality of products. This results in old cultivars and hybrids becoming neglected.

Republika Srpska is located in the northern, eastern and south-eastern parts of Bosnia and Herzegovina and has two distinctive climate types: continental in the north and east, and Mediterranean in the south. The ecological conditions make it possible to distinguish three agro-ecological zones. The first zone is in the North, being represented by a lowland and slightly undulating area. The growing season at temperatures above 5 °C lasts for 250 days and the sum of average daily temperatures above 5 °C is 3613°C. The average rainfall is about 900 mm and the average annual drought period is 37 days. The second agro-ecological area is in the highlands. The growing season at temperatures above 5 °C lasts for 225 days and the sum of average daily temperatures above 5 °C is 2940 °C. The average rainfall is about 1050 mm and the average annual drought period is 33 days. The third agro-ecological zone covers the Mediterranean part of East Herzegovina that has a lot of rainfall. The growing season at temperatures above 5 °C lasts for 320 days and the sum of average daily temperatures above 5 °C is 4630 °C. The average rainfall is about 1050 mm and the average annual drought period is 50 days. (Farm Management Manual 2002).

These data suggest that the area of Republika Srpska, although geographically small, has quite diverse climatic and soil conditions. These ecological characteristics enable the growth and development of a great number of populations, ecotypes, wild relatives and fruit cultivars characterized by different pomological traits.

The present territory of Republika Srpska, as a part of Bosnia and Herzegovina, was exposed to different civilizations throughout history. The chronological record of events related to fruit cultivation before the Slavs came to the Balkans, is not well known (Adamič *et al.* 1963), but there are evidences proving that the Slavs established fruit cultivation in this area. The first written record of fruit cultivation in Bosnia and Herzegovina dates back to the period of

Ottoman Empire (Vitolović 1949), but the first register and statistics on fruit growing were done in 1882-1896 during the Austro-Hungarian Empire (Bubić 1977). At the time, the plum, along with apple and pear, was the most important fruit species. Prunes were the main export commodities of Bosnia and Herzegovina and Serbia during the 18th century. Bosnia and Herzegovina and Serbia were major suppliers of prunes in the world market until the Californian prune appeared. At that time, a great number of foreign cultivars originating in the East and West were introduced. It was quite a common habit to give different local names to a single cultivar. Furthermore, through spontaneous or planned hybridization and selection these cultivars were used in developing new autochthonous cultivars. During the period between World War I and World War II, great attention was given to the improvement of fruit growing, which resulted in the establishment of many nurseries, agricultural schools and collection orchards of autochthonous and newly introduced fruit cultivars. (Bubić 1997). Meanwhile, after the World War II, most of these collection orchards were not preserved as they were not properly managed.

The above facts indicate that this and other regions of Yugoslavia became very rich in fruit genetic resources. Although this particular area of former Yugoslavia or the newly created states could be considered as a primary gene centre of some fruit species, this is not recognized in literature due to the lack of systematic studies in the earlier period. Only the term 'Balkans' can be found in literature as associated with the genetic fruit resources of this area. The term 'Balkans' is the only one used in reference to Yugoslavia or the new states in Vavilov's research and his chart of distribution of some wild species and their relatives (1926), while at the same time, other Balkan countries such as Bulgaria, Romania, Greece and Hungary were investigated in detail (Paunović 1992).

During the last decades of the past century, only few studies on germplasm were conducted. Paunović and Mičić (1997) report results of previous studies carried out in Yugoslavia, indicating that there are 124 registered wild fruit species and their relatives. As for studies on germplasm, forest fruits are of huge importance (Mičić *et al.* 1987, Miletić *et al.* 1997). Paunović and Mičić (1997) suggested that the area of Bosnia and Herzegovina could be considered as a gene centre for species of wild fruits and their relatives of a number of genera: *Malus*, *Pyrus*, *Chaenomeles*, *Sorbus*, *Crataegus*, *Mespilus*, *Eriobotrya*, *Prunus*, *Amygdalus*, *Juglans*, *Corylus*, *Castanea*, *Cornus*, *Morus*, *Sambucus*, *Fragaria*, *Ribes*, *Rubus*, *Rosa*, *Ficus*, *Punica*, *Zizyphus*, *Citrus*. Autochthonous pear cultivars were collected over 1976-1980 during the great expedition to the Balkans (Zwet *et al.* 1978). A total of 225 accessions of pear were collected in Serbia, Kosovo and Metohija, Bosnia and Herzegovina, Macedonia and Montenegro. The pear collections are now placed in Corvallis and Kearneysville (Paunović 1992). During 1983-1985, investigations, collection and conservation of *Prunus domestica* and *Prunus insititia* were done and a detailed description of 64 accessions of *Prunus domestica* and *Prunus insititia* (Paunović *et al.* 1985) was made.

