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THE DIFFERENCE OF SAMPLES OF *ZIZYPHUS JUJUBA* MILL., 1768 IN THE COLLECTION OF THE KHOROL BOTANICAL GARDEN

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Among the population of the forest-steppe zone of Ukraine, there is an increased interest in the growing of subtropical fruit plants, in particular, the Zizyphus jujuba Mill. For the gradual introduction of a new fruit plant into the culture, there is foremost a need to create a gene pool environment of the species involving methods of introduction and selection. A significant role in solving this problem is given to botanical gardens. They are the ones to introduce and select plants. One of the main directions of scientific research of the Khorol Botanical Garden is the introduction of subtropical fruit crops in the forest-steppe of Ukraine, where the collection of Z. jujuba plants was selected. It consists of 50 plants. They are 11 years old and have the life-form of a tree. Plants are planted in two rows, 4 meters apart, and with a 2 meters distance among plants on each row. The shape of the trees is improved by pruning and forming their trunks and crowns. Three-year hybrid seedlings of Z. jujuba were taken as planting material of the collection. The local middle-fruited specimen created as a result of several reproductive cycles was used as the source for winter hardiness. Hybrid seeds were harvested from it. Samples of large fruits were also used, but with defective seeds that definitely need protection from frost in the winter conditions of the forest-steppe of Ukraine. Valuable Z. jujuba genotypes such as Ta-Yang-Tsao and of the Vakhshsky varieties were used as hybrids as the source of large fruits. They were introduced by the transfer of vegetative material in the form of cuttings. The study on the difference of Z. jujuba samples was conducted after the morphological description of the collection during 2019–2021. The sample was considered excellent in the case of distinguishing it from others by the method of comparing the descriptions of the samples. The research revealed valuable genotypes, namely 11 samples different from those available in the collection. Among them, the most important elements of the novelty of the samples are namely short stature, small amount or absence of thorns, the size of the fruiting shoot, size of the leaf blade, size of the fruit, shape of the fruit, fruit weight, and the fruit's juiciness. The Natural and climatic conditions of the forest-steppe of Ukraine contribute to the cultivation of selected samples. These samples are also characterized by high vegetation productivity and fruiting.

Key words: *Zizyphus jujuba, forest-steppe of Ukraine, collection, sample, difference.*

ВІДМІННІСТЬ ЗРАЗКІВ *ZIZYPHUS JUJUBA* MILL., 1768 У КОЛЕКЦІЇ ХОРОЛЬСЬКОГО БОТАНІЧНОГО САДУ

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Серед населення лісостепової зони України зростає зацікавленість у вирощуванні субтропічних плодових рослин, зокрема, Zizyphus jujuba Mill. Для поступового введення в культуру нової плодової рослини виникає необхідність у створенні середовища генофонду виду із залученням методів інтродукції та селекції. Значна роль у розв'язанні цієї проблеми відведена ботанічним садам. Вони якраз і проводять інтродукцію та селекцію рослин. Одним з основних напрямків наукових досліджень Хорольського ботанічного саду є інтродукція субтропічних плодових культур в Лісостеп України. Виокремлено колекцію рослин Z. jujuba, що презентована 50 рослинами. Вони є віком 11 років та мають життєву форму дерева. Рослини висаджено у два ряди з кроком у ряду 2 м і на відстані між рядами 4 м. Форми дерев поліпшено шляхом обрізки та формування штамбу і крони. За посадковий матеріал колекції взято трирічні гібридні сіянці Z. jujuba. У якості джерела зимостійкості використали місцевий середньоплідний зразок, створений у результаті кількох репродуктивних циклів. З нього й заготовляли гібридне насіння. Також використовували зразки з крупними плодами, але з неповноцінним насінням, яке в умовах Лісостепу України неодмінно потребує захисту у зимовий період від морозів. У якості джерела крупноплідності до гібридизації залучали такі цінні генотипи Z. jujuba як сорти Та-Ян-Цзао та Вахшський. Вони інтродуковані перенесенням вегетаційного матеріалу у вигляді живців. Дослідження на відмінність зразків Z. jujuba проведено після морфологічного опису колекції упродовж 2019–2021 років. Зразок відносили до відмінного у випадку вирізнення його з-поміж інших методом порівняння описів зразків. У процесі досліджень виявлено цінні генотипи, а саме 11 зразків відмінних з-поміж наявних у колекції. Серед них найважливішими елементами новизни є низькорослість, мала кількість або відсутність колючок, величина плодоносного пагона, величина листкової пластинки, розміри плоду, основна форма плоду, маса плоду, соковитість плоду. Природньо-кліматичні умови Лісостепу України визначено як ті, що сприяють культивуванню відібраних зразків. Вони характеризуються також високою вегетативною продуктивністю та плодоношенням.

