RESEARCH PAPER

Gene pool of wild fruit plants in Uzbekistan

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Received: 14th June, 2026; Revised: 20th July 2026; Accepted: 20th August, 2026; Available Online: 05th September 2026

ABSTRACT
This article investigates the gene pool and geographical distribution of wild fruit plant species and locally adapted cultivars in Uzbekistan that demonstrate resistance to extreme environmental stresses, including heat, cold, soil salinity, drought, and shallow groundwater conditions. In the context of ongoing global climate change, the identification and conservation of stress-tolerant genetic resources have become increasingly important for ensuring sustainable horticultural production and long-term food security. The study analyzes the ecological characteristics, adaptive potential, and distribution patterns of wild relatives of cultivated fruit species growing in diverse agroecological zones of Uzbekistan, including arid plains, foothill regions, and mountainous areas. Particular attention is given to species and ecotypes that have naturally evolved mechanisms of tolerance to high summer temperatures, winter frosts, saline soils, and fluctuating groundwater levels. In addition, the article examines traditional fruit cultivars developed through long-term folk selection by local farmers. These varieties, shaped by centuries of adaptation to specific soil-climatic conditions, represent valuable genetic resources for breeding programs aimed at improving stress resistance and productivity. In the study, plant salinity tolerance was determined based on soil electrical conductivity (EC_e), resilience to temperature stresses was assessed through the leaf electrolyte leakage (EL) index, and tolerance to shallow groundwater conditions was evaluated using hydrogeological well monitoring methods. The comparative analysis highlights the significance of integrating wild gene pools and traditional cultivars into modern breeding strategies.

Keywords: species, drought, resistance, saline soils, groundwater

How to cite this article: Sulaymanov OM, Rakhimov R, Jurakulovich OA, Jabborkulovna KS, Samiyevich BS., Gene pool of wild fruit plants in Uzbekistan. Int J Drug Deliv Technol. 2026; 16(87s): 873-879. DOI: 10.25258/ijddt.16. 87s.88
Source of support: Nil.
Conflict of interest: None

INTRODUCTION

Central Asia is recognized as one of the major centers of origin and diversity of cultivated fruit crops, as proposed by Vavilov (1992). Owing to its diverse ecological conditions, the region harbors a rich assemblage of wild fruit species and their crop wild relatives, including apple (*Malus* spp.), apricot (*Prunus armeniaca*), pear (*Pyrus* spp.), almond (*Prunus dulcis*), walnut (*Juglans regia*), and pistachio (*Pistacia vera*) (Hajjar & Hodgkin, 2007; Cornille et al., 2019). These species represent valuable components of the regional gene pool, defined as the total genetic diversity available within cultivated species and their wild relatives that can be utilized for crop improvement and adaptation.

Uzbekistan occupies a strategically important part of Central Asia and encompasses a wide range of ecological environments, from arid deserts to mountain ecosystems. Such environmental heterogeneity has contributed to the formation and preservation of genetically diverse populations of wild fruit species. Long-term exposure to drought, temperature extremes, soil salinity, and other environmental stresses has promoted the development of adaptive traits that are of considerable value for modern breeding programs (Authors Collective, 1968–1983; Holikov & Pratov, 1970).

Wild fruit species and traditional local cultivars constitute an important source of genes associated with tolerance to abiotic and biotic stresses, including drought, heat, salinity, diseases, and pests. These genetic resources are increasingly important in the context of global climate change, which threatens agricultural productivity and biodiversity worldwide (Abbo et al., 2007). The utilization of wild relatives and traditional varieties has become a key strategy for developing climate-resilient horticultural systems and ensuring long-term food security.

Uzbekistan possesses a rich heritage of fruit genetic resources that has been shaped through centuries of natural selection and farmer-led selection. According to the

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Bioversity International/UNEP-GEF project on on-farm conservation of agrobiodiversity in Central Asia, numerous local varieties of apricot, apple, pear, walnut, almond, pistachio, and pomegranate remain conserved in traditional farming systems (Bioversity International & UNEP-GEF, 2012). These local cultivars retain valuable adaptive characteristics and represent an important reservoir of genetic diversity for future breeding efforts (Bioversity International & UNEP-GEF, 2012; Bioversity International, 2012).