In the eighties of the last century, the Strategy of Technological Development of Yugoslavia envisaged the establishment of Yugoslav Plant Gene Bank as a federal institution. All related institutions took part in this project as well. The activities planned by the project included: inventory, collection, identification, multiplication, characterization and establishment of Gene Bank.

Before the war (1992 – 1995), the inventory and collection activities and the documentation on Multi-crop Passport Descriptors (MCPD) were implemented to a great extent. The project documentation was mainly forwarded to the leading coordinator or kept within the institutions involved in the project implementation. Meanwhile, a great amount of documentation was destroyed during the war. After the war (1995), Bosnia and Herzegovina was split into two entities. Accordingly, the activities on plant genetic resources (PGR) were reorganized as well. Recently, in South East Europe, PGR activities have been resumed in line with the Convention of Biological Diversity (CBD), FAO Global Plan of Action (GPA) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and with support from Swedish International Development Cooperation Agency (Sida) (Đurić *et al.* 2007, 2008).

Apart from the above studies, work on fruit germplasm mostly included research into the characteristics of wild relatives of fruit crops (Mičić *et al.* 1987, Miletić *et al.* 1997), studies on autochthonous cultivars or eco-populations that are of importance for the selection of rootstocks (Lučić *et al.* 1994) and cultivars (Muratović *et al.* 1988). Most studies focus on the pomological or other characteristics of cultivated, new or autochthonous fruit cultivars (Mališević *et al.* 1987, Mičić *et al.* 1995, Nikolić *et al.* 1996).

Material and Methods

The activities related to the inventory, collection and conservation of plant genetic resources for food and agriculture in B-H have been resumed through the SEEDNet project in accordance with the main objective of the project to implement long-term conservation and sustainable use of the plant genetic diversity in the region of South Eastern Europe through a coordinated network of functional national programmes.

The activities include the four main activities of FAO GPA: *in situ* conservation, *ex situ* conservation, use of plant genetic resources and strengthening of institutional capacities. The conservation methods have been applied according to the FAO standards (Engels and Visser 2003). The activities have been implemented through six regional and national working groups divided by species: maize and cereals, fodder crops, fruits and *Vitis*, vegetables, medicinal and aromatic plants and industrial plants.

The results on the fruit germplasm inventory, collection and conservation methods employed in Republika Srpska over the last 5 years are given in this work.

Results and Discussion

The data on the inventory collected before the last war in Bosnia and Herzegovina have been partially preserved. The first activities on the conservation of fruit genetic resources focused on making an inventory and providing an overview of previously registered accessions. Due to the migration of local people and huge devastations during the war, it was not possible to find all locations inventoried during the first expedition (1988 – 1991). At the time, there were no geoinformation

technologies and locations were marked according to the tree position relative to other objects (house, road, column etc.). The search for the trees was also additionally complicated by the fact that huge areas of land were mined. Nevertheless, a certain number of accessions were re-inventoried and supplied with the descriptors. The data on the accessions obtained before the war were entered into the database (Table 1).