Ключові слова: *Zizyphus jujuba, Лісостеп України, колекція, зразок, відмінність.*

Introduction

In conditions when the number of days with low temperatures in the autumn-winter period is decreasing, the population of the forest-steppe zone of Ukraine has an increased interest in the growing subtropical fruit crops. *Zizyphus jujuba* Mill is known among such cultures. This is due to the fact that *Z. jujuba* plants have high drought resistance, are resistant to viral and fungal diseases, bacteriosis, cancer, and are not damaged by insects. Therefore, they do not require protection with special chemicals for the garden. Jujube is highly esteemed for its nutritional value.

The Bible says of such plants: "The fruit thereof shall be for meat, and the leaf thereof for medicine" [1]. Moldovan scholars note that jujube has been “successfully introduced into the culture in Stavropol, Moldova, and Ukraine. In terms of the complex of biologically active components, it is unique among fruit plants cultivated in Asian and European countries. Jujube fruits in the fresh and processed form are used in the treatment of vitamin deficiency, cirrhosis of the liver and kidney stones" [2]. They are superior to other fruit crops in terms of dry matter content and have a rich chemical composition. *Z. jujuba* has long been known for its healing properties. Eating its fruits lowers blood pressure, strengthens blood vessels, accelerates the recovery of the body after severe illness [3–8].

Margarita and Oleksandr Karnatovsky suggest "the use of jujube in green building because it has original beautiful crowns, leaves and brightly colored fruits. Moreover, jujube is decorative throughout the growing season" [9].

For the gradual introduction of a new fruit plant into the culture, there is a need to create and further form in the changed natural and climatic conditions of the gene pool of the species with the involvement of methods of introduction and selection [10, 11]. A significant role in solving this problem is given to

botanical gardens, that conduct the introduction and selection of plants. This is of great environmental, scientific and economic importance [12].

One of the main directions of scientific research of the Khorol Botanical Garden is the introduction of subtropical fruit crops in the forest-steppe of Ukraine. In 2014, a significant collection of *Z. jujuba* from introduced highly adaptive specimens of the species was established on the territory of the garden in the scientific zone [13]. The collection of *Z. jujuba* specimens is maintained in a viable condition by the staff of the institution and is preserved as a local population hybrid fund of the species [14–17]. This collection is located on the northern border of the cultural range of the species. It is a valuable genetic material for selection for winter hardiness and other economic indicators [18, 19].

The aim of the research was to characterize the Z. jujuba specimens available in the collection for difference and to identify promising specimens for distribution in the forest-steppe of Ukraine.

Materials and methods of research

The research material is a species *Z. jujuba.* This is a branchy thorny bush or small tree up to 3–8 m tall with angularly tortuous bare, reddish-brown branches. At the corners of the branches there are paired strong and sharp thorns up to 3 cm long and thin, straight, greenish, two-row leafy shoots, resembling a complex pinnate leaf. Leaves are leathery, glabrous, dark green on the top, shiny, oblique, their form varies from oblong-ovate to broadly lanceolate. Side parts are obtuse, rounded or weakly heart-shaped at the base, obtuse- and fine-toothed, on short petioles or almost sessile with small stipules at the base. Flowers are stellate, small (3–4 mm in diameter), greenish, in dense globular inflorescences on very short peduncles. Fruits – drupes, are spherical, oblong, pear-shaped or barrel-shaped, reddish-brown, and shiny, usually with one stone. Flesh is floury, chubby, in some samples – juicy. Depending on the sample, *Z. jujuba* plants have their own parameters according to the average fruit weight and are conventionally divided into small-fruited, medium- and large-fruited with a fruit weight of 5 g, 5 to 10 g and more than 10 g, respectively [20].