Despite the recognized importance of Central Asia as a center of fruit crop diversity, comprehensive information regarding the composition, distribution, and breeding value of wild fruit gene pools in Uzbekistan remains fragmented and insufficiently systematized. Previous studies have mainly focused on species distribution or varietal descriptions, while relatively limited attention has been paid to the integrated assessment of wild fruit genetic resources and their significance for conservation and breeding programs.

Therefore, the objective of this study was to evaluate the diversity and significance of wild fruit gene pools in Uzbekistan, assess their adaptive potential under arid and semi-arid environmental conditions, and determine their importance for the conservation of genetic resources and the development of climate-resilient fruit breeding programs.

The purpose of the study: To scientifically substantiate the gene pool of wild species of fruit plants growing in Uzbekistan that are resistant to heat, cold, salinity, and growing in areas with surface groundwater.

RESULTS AND DISCUSSION

The wild relatives and forms of fruit crops growing in the region, adapted to harsh soil and climate conditions, possess valuable genes capable of combating global climate change. Especially important are the drought- and heat-resistant genes found in wild fruit species, which may be regarded as a “valuable genetic resource”. Thus, conserving this gene pool for future generations is a critical responsibility.

Wild Apple Genetic Resources in Uzbekistan. Among wild fruit species occurring in Uzbekistan, wild apple species (Malus spp.) are of particular interest because Central Asia is considered one of the primary centers of diversity for the genus Malus. These species represent valuable genetic resources for fruit breeding due to their adaptation to drought, heat, salinity, and other environmental stresses.

Several wild apple species have been reported from different ecological regions of Uzbekistan, including *Malus sieversii*, *Malus orientalis*, *Malus pumila*, *Malus prunifolia*, *Malus niedzwetzkyana*, *Malus sylvestris*, and *Malus turkmenorum*. These species occur mainly in mountain forests, foothill ecosystems, and riverine habitats, where they have evolved under diverse environmental conditions.

Particular attention has been paid to *Malus sieversii*, which is recognized as one of the most important progenitors of cultivated apple and serves as a source of valuable traits for breeding programs. Other species, such as *Malus niedzwetzkyana* and *Malus turkmenorum*, possess unique morphological and adaptive characteristics that may contribute to the development of cultivars with enhanced tolerance to abiotic stresses.

The conservation and evaluation of wild apple populations are therefore essential for maintaining genetic diversity and supporting future breeding efforts aimed at improving climate resilience and sustainable fruit production.

This species has two botanical forms:

Khazorasp Late Apple- widespread in the Khorezm region, *Babaarab Form* – mainly found in Ashgabat (Turkmenistan).

Babaarab tends to grow as a shrub, while Khazorasp is a single-trunk tree form. It produces many root suckers, is semi-dwarf (3–6 meters tall), begins bearing fruit in 2–3 years, and flowers early in spring.



Table 1: Presents the geographical distribution of major wild apple species occurring in Uzbekistan.

№	Fruit Species	Regions Where Wild Species Grow
1	*Malus silvestris*	Tashkent Region (Bostanliq Forest Enterprise), Surkhandarya Region (Boysun Mountains), Kashkadarya Region (Yakkabog‘, Kitob, and Shakhrisabz District Mountains), Samarkand Region (Urgut, Nurata Mountains)
2	*Malus sieversii*	*— (Please provide the region if needed)*
3	*Malus orientalis*	Tashkent Region (Bostanliq Forest Enterprise)
4	*Malus pumila*	Tashkent Region (Bostanliq Forest Enterprise), Namangan Region (Forest Enterprises)
5	*Malus prunifolia*	Tashkent Region (Bostanliq Forest Enterprise), Surkhandarya Region (Boysun District)
6	*Malus niedzwetzkyana*	Tashkent Region (Bostanliq District), Khorezm Region (in riverine forests and isolated areas)
7	*Malus turkmenorum*	Republic of Karakalpakstan, Khorezm Region, and riverine forests of Turkmenistan (in isolated stands)

***Khazorasp Late Apple* - Wild Pear Species (Pyrus) in Uzbekistan.** In the mountainous and foothill regions of the Republic, as well as in the Khorezm and Bukhara regions, several wild pear species grow naturally.