Tab. 1. Accessions inventoried during 1989 - 1991 and re-inventoried during 2005

Accessions inventoried during 1989 - 1991	Scientific name	Morphological descriptors	MCPDs	Collection forms	Re-inventory (2005)
Lipovača	<i>Malus × domestica</i> Borkh.	+	+		
Divljaka	<i>Malus × domestica</i> Borkh.	+	+		
Đulabija	<i>Malus × domestica</i> Borkh.	+	+		
Kiseljača	<i>Malus × domestica</i> Borkh.	+	+		
Prancija	<i>Malus × domestica</i> Borkh.	+	+		
Crvena stolovača	<i>Malus × domestica</i> Borkh.	+	+		
Zimnjača	<i>Malus × domestica</i> Borkh.	+	+		
Muškinja	<i>Malus × domestica</i> Borkh.	+	+		
Djedovača	<i>Malus × domestica</i> Borkh.	+	+		
Prijedorska šarenika	<i>Malus × domestica</i> Borkh.	+	+	+	+
Krupna divljaka	<i>Malus × domestica</i> Borkh.	+	+		
Lisica	<i>Pyrus communis</i> L.	+	+	+	+
Kruška	<i>Pyrus communis</i> L.	+	+		
Ilinjača	<i>Pyrus communis</i> L.	+	+		
Vašerka	<i>Pyrus communis</i> L.	+	+		
Čupeklja	<i>Pyrus communis</i> L.	+	+	+	+
Mioljka	<i>Pyrus communis</i> L.	+	+	+	+
Susakuša	<i>Pyrus communis</i> L.	+	+	+	+
Čečavka	<i>Pyrus communis</i> L.	+	+		
Litrenjača	<i>Pyrus communis</i> L.	+	+	+	+
Lubeničarka	<i>Pyrus communis</i> L.	+	+	+	+
Trnovača	<i>Pyrus communis</i> L.	+	+		
Orah	<i>Juglans regia</i> L.	+	+		
Orah mekiš	<i>Juglans regia</i> L.	+	+		
Orah	<i>Juglans regia</i> L.	+	+		
Orah kasni	<i>Juglans regia</i> L.	+	+		
Kajsija	<i>Prunus armeniaca</i> L.	+	+		
Šentelija	<i>Prunus persica</i> L.	+	+		
Vinogradarska breskva	<i>Prunus persica</i> L.	+	+		
Cipov	<i>Prunus avium</i> L.	+	+		
Azijanka	<i>Prunus avium</i> L.	+	+		
Karaaršlama	<i>Prunus avium</i> L.	+	+		
Biljur	<i>Prunus avium</i> L.	+	+	+	+
Višnja	<i>Prunus cerasus</i> L.	+	+		
Domaća višnja	<i>Prunus cerasus</i> L.	+	+		
Turgulja	<i>Prunus domestica</i> L.	+	+		
Miškovačka rana	<i>Prunus domestica</i> L.	+	+		
Banjalučka bjelica	<i>Prunus domestica</i> L.	+	+		
Varaljka	<i>Prunus domestica</i> L.	+	+		
Vlainjača	<i>Prunus domestica</i> L.	+	+		
Kraljica Bosne	<i>Prunus domestica</i> L.	+	+		
Crna džanarika	<i>Prunus cerasifera</i> L.	+	+		
Džanarika	<i>Prunus cerasifera</i> L.	+	+		
Žuta džanarika	<i>Prunus cerasifera</i> L.	+	+		
Crvena džanarika	<i>Prunus cerasifera</i> L.	+	+		
Crvena džanarika	<i>Prunus cerasifera</i> L.	+	+		
Crvena džanarika	<i>Prunus cerasifera</i> L.	+	+		

