



Assessment of variability in morphological characters of apricot germplasm of Kashmir, India



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ABSTRACT

In the present study, 40 Kashmiri apricot cultivars/genotypes were assessed for 28 morphological traits. The results displayed a high level of variability among all the cultivars/genotypes. The fruit characteristics such as fruit size, shape, fruit volume, flesh and skin color which determines the quality and marketability of apricot exhibited huge variation. Two groups were identified based on fruit size; small fruit (< 30 g) and large fruit (> 30 g). PCA revealed that 84.28% of the total variance among cultivars/genotypes was explained by the first ten components. UPGMA cluster analysis divided apricot cultivars into two groups. Cluster I contains the 33 cultivars/genotypes and cluster II contains six cultivars/genotypes. The present study highlighted that the characters related to fruit morphology such as, dimensions, shape, fruit flesh color and leaf dimensions and shape are valuable traits for fast and easy discrimination of apricot cultivars. This is the first report on genetic diversity analysis of apricot cultivars/genotypes from the region. This study would provide a sound and authentic basis for effective management and sustainable utilisation of apricot germplasm in future breeding programmes in the region.

1. Introduction

Apricot, *Prunus armeniaca* L., is one of the most popular temperate fruit trees grown world over (Faust et al., 1998; Ercisli, 2009). Apricot ranks as the third most economically important stone fruit crop after peach and plum (OECD, 2002; FAOSTAT, 2009). It belongs to the family Rosaceae, subfamily Prunoideae, genus *Prunus*, subgenus *Prunophora* Focke and section *Armeniaca* (Lam.) Koch (Rehder, 1949). The generic term apricot includes four different species, viz, *P. armeniaca* L., the cultivated apricot; *P. sibirica* L., the Siberian apricot; *P. mandshurica* (Maxim.) Koehne, the Manchurian apricot; *P. mume* (Siebold) Siebold & Zucc., the Japanese apricot and one naturally occurring interspecific hybrid, *Prunus* × *dasycarpa* Ehrh., the black or purple apricot. Amongst these, *P. armeniaca* is the most widely cultivated (Hormaza, 2002; Uzun et al., 2010), with highest global production. Apricot cultivars are divided into four eco-geographical groups: Central Asian,

Irano Caucasian, European, and Dzhungar-Zailing (Lopes et al., 2002). The Central Asian group is the oldest group with the richest variation. Most of the cultivars are self-incompatible with small to medium sized fruits which ripen over a long period and require high chilling.

Kashmir Himalayan region, part of the Central Asian center of origin of apricot (Vavilov, 1951), is particularly suited for apricot production by virtue of its favorable climatic and eco-geographical conditions. It is the leading producer of apricots in the sub-continent with a total production of 14501MT from an area of 6287 ha in the year 2012–13 (<http://hortikashmir.gov.in/>). It has a rich legacy of apricot cultivation as well as an affluent apricot germplasm comprising of both indigenous and exotic varieties with most of the exotic cultivars from the European group (Bhat et al., 2013). The richness of apricot germplasm reflects a long period of plant introduction from adjoining areas (Zaffar et al., 2004). However, in absence of proper documentation and management, there is a risk of loss of these genetic resources (Dwivedi and Dwivedi,

Abbreviations: acc, accession; ANOVA, analysis of variance; CITH, Central Institute of temperate horticulture; cv., cultivar; CV, coefficient of variance; DUS, distinctness uniformity and stability; g, gram; KUBG, Kashmir university botanical garden; lbf, pound-force; PCA, principal component analysis; UPGMA, unweighted pair group method with arithmetic mean; UPOV, international union for the protection of new varieties of plants

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2004).

Given the importance of apricot industry for this unique ecogeographic zone, characterization of germplasm collections, and genetic diversity analysis is a prerequisite for any breeding programme. Morphological characterization is timely for cultivar identification, selection, delineation and germplasm management in start-up programmes intended for selection of superior genotypes for breeding programmes. Several studies have been undertaken on the variability of germplasm resources of European (Audergon et al., 1991; Badenes et al., 1998; Milošević et al., 2010) and Irano-Caucasian eco-geographical groups (Asma and Ozturk, 2005; Asma et al., 2007), resulting in the identification of interesting cultivars that have been used to generate new selections through breeding programmes (Forte, 1971; Alméras et al., 2002; Hormaza et al., 2002,b; Krichen et al., 2014a,b). However, the number of studies on *trans*-Himalayan germplasm is limited (Dwivedi and Atrey, 2002). Therefore, genetic resource management including collection, precise characterization and documentation of extant variability is of paramount importance for conservation, breeding and commercialization of potential apricot cultivars/genotypes in this region.

Accordingly, the present study was undertaken to assess the genetic diversity in apricot cultivars/genotypes grown in the Kashmir valley through morphological characters. Though, there are several reports on the assessment of genetic diversity of apricot germplasm from this *trans*-Himalayan region, but most of them are restricted to few cultivars maintained at specific locations. This is the first report on genetic diversity analysis of apricot cultivars/genotypes grown throughout the valley of Kashmir and would provide a basis for effective management and sustainable utilisation of apricot germplasm in the region.