1. **Forest Common Pear – *Pyrus communis* L.** This species has many local forms. The fruits are round or pear-shaped and small in size. The fresh fruits are rarely consumed; instead, they are primarily dried. The tree can grow up to 20 meters tall, and in some areas, specimens aged 200–300 years can be found. It is highly resistant to drought, heat, cold, diseases, and pests. The tree produces a large number of root suckers.
2. **Central Asian Pear – *Pyrus Asiae mediae* Pop.** Commonly found in apple-walnut forest ecosystems. The tree is large and spreads broadly. It is thornless. The fruits are large, sweet, juicy, and turn yellow when ripe. It flowers early and is tolerant to cold, extreme heat, and drought.



3. **Turkmen Pear – *Pyrus turcomanica* Maleev.** This species grows wild in the Khorezm and Bukhara regions, the Republic of Karakalpakstan, and the Hisor Mountains. It is a naturally semi-dwarf tree (up to 4 meters tall), thornless. The fruit is round, slightly flattened, sweet, and has a waxy taste. It grows well in areas with shallow groundwater. It is tolerant to salinity, cold, and high temperatures. *Khorezm Folk Herb (Nashvoti)*
4. **Korzhinsky Pear – (*Pyrus korshinskyi* Litv.) -** Tree height: 10–12 meters. Young shoots are pubescent, without thorns. Flowers bloom in April; fruit ripens in October. The fruit is small, pear-shaped or round, with a sour taste and edible. Highly tolerant to drought, heat, and cold.
5. **Regel Pear or Bear Pear – (*Pyrus regelii*) -** Tree/shrub height: 2.5–6 meters. The fruit is pear-shaped, small, and soft with a thick, bluish-yellow skin. The taste is bitter and sour; the seeds are very large. It becomes edible after long storage. This wild pear is highly resistant to drought and cold. Thrives well in rocky areas.

In nature, a natural hybrid of this wild pear and the Korzhinsky wild pear - called the Bukhara pear — is often found. It produces root suckers.

6. **Pyrus bucharica Litw. -** Grows well in saline soils and areas with surface-level groundwater. Its flowers produce abundant nectar, attracting many bees. It is resistant to cold and heat.

Apricot – Armeniaca Mill (Wild Apricot). - *Armeniaca vulgaris* – resistant to drought, scorching heat, and cold. It is distributed in wild form in mountainous and foothill regions. It can grow up to 15 meters in height. The fruits are small, with a bitter pit. Occasionally, there are varieties with large fruits and sweet pits. It grows vigorously, enters fruiting early, and has a long lifespan. The plant is demanding on soil moisture when the flower buds appear.

***F. Kostin* categorizes cultivated apricots into four groups:** Iran-Caucasus, Central Asia, Europe, and Jungar. These groups include nearly 300 varieties. The representatives of each group ripen at different times. Regarding yield, sugar content, flavor, and fruit coloration, the Central Asian group is considered the best. The representatives of the Central Asian group are further divided into three smaller groups: Fergana, Zarafshan, and Khorezm. The Fergana group representatives are used for processing and making dried fruit. The Zarafshan group representatives are universal, but have low sugar content. The Khorezm group is used for fresh consumption, highly resistant to cold, and grows well in saline soils.