Tab. 2. Accessions in the field collection on Mt. Manjača

Accession name	Scientific name	MCPD	Collection form	Grafted in collection
Kiseljak	<i>Malus × domestica</i> Borkh.	+	+	+
Petrovača crvena	<i>Malus × domestica</i> Borkh.	+	+	+
nn 1	<i>Malus × domestica</i> Borkh.	+	+	+
Ljepocvjetka	<i>Malus × domestica</i> Borkh.	+	+	+
Kanjiška	<i>Malus × domestica</i> Borkh.	+	+	+
Šarenika	<i>Malus × domestica</i> Borkh.	+	+	+
Habikuša	<i>Malus × domestica</i> Borkh.	+	+	+
Lederica	<i>Malus × domestica</i> Borkh.	+	+	+
Zelenika	<i>Malus × domestica</i> Borkh.	+	+	+
Ovčiji nos	<i>Malus × domestica</i> Borkh.	+	+	+
Kanada	<i>Malus × domestica</i> Borkh.	+	+	+
Senabija	<i>Malus × domestica</i> Borkh.	+	+	+
Petrovača bijela	<i>Malus × domestica</i> Borkh.	+	+	+
Kisela krupna	<i>Malus × domestica</i> Borkh.	+	+	+
Slatka zelenika	<i>Malus × domestica</i> Borkh.	+	+	+
Huseinbegovača	<i>Malus × domestica</i> Borkh.	+	+	+
Eliflana slatka	<i>Malus × domestica</i> Borkh.	+	+	+
Funtača	<i>Malus × domestica</i> Borkh.	+	+	+
Cvjetača	<i>Malus × domestica</i> Borkh.	+	+	+
Butulija	<i>Malus × domestica</i> Borkh.	+	+	+
Staklara	<i>Malus × domestica</i> Borkh.	+	+	+
Srebreničanka	<i>Malus × domestica</i> Borkh.	+	+	+
Bobovec	<i>Malus × domestica</i> Borkh.	+	+	+
Šadička	<i>Malus × domestica</i> Borkh.	+	+	+
Srebrenjača	<i>Malus × domestica</i> Borkh.	+	+	+
Pramenka	<i>Malus × domestica</i> Borkh.	+	+	+
Penka	<i>Malus × domestica</i> Borkh.	+	+	+
Zelenika	<i>Malus × domestica</i> Borkh.	+	+	+
nn 2	<i>Malus × domestica</i> Borkh.	+	+	+
nn 3	<i>Malus × domestica</i> Borkh.	+	+	+
nn 4	<i>Malus × domestica</i> Borkh.	+	+	+
Takiša	<i>Pyrus communis</i> L.	+	+	+
Kanjuška	<i>Pyrus communis</i> L.	+	+	+
Urumenka	<i>Pyrus communis</i> L.	+	+	+
Lubeničarka	<i>Pyrus communis</i> L.	+	+	+
Stambolka	<i>Pyrus communis</i> L.	+	+	+
Izmirka	<i>Pyrus communis</i> L.	+	+	+
Batva	<i>Pyrus communis</i> L.	+	+	+
Karamut	<i>Pyrus communis</i> L.	+	+	+
Ranka	<i>Pyrus communis</i> L.	+	+	+
Karamut, crni	<i>Pyrus communis</i> L.	+	+	+
Karamut, bijeli	<i>Pyrus communis</i> L.	+	+	+
Kantaruša	<i>Pyrus communis</i> L.	+	+	+
Avraška	<i>Pyrus communis</i> L.	+	+	+
Mednjica	<i>Pyrus communis</i> L.	+	+	+
nn 1	<i>Pyrus communis</i> L.	+	+	+
Hrušt, badovinski	<i>Prunus avium</i> L.	+	+	+
nn 1	<i>Prunus avium</i> L.	+	+	+
Meršan	<i>Prunus avium</i> L.	+	+	+
Hrušt, rani	<i>Prunus avium</i> L.	+	+	+
Aršlama	<i>Prunus avium</i> L.	+	+	+
Rušt, domaći	<i>Prunus avium</i> L.	+	+	+

The second step was to conduct expeditions to new locations and make inventory there through local and regional activities. During more than 20 expeditions in the period 2005-2008, new accessions were inventoried and partially collected. These accessions were provided with collection forms and passport descriptors. All collected accessions were regenerated and the inventoried accessions will be collected and regenerated during autumn 2009 in order to be entered into the field collection. A certain number of accessions that are in good condition will be conserved at the conservation farm. The inventory and collection of accessions during 2005-2008 were conducted in different parts of Republika Srpska: Banjaluka, Sarajevo, Semberija, Hercegovina. Since 2005, 254 new accessions have been inventoried: *Pyrus communis* L. (91), *Malus × domestica* Borkh. (64), *Prunus avium* L. (44), *Prunus domestica* L. (20), *Ficus carica* L. (11), *Vitis vinifera* L. (11) *Corylus avellana* L. (5), *Prunus cerasus* L. (3), *Prunus cerasifera* L. (2), *Prunus persica* L. (1), *Cydonia oblonga* (1) and *Sorbus domestica* (1). In the region of Semberija (the village of Batkovići), an inventory was made of the trees aged over 100 years (their origin probably dating back to 1892). These accessions include apple named Segunjača and pear called Mirisavka. The data on the collections have been processed and preserved in the Republic Gene Bank archives located at the Institute of Genetic Resources, the institution responsible for implementing the Programme for the Conservation of Plant Genetic Resources of Republika Srpska. Two farms have been selected for on-farm conservation, the one located in Bijeljina and the other in Prnjavor.

