Scientia Horticulturae 125 (2010) 380–389

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

A survey and morphological evaluation of fig (*Ficus carica* L.) genetic resources from Slovenia

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ARTICLE INFO

Article history:
Received 18 November 2009
Received in revised form 14 April 2010
Accepted 16 April 2010

Keywords:
Ficus carica L.
Morphology
Gene bank

ABSTRACT

In order to collect all existing phenotypic variation of fig accessions grown in Slovenia and to plan the conservation strategy by establishment of national collection in the northern part of Adriatic coast, the survey of family yards and Slovenian orchards was performed. Two main fig growing regions were included into the field inventory: littoral zone (Slovene Istria) and hinterland zone (Goriška Brda and Vipava Valley). All collected material was morphologically characterized according to internationally accepted descriptors for *Ficus carica* L., and some new descriptors for leaves and fruits were introduced. For identification the patterns of morphological variation within the fig germplasm principal component analysis (PCA) was used and cluster analysis was performed to decide the ultimate number of clusters by which the accessions could be assessed. Twenty-five Slovenian accessions were compared with fig varieties from a private fig collection in Croatia in order to assess the degree of similarity of figs grown on a broader region of Istria. Altogether 38 accessions were evaluated for 74 phenotypic characters. The results of morphological evaluation confirmed the usefulness of phenotypic markers for fig genetic resources characterization developed by IPGRI and CIHEAM (2003), but some new variables that in our study shoved high discrimination value could be added. Results of morphological evaluation contributed to the selection of accessions for the first national Slovenian fig gene bank. The national gene bank and fig data base will make a fundamental contribution to further genetic improvement of fig crops in Slovenian agriculture.

1. Introduction

The common fig (*Ficus carica* L.) is a typical Mediterranean fruit species, widely spread in Near East, African, and South European countries. Since ancient times the exotic fig fruits have provided a valuable food for people and animals in the Mediterranean region. Domestication brought a considerable increase in the size of the fruit and its sugar content, as well as a characteristic shift to vegetative propagation (Zohary and Spiegel-Roy, 1975). Study of mtDNA of natural fig tree populations confirmed the contrasting diversity within populations and different levels of genetic differentiation among figs in Mediterranean Basin (Khadari et al., 2005). Long history and expansion of fig cultivation thought that Mediterranean Basin has contributed to the diversity of existing varieties and allowed the development of geographically distinct fig ecotypes.

In 2007, the world fig production was estimated be to 1 million tons. Turkey is the largest fig producer (270,830 ton, 25% of total world crop), while Portugal boasts the largest surface area planted with figs (86,500 ha, FAOSTAT (http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor). In Mediterranean countries of the European Union the fig is considered as a minor commercial fruit, probably because its production cannot compete with olives, grapes, and citrus, the leading crops of Mediterranean agriculture. Nevertheless, fig cultivation in Europe occupies special niches at the local levels and is maintained by cultural preference and traditional practices. Frequently, figs thrive in association with other Mediterranean plants on home gardens, which are also known as a refuge for plant genetic diversity, containing unique or rare ecotypes that have evolved or have developed locally (Engels, 2001).

The presence of Mediterranean climate in the south-western part of Slovenia allowed the introduction and cultivation of great number of Mediterranean agricultural plants. There are three main areas of particular value for fig growing: Slovene Istria, Vipava Valley and Goriška Brda. Nineteen percent of Slovenian figs are produced in Slovene Istria; the coastal region of the country. According to FAOSTAT (http://faostat.fao.org/site/

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doi:10.1016/j.scienta.2010.04.030

Table 1
List of fig accessions included into morphological analysis and sampling locations with geographical information.

