International Journal of Agricultural and Natural Sciences
E-ISSN: 2651-3617 15(2): 221-225, 2022
Research Article

APPLE GENETIC RESOURCES IN KYRGYZSTAN GEOGRAPHY: DETERMINATION, EVALUATION, AND CONSERVATION

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(Received 23th June 2022; accepted 17th November 2022)

ABSTRACT. It has been reported that the origin centers of apples in the world are East Asia, Central Asia, West Asia-Europe and North America. Central Asia, known as the geography of Turkestan, is an important gene center and distribution area for apples. It has been reported that wild apple genetic resources in this region are of critical importance. The reason for this has been shown as the narrowing of genetic diversity with the selection made according to the desired characteristics in commercial apple varieties. It has been stated that apple populations in Central Asia are an important gene pool that will contribute to resilience to biotic and abiotic stress conditions, fruit quality characteristics, tree growth form and some other unsolved problems. Kyrgyzstan is one of the important apple origin centers in the Central Asian region. In different regions of Kyrgyzstan, there are significant natural apple populations and forests, as well as walnut, pistachio, almond species. There are three types of apples naturally found in Kyrgyzstan. These are *Malus sieversii* (Ledeb.) M. Roem, Malus kirghisorum and *Malus niedzwetzkyana* (Dieck), known as the origin of cultivated apples. C.K. Schneid. are types. In addition to these, cultivated apples (*Malus domestica* Borkh) are also grown in this region. The fact that different species have been grown in the same region for a long time has created a rich diversity. In the studies carried out, fruit weight in the genotypes of these different species varied between 3.0-316.08 g. On the other hand, in genetic diversity studies, all materials were separated from each other and genetic similarity levels were found to be between 0.74-0.95. In order to preserve this rich diversity, studies such as reproduction, establish of collections, determination of the characteristics of genotypes and use as breeding material are needed.There are many plant species that are endangered and need to be protected in the Central Asian region. In the study on endangered species, *M. sieversii* and *M. niedzwetzkyana* were declared as endangered species and included in the red list. It has been stated that these species are endangered due to habitat loss and degradation, opening up of agricultural areas and genetic erosion. Despite the narrow genetic basis of cultivated apples, it has been emphasized that it is imperative to protect these endangered species at ex situ and in situ levels, which will increase genetic diversity. On the other hand, it was emphasized that *M. niedzwetzkyana* was also included in the list of the Red Book of Threatened Species of Kazakhstan. In this study, it is focused on the studies that can be done to reveal the apple genetic diversity, conservation strategies and evaluation of Kyrgyzstan, which is located in the center of Central Asia.

Keywords: *Apple, characterization, Malus spp.*

INTRODUCTION

Apple is one of the most grown fruit species in the world and its annual production is around 86 million tons. Turkey is one of the important producer countries and the production is 4.3 million tons [1]. Today, cultivated apple (*Malus domestica* Borkh.) can be grown in a wide geography from the cold regions of Siberia to the equatorial

climate. It has been reported that the origin centers of apples in the world are East Asia, Central Asia, West Asia-Europe and North America [2].

It is accepted that the origin of cultivated apples has a complex structure. The high level of cpDNA variation detected in *Malus* cultivars in studies shows this complex structure [3]. On the other hand, some researchers reported that wild species along the Silk Road, *M. baccata* (L.) (native to Siberia), *M. orientalis* (native to the Caucasus) and *M. sylvestris* Mill. (specific to Europe) may have contributed to the formation of cultivated apples [4]. *M. sieversii* (Ldb.) M. Roem, a Central Asian wild apple, is considered to be the main species contributing to the M. domestica gene pool, considering fruit and tree morphology and genetic data. The region where the apple was first cultivated is considered to be the forests of the Tian Shan mountains in Central Asia. The reason for this situation is the remarkable intraspecies morphological diversity seen in wild apples in this region (Cornille et al., 2012). Duan et al. [5], reported in their population analysis that the source of modern cultivated apples was the densely intertwined interactions of *M. sieversii* with *M. sylvestris* in Kazakhstan. The researchers emphasized that *M. sieversii* in the Xinjiang region is an isolated ecotype with a homogeneous structure and has significant potential for future apple development studies. On the other hand, he stated that Chinese native species such as *M. asiatica* and *M. prunifolia* may have been formed by crosses between *M. baccata* and *M. sieversii* in Kazakhstan.