2. Materials and methods

2.1. Field survey

Apricot germplasm of Kashmir in general is scattered in the form of single trees in apple orchards of the Valley. We do not have specific apricot orchards in Kashmir Valley as is found in Ladakh area of Jammu and Kashmir State. In order to assess the available apricot germplasm and maximize the variability of the collected plant material, extensive field surveys were undertaken throughout Kashmir Valley during 2014–2016 growing seasons (Table 1). The information on cultivar name was gathered through local knowledge and based on available literature in Govt. Horticulture Nurseries. Wherever, the name of the cultivar was not known, such trees were designated as unknown genotype. A single tree of each cultivar/genotype was then tagged with an accession number and samples were collected from the tagged trees during the growing season.

2.2. Morphological data

A total of 28 morphological characters were recorded from 40 cultivars/genotypes of apricot during the present study. The tree habit, leaf and fruit characteristics of all selected genotypes were recorded based on standard DUS guidelines on apricot (Protection of Plant Varieties and Farmer's Rights Authority, Govt. of India, 2012) (Table 2). Fruit characteristics were observed at maturity stage, when fruit was ready for harvest and leaf characteristics were recorded from fully developed leaves of the middle third of current season's shoot. For fruit characteristics a total of 20 random samples of fruits were taken. Qualitative traits such as fruit shape, fruit skin/flesh color, stone shape etc. was assigned according to DUS guidelines (UPOV, 2012), leaf area was measured by millimeter graph paper method (Pandey and Singh, 2011). Fruit, stone and kernel weight was measured with the help of digital scale and expressed in gram (gm). Fruit and leaf dimensions were measured with the help of an electronic digital caliper 150 mm (Mitutoyo corporation). Fruit flesh firmness was determined using

penetrometer (FHT 803) with 11 mm plunger tip and the data was expressed in lbf.

2.3. Statistical analysis

Twenty-eight morphological traits from fruits and leaves were measured during the growing season (Table 2). Analysis of variance (ANOVA) was performed on genotypes as treatment with ten replications. The mean value for trait/genotypes ratio was used for measuring correlation and PCA analysis, using SPSS ver. 11 software.

3. Results

3.1. Morphological variability assessment

A total of 40 apricot genotypes were used for morphological characterization in the present study. Morphological characterization was carried out using 12 quantitative morphometric traits (measured on a set of 10 fruits and 10 leaves for each accession) and 16 qualitative morphological characters defined in the guidelines for the conduct of tests for Distinctness, Homogeneity and Stability (DUS) established by the international union for the protection of new varieties of plants (UPOV, 2012). These characters are summarized in Table 2.

3.2. Frequency distribution of the observed modalities within Kashmiri apricot germplasm

Frequency histograms plotted relative to different modalities of the studied variables and number of accessions belonging to each modality are shown in Fig. 1.

3.2.1. Fruit characters

The maximum, minimum and mean values of fruit characters of different cultivars and accessions are presented in Table 3. A high degree of variation was found in important quantitative characteristics related to the fruit. Highest fruit weight (FW) was recorded for cv. Amb cher 73.78 g, while the lowest FW of 11.75 g, was found in case of acc. KUBG01 with a CV of 0.4. The mean FW was recorded as 36.00 g. A total of 21 cultivars/genotypes had fruit weight > 30 g. Fruit length (FL) varied from 26.65 mm in acc. KUBG01 to 53.88 mm in cv. Amb cher, with a CV of 0.16, while fruit width (FWd) ranged from 29.33 mm in acc. KUBG01 to 50.77 mm in cv. khubani with a CV of 0.15. The average FL and FWd was 39.80 mm and 38.84 mm respectively. A total of 30 cultivars and accessions had FL and FWd > 30 mm. Fruit flesh is the main edible portion of apricot and a higher ratio of weight of pulp to weight of stone (PW/SW) is an important pomological attribute. PW/SW ranged from 3.76 g, in acc. KUBG01 to 22.15 g, in cv. Amb cher with an average of 10.57 and CV of 0.33. Stone weight (SW) ranged from 1.62 g, in acc. Zaura-1 to 4.73 g in cv. Perfection, with an average of 3.06 g and CV 0.22. Kernel weight (KW) ranged from 0.27 g, in cv. Amb cher to 0.88 g in cv. Perfection, with mean of 0.54 g, and CV of 0.23 (Table 4).

Apricot fruit qualitative characters represent an important index of consumer preference and hence the marketability. Fruit shape (FS) was predominantly round with shallow suture and rounded apex. Ground color of skin (FGS), presented a continuous distribution from greenish yellow to red blush color. Yellow color was the most frequent modality compared to the greenish yellow, light orange, orange and red blush colors. In this study, firmness of flesh (FFF) and free stone trait (FS) was dominant. Stone color was predominantly brown and stone shape (SS) ovate. The kernel taste of 23 cultivars and types was sweet and that of the remaining 17 was bitter.

3.2.2. Leaf characters

All the modalities were represented for leaf dimensions (LBL, LBW, LA), showing the presence of small to large sized leaves in Kashmiri

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