Geographical Distribution of Wild Fruit Species Growing in Uzbekistan

No.	Fruit Species	Geographical Distribution of Wild Species
1.	Pyrus (P. communis)	Tashkent region, Bostanliq district; Namangan region, Koson district
2.	P. agial	Tashkent region, Bostanliq district
3.	P. turomonica	Republic of Karakalpakstan, Khorezm region, Bukhara region, Hisar mountains
4.	P. Porshinskyis	Tashkent region, Kashkadarya, Surkhandarya, Navoi regions
5.	P. Regelin	Kashkadarya, Surkhandarya regions
6.	P. ceracifera	Tashkent, Samarkand, Kashkadarya, Surkhandarya, Namangan regions
7.	P. spinoza	Samarkand, Tashkent, Namangan regions
8.	P. domestica	Namangan region
9.	Cerasus (Cer. vulgaris)	Samarkand region
10.	Diospyros lotus (D. var. Caucasica)	Surkhandarya region
11.	Ficus corica L.	Surkhandarya region
12.	Punica drapatit var. silvestria	Surkhandarya region
13.	Juglans Neaia	Namangan, Samarkand, Tashkent, Surkhandarya, Kashkadarya regions
14.	Pistacia L (P. Vera L)	Namangan, Samarkand, Tashkent, Surkhandarya, Kashkadarya regions
15.	Amudalus spinosissima Ved., A. Pulunnikowii Litw, A. Bucharica Bge	Surkhandarya, Kashkadarya, Samarkand, Navoi, Nurota mountains

The Fergana small group representatives, such as Isfarak, Kandak, Kursadik, and Sulkhani, produce high-quality dried fruit that has significant export value.

Plum (Prunus Mill.)

Plum – (Prunus ceracifera Ehrh) – a tree or shrub with thorns, producing many root suckers. The fruit is small, yellow, red, or black, with thin skin. There are many forms that are resistant to drought, cold, and thrive in mountainous areas. It flowers early and starts fruiting 2-3 years after planting. Plum and peach are considered the best rootstocks for grafting.

Tern (Prunus spinosa Z.) – Resistant to drought and cold, light-loving, highly productive, and a thorny shrub. The fruits are small, dark purple to black, and coated with a waxy bloom. It is used as a rootstock for peach, apricot, and plum, making them more resistant to cold, drought, and heat.



Domestic Plum (Prunus domestica L.) - Wild forms of *Prunus domestica* grow in the high mountains of Kyrgyzstan and Uzbekistan, particularly in the Namangan region. It grows in tree-like, shrub, or semi-shrub forms in mountainous and foothill areas. There are two forms: thorny and thornless. It is propagated by root suckers. This plant is resistant to cold, drought, heat, and salt. The fruit weighs 30-35g. It fruits very early. Its root system is very strong and grows close to the surface. Locally, it is known as "qora gayloni" (black gailon).

Qora g'ayloni (Wild Plum) – The fruits are processed and dried. The dried fruits are exported to the global market, with this fruit constituting 90% of dried apricot exports.

Sour Cherry and Cherry (Cerasus L.) - *Magelobka (Cerasus magleba Mill.)* – A tree or shrub with a very strong root system that does not produce root suckers. The fruits are small, red-black, sour, and unsuitable for consumption. It is very resistant to heat, drought, and cold. Used as rootstock for cherries and sour cherries.

Sour Cherry (Cerasus vulgaris Mill.) – A natural semi-dwarf shrub that produces many root suckers. Its fruits are red or sometimes black, and the pit is difficult to separate from the fruit. The taste is sour and pleasant. Its roots develop strongly. The plant is resistant to drought, heat, cold, and salinity. Its dried fruits are of export significance, while the fresh fruits are used in the processing industry (for making compote, juice, and jam).

V. Gujumchiya (Cerasus verrucoda Franch.) – A low-growing shrub that flowers in May. Its fruits are small, oval-shaped, with a strong ribbed pit. It grows in rocky areas and is resistant to drought, heat, cold, diseases, and pests. It is not commonly used as a rootstock for cherries and sour cherries. The fruit is consumed by locals both dried and fresh.

Persimmon (Diospyros lotus) – Grown in subtropical regions of our country where winters are not extremely cold.