A field collection for ex situ conservation has been established on Manjača, 20 kilometers south of Banjaluka at 350 m a.s.l. The collection is composed of 51 accessions and 251 trees. There are 30 apple, 15 pear and 6 cherry cultivars (Table 2).

Conclusions

Republika Srpska has different types and climates and is very rich in fruit germplasm. Therefore, it can be considered as a gene centre for wild species of fruits and their wild relatives. Fruit growing has been practiced for a long time in this area and a certain number of primitive domestic cultivars were found. During different historical epochs, foreign germplasm was introduced from the East and West. The introduction of foreign germplasm resulted in the creation of new genotypes or cultivars through planned or spontaneous hybridization. This flora richness has not been systematically studied and the establishment of collections for different ecological and production conditions was not performed. There is a small number of studies that confirmed the necessity for a planned and systematic approach to investigating the fruit germplasm and its conservation particularly because of the fact that these fruits are perennial species. The most cost-effective approach is to keep fruits in the field ex situ collections and check its health status (primarily for viruses) and eliminate duplicates. The studies conducted during 2005-2008 confirmed the above as many different accessions were found on a small area. By the end of 2008, the Republic Gene Bank had received data on 47 re-inventoried accessions (inventoried during 1989-1991), 254 accessions inventoried during 2005-2008 and 51 accessions conserved at the field ex situ collection. It is necessary to conduct more intensive work on the inventory, collection and conservation of fruit genetic

resources, such that would certainly be supported by the Programme for Conservation of Plant Genetic Resources of Republika Srpska.

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GENETIČKI RESURSI VOĆAKA U REPUBLICI SRPSKOJ

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Rezime

Republika Srpska se nalazi u severnom, severo-istočnom i jugoistočnom delu Bosne i Hercegovine. Zahvaljujući takvoj geografskoj poziciji izražene su dve različite klimatske zone: kontinentalna na severu i istoku i mediteranska na jugu. Ovo područje je tokom istorije bilo pod uticajem različitih civilizacija i kultura, te je zahvaljujući tome i geografskom položaju postalo veoma bogata u biološkoj raznovrsnosti. Najveće istraživanje germplazme provedeno je tokom perioda osamdesetih godina kroz program Banka biljnih gena Jugoslavije. Međutim, zbog ratnih dešavanja ove aktivnosti su zaustavljene više od 10 godina. Dokumentacija (MCPDs - engl. Multi Crop Passport Descriptors) je sačuvana samo za neke prinove: *Malus × domestica* Borkh. (11), *Prunus domestica* L. (6), *Pyrus communis* L. (11), *Prunus avium* L. (4), *Prunus cerasus* L. (2), *Prunus persica* L. Batch. (2), *Prunus armeniaca* L. (1), *Prunus cerasifera* Ehrh. (6) i *Juglans regia* L. (4). Rad na očuvanju biljnih genetičkih resursa obnovljen je kroz međunarodni projekat "SEEDNet - Razvojna mreža jugoistočne Evrope za očuvanje biljnih genetičkih resursa 2004 - 2014" sa Univerzitetom u Banjaluci kao partnerom za implementaciju projekta u Republici Srpskoj. Ovaj projekat je pomogao da se obnovi rad na inventarizaciji i kolekcionisanju, kao i uspostavljanje i opremanje republičke banke gena, te da se usvoji Program očuvanja biljnih genetičkih resursa Republike Srpske. Inventarizacija i kolekcionisanje se obavljaju kroz rad republičke i regionalne radne grupe za voćke i vinovu lozu. Od 2004. godine inventarisane su slijedeće prinove: *Pyrus communis* L. (91), *Malus × domestica* Borkh. (64), *Prunus avium* L. (44), *Prunus domestica* L. (20), *Ficus carica* L. (11), *Vitis vinifera* L. (11), *Corylus avellana* L. (5), *Prunus cerasus* L. (3), *Prunus cerasifera* L. (2), *Prunus persica* L. (1), *Cydonia oblonga* (1) i *Sorbus domestica* (1). Sve prinove su dokumentovane kroz kolekcione forme i MCPDs. Konzervacija se obavlja kao *ex situ* u kolekcionom zasadu podignutom na Manjači, 20 km južno od Banjaluke, koji sadrži sljedeće prinove: *Malus × domestica* Borkh. (31), *Pyrus communis* L. (15) i *Prunus avium* L. (6).