	Accession name	Location	Latitude	Longitude	Elevation
Littoral zone (Slovenska Istra)	'Bela Petrovka'	Dekani	45°32,861′	13°47,921′	15 m
	'Belica'-1	Padna	45°29,353′	13°40,868′	146 m
	'Črna Petrovka'	Glem	45°29,372′	13°47,341′	325 m
	'Črni Matalon'	Panda	45°29,399′	13°40,883′	177 m
	'Kanora'	Dekani	45°32,874′	13°47,890′	17 m
	'Rjavi Matalon'	Dekani	45°00,105′	13°33,231′	17 m
	'Zeleni Matalon'	Glem	45°29,261′	13°47,023′	285 m
	'Zuccherina'	Šalara	45°31,297′	13°43,039′	15 m
	'Kamberij'-2	Šared	45°31,132′	13°39,271′	53 m
	'Pinčica'	Seča	45°29,819′	13°36,453′	53 m
	'Zelenka'	Panda	45°29,358′	13°40,856′	146 m
	'Laščica'	Nova Vas	45°28,614′	13°42,629′	238 m
	'Miljska figa'	Seča	45°29,815′	13°36,456′	53 m
	'Sivka'	Smokvica	45°29,552′	13°53,990′	282 m
	'Flazana'-2	Šared	45°31,132′	13°39,271′	53 m
Hinterland zone (Goriška Brda and Vipava valley)	'Repenca'	Ajdovščina	45°51,097′	13°50,375′	171 m
	'Zelena'	Padna	45°29,353′	13°40,868′	146 m
	'Flazana'-1	Ajdovščina	45°51,097′	13°50,375′	171 m
	'Padovana'	Snežatno	45°59,932′	13°34,586′	183 m
	'Belica'-2	Planina	45°51,539′	13°54,561′	285 m
	'Belica'-3	Snežatno	45°59,932′	13°34,586′	183 m
	'Kamberij'-1	Šmihel	45°57,213′	13°43,448′	216 m
	'Madona Rjava'	Šmihel	45°57,211′	13°43,445′	216 m
	'Zelena Bonka'	Snežatno	45°59,932′	13°34,586′	183 m
	'Madniči'	Kozana	46°00,057′	13°33,158′	141 m
Croatia					
Collection Medulin	'Grčka crna'	Medulin	44°48,435′	13°56,941′	17 m
	'Bjelica'	Medulin	44°48,435′	13°56,941′	17 m
	'Petrovača crna'	Medulin	44°48,435′	13°56,941′	17 m
	'Fico della Madonna'	Medulin	44°48,435′	13°56,941′	17 m
	'Sušioka'	Medulin	44°48,435′	13°56,941′	17 m
	'Šaraguja'	Medulin	44°48,435′	13°56,941′	17 m
	'Bružetka crna'	Medulin	44°48,435′	13°56,941′	17 m
	'Bružetka bijela"	Medulin	44°48,435′	13°56,941′	17 m
	'Rezavica'	Medulin	44°48,435′	13°56,941′	17 m
	'Vodenjača'	Medulin	44°48,435′	13°56,941′	17 m
	'Termenjača'	Medulin	44°48,435′	13°56,941′	17 m
	'Zimica'	Medulin	44°48,435′	13°56,941′	17 m
	'Crnica'	Medulin	44°48,435′	13°56,941′	17 m

567/DesktopDefault.aspx?PageID=567#ancor), the fig harvest in Slovenia considerably decreased in the period between 1992 and 2007 (from 152 to 50 ton per year). Despite the fig tree is recognized as an important ethno botanical plant in Slovenia, its economic potential of cultivation has been poorly addressed, and the fig tree is considered as an underutilized fruit species in the region. The main reasons for production decline are the limited information on fig genetic structure and varietal characterization, and the lack of fig growing guidelines for the producers. Revitalization of fig growing in Slovenia is important for many reasons, such as: diversification of agriculture in the region, development of new typical agricultural products and their increased offer at local markets, introduction of figs into food processing industry, acquisition of new source of income for local growers and family farms, and preservation of agrobiodiversity.

Traditionally, the amount and distribution of genetic diversity has been determined by morphological markers. Despite, expression of these markers was strongly influenced by environmental conditions and agronomic technologies, the morphological characterization is highly recommended first step that should be made before more in-depth biochemical or molecular studies are attempted (Hoogendijk and Williams, 2001). Thus, morphological description continues to be the first step in the process of genetic diversity preservation of agricultural plants. The inventory of plants based on morphological descriptions enable the first inside into extent of phenotypic diversity and is of great importance for planning genetic resources preservation strategy and establishment of national collections.

According to our knowledge there are no available records or any other information about Slovenian fig genetic resources. In order to promote underutilized fig as a nutritionally rich and functional food and to preserve existing genetic variability of figs grown in Slovenia, the inventory, evaluation, and conservation strategy of fig genetic resources is necessary.

The main objectives of the this study were: (1) to make an inventory of local fig genetic resources from different orchards and home gardens in Slovenia, (2) to describe and evaluate collected plant material according to morphological characteristics and to determine the amount of genetic diversity and, (3) to compare Slovenian local varieties with fig genetic resources from Croatia. The results of the study will be used for the establishment of the first Slovenian fig genetic resources collection. The primarily goal of figs *ex situ* conservation from the northern coast of Adriatic Sea is to prevent valuable and unique genetic resources to being lost and the second one to enhance the study of agronomical important traits, biological functional properties of fruits and genetic structures of varieties under equal growing conditions.

2. Materials and methods

2.1. Plant material

The germplasm collecting mission and field survey were performed during vegetation (June–October) in 2005–2007 with the aim of collecting all existent variability of cultivated figs through