Wild Persimmon (Diospyros lotus var. Caucasica) – Known locally as *sapsan*, this variety grows wild in the subtropical climate of Surxandaryo region. It flowers in May and ripens in November. The fruits are small and have a slightly bitter taste. It is resistant to dry climates and heat. Wild persimmon is used as rootstock for persimmon cultivation.

Diospyros lotus var. – Wild persimmons of this type grow in the southern regions of Fergana. The fruits are small and have a dry, bitter taste. It is resistant to dry climates and heat. Wild persimmon is used as rootstock for persimmon cultivation.

Fig (Ficus L.) – *Ficus corica L.* Cultivated figs are grown extensively. The wild form grows in subtropical climates (Surxandaryo) at altitudes ranging from 900 to 1800 meters above sea level. This species is resistant to drought, diseases, and pests, with medium cold resistance. It is recommended as a genetic material for developing new varieties.



Pomegranate (Punica granatum) – *Wild Pomegranate (Punica granatum var. silvestria)* grows in all districts of Uzbekistan. It thrives in the subtropical regions of the country, particularly at altitudes of 1000-1300 meters above sea level. This species is resistant to drought and heat and is recommended for use as genetic material for breeding new varieties.

Thin-skinned Pomegranate

Walnut (Juglans Neaia). The wild forms of this species are found in natural walnut forests. Its fruits are small, with the husk tightly attached to the nut. It is drought-resistant and moderately resistant to cold. In Uzbekistan, many cultivated varieties and forms of walnut grow in the mountainous, foothill regions and plains.

Pistachio (Pistacia Vera L.) - The true pistachio (P.Vera L.) is a tree or shrub. It is cultivated in Uzbekistan, and there are pistachio orchards that are over 300 years old. The wild forms of the cultivated pistachio are found in the mountainous, foothill, and steppe regions. It is resistant to drought, cold (-33°C), dry climates, and high temperatures (+42°C). The fruits are small and do not open when ripe. It is widely consumed and has a very pleasant taste.

Almond (Amygdalus communis)

Bitter Almond (Amygdalus spinosissima Ved.) A shrub with a thorny, spiny stem. The fruits are oval-shaped, small, and covered with fine hairs. The kernel is bitter and inedible. It is resistant to drought, cold, and dry climates. It is used as a rootstock for peach and sweet almond varieties.



Pitunkov Almond (P. Pulunnikowii Litw.) - A shrub, 1-1.5 meters tall. The kernel contains up to 52% oil. Its branches are spiny, and the fruit is small and inedible.

Bukhara Almond (A. bucharica Bge) - A shrub with small, oval-shaped fruits containing up to 62% oil. It is resistant to drought, cold, and dry climates. Its fruits contain 62% oil. It is used as a rootstock for sweet almonds, apricots, and plums. It is of great importance in stone fruit cultivation.

Grapevine (Vitis Sativa)

Wild Grapevine (V. Venifera L.) This species grows in subtropical climates and in the foothill regions of our area. Numerous local varieties have been developed through selective breeding. The wild grapevine is valued for its resistance to drought, heat, diseases, and pests.

Among the local varieties that are resistant to heat and drought are Bahtiyori, Bishti, Jabbor Qora, Qizil Salak, Oq Kishmish, Qora Kishmish, Nimrang, Safedak, Sohibi, Sultoni, and Charoslar, which are cultivated for vine production.

Wild Grapevine (Vitis Venifera L.)

Through selective breeding of wild forms over the years, various valuable horticultural characteristics have been developed. For example, 7 varieties of apples, 6 varieties of pears, 17 varieties of apricots, 4 varieties of walnuts, 2 varieties of peaches, 2 varieties of plums, 3 varieties of cherries and sour cherries, 2 varieties of figs, 2 varieties of almonds, 8 varieties of quinces, 5 varieties of pomegranates, and 2 varieties of peaches have been adapted to the diverse climatic conditions of our Republic.

CONCLUSION

In the context of global climate change, maintaining the genofund of wild fruit plants that are resistant to heat, drought, cold, and soil salinization is of significant importance for both nature and future generations.

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