Central Asia is an important origin of apple and has a rich genetic diversity. Kyrgyzstan is one of the important gene centers for apple in Central Asia. There are significant natural apple populations along with other fruit species in different regions of the country (Fig.1). On the other hand, it is emphasized that there are human-induced losses in these genetic resources and this rich diversity may disappear in the future [6]. Three species of apples found naturally in Kyrgyzstan are: *Malus sieversii* (Ledeb.) M. Roem, *Malus kirghisorum* and *Malus niedzwetzkyana* (Dieck). C.K. Schneid. The arid mountainous regions of Kazakhstan, Kyrgyzstan, China, Tajikistan, Uzbekistan and Turkmenistan are natural distribution areas for *M. sieversii*. *M. kirghisorum* is reported as a species that is genetically close to *M. sieversii* but differs in fruit shape, color and other characteristics. In *M. niedzwetzkyana*, there are pink-purple pigmentations on leaves, flowers and fruits. These two species can be found in the same regions, but *M. sieversii* is more common [7].

EVALUATION AND CONSERVATION RECOMMENDATIONS

Since the geography of Kyrgyzstan in Central Asia has a mountainous structure, different apple species can naturally spread. In the process, a significant level of genetic diversity has occurred with the effect of interactions between different species. However, populations are lost to a large extent, especially due to human-induced factors. Wilson et al. [8], stated that mixed fruit forests in Central Asia have decreased dramatically in the last 50 years and only around 5-10% remain original. It has been reported that these forests extend at an altitude of 800-2100 m and along the foothills of the Tanrı Mountains. It has been emphasized that mixed fruit forests can remain at the highest level in Kyrgyzstan, the forest-rich country of Central Asia [9]. At this point, agricultural practices, the opening of new agricultural areas, the increase in grazing pressure, and the unsustainable use of forest products pose a great danger to fruit forests [10;8]. Under all these threats, it is necessary to carry out some studies to protect and

evaluate this rich diversity without being lost. In this context, it is of great importance to raise awareness of the local people to reduce the destruction of mixed forests, including apple populations. At the same time, different non-wood energy sources that can be used should be offered to the people living in this region. In addition, it is necessary to carry out studies to protect and improve existing populations as they are. At this point, it is important to take measures to prevent landslides and soil losses that occur naturally, especially in the region.

Fig 1. *Apple populations mixed with different plant species (Photo: A. Uzun©)*

Apart from in situ conservation strategies, the establishment of core collections in different regions with suitable climates should be considered to pass on the species included in the apple populations to the next generations. On the other hand, it is important to characterize them (morphological and molecular) and reveal their other properties. It has been stated that apple populations in Central Asia are an important gene pool that will contribute to resilience to biotic and abiotic stress conditions, fruit quality characteristics, tree growth form and some other unsolved problems [11]. Some studies have been carried out on the conservation, evaluation and characterization of mixed fruit forests and apple genetic resources in this region. Eastwood et al. [12], reported that many international projects have been implemented to protect forests with endangered species in Central Asia. Omasheva et al. [13], revealed the genetic diversity and current situation in *M. sieversii* genotypes in Kazakhstan. In the study, a high level of diversity was determined between genotypes, and it was emphasized that natural hybridizations occurred between this species and other species. Uzun et al. [14], revealed fruit characteristics in different apple species in Kyrgyzstan. Fruit weight in the genotypes used in the study was 3.0-316.8 g; fruit length, 14.9-79.8 mm; fruit diameter, 18.0-89.5 mm; The total soluble solids (TSS) varied between 8.0 and 22.8% and it was determined that there was a rich variety in terms of fruit characteristics. Also, Uzun et al. [15], determined the genetic similarity levels between apple materials between 0.74-

0.95 in their study on apple genotypes originating from Kyrgyzstan. All of the materials used in this study were genetically separated from each other. Wilson et al. [8], conducted studies on the distribution of *M. niedzwetzkyana* in Kyrgyzstan. They emphasized that this species is found in certain regions of Kyrgyzstan and in very limited numbers and must be protected. Yang et al. [16], examined the genetic relationships between *M. niedzwetzkyana* and *M. sieversii* genotypes in China and reported that the similarities of these two species are higher in China than in other countries. On the other hand, studies have been carried out on scab resistance in genotypes of *M. niedzwetzkyana* species in Kazakhstan and variations between genotypes have been determined in this regard [17].

At this point, taking into account the information given above, studies on the in situ protection, evaluation and ex situ conservation of forests in Central Asia, which are especially rich in fruit species and are at risk of extinction, should increasingly continue. In addition to these studies on apple species, which are the subject of the study, it is important to establish breeding programs that will further expand the gene pool.

Acknowledgment. The authors thank to Scientific Research Projects Unit of Erciyes University for funding and supporting the project with the project number of FOA-2014-5037.

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