The plant collection of *Z. jujuba* in the Khorol Botanical Garden is presented by 50 plants aged 11 years. They have the life-form of a tree. Plants are planted in two rows, 4 meters apart, and with a 2 meters distance among plants on each row. The shape of trees is improved by pruning and forming the trunk and crown.

Three-year hybrid seedlings of *Z. jujub*a were used as planting material of the collection, where the local medium-fruited specimen was used as a source of winter hardiness. It is created as a result of several reproductive cycles. Hybrid seeds were harvested from it. We also used samples with large fruits, but defective seeds, which in the conditions of the forest-steppe of Ukraine definitely need protection in winter from severe frosts. Valuable *Z. jujuba* genotypes such as Ta-Yang-Tsao and Vakhshsky varieties were used as hybrids as a source of large fruits. They are introduced by the transfer of vegetation material in the form of cuttings [19, 21].

Seedlings planted in 2014 in the process of growth and development showed a significant splitting of parental forms with the formation of new first-generation hybrids with valuable morphological and ecological features.

A sample of the gene pool of a species (culture) is the lowest unit of the collection of plant gene pool samples that can be reproduced in genetic integrity. In the case of fruit crops, the sample may be plants or parts thereof, in particular cuttings. A specimen meets the condition of difference if it is clearly different from any other specimen in the collection.

Studies on the difference between Z. jujuba specimens were performed after the morphological description of available specimens of the collection during 2019–2021. The sample was considered different in the case of distinguishing it from others by the method of comparing the descriptions of the samples [22, 23, 24].

Research results and their discussion

Z. jujuba is a suitable object of introduction and selection due to such bioecological properties of the plant as high fertility, annual flowering and fruiting. *Z. jujuba* prototypes of the Khorol Botanical Garden during the growing season have time to go through all its inherent phases of development and prepare for the transition to a state of rest.

In the process of research of hybrid specimens of *Z. jujuba* of the Khorol Botanical Garden, valuable genotypes were identified, namely 11 specimens that are different from those available in the collection (Table 1, 2).

1. Biometric difference of selected samples of jujube (parameters of leaves, fruits, seeds are averaged)

№ s / n	Indicator		Samples (number)				
			4–5–3	4–5–5	4–5–6	4–5–8	4–5–9
1.	Height of plants, cm		140	205	210	195	200
2.	The power of tree growth		average height	vigorous	vigorous	average height	average height
3.	Vegetation period, days		205	205	205	204	200
4.	The number of thorns on annual growth, pcs.		16	2	6	-	7
5.	Annual shoot in length, cm		35.0	55.0	71.0	37.0	82.0
6.	Annual shoot in thickness, cm		0.7	0.7	0.6	0.7	1.0
7.	One-year shoot. Internodes in length, cm		5.0	9.0	8.0	6.3	9.5
8.	Fruiting shoot in length, cm		18.0	15.5	19.5	18.0	24.8
9.	Leaf blade, cm	length	4.5	5.3	5.0	5.0	4.5
		width	2.5	2.6	2.6	2.2	2.4
10.	Shape of the leaf blade		egg-like	egg-like	egg-like	egg-like	egg-like
11.	Petiole in length, cm		0.3	0.5	0.4	0.6	0.6
12.	Size of the fruit, cm	diameter	1.7	2.1	2.2	2.4	2.2
		length	2.9	3.4	2.9	2.7	2.4
13.	The main shape of the fruit (side view)		narrowly elliptica	elliptical	elliptical	round	round
14.	The shape of the top of the fruit in the longitudinal section		obtuse	round	round	round	round
15.	Fruit weight, g		5.0	8.5	6.7	8.4	5.6
16.	The color of the fruit flesh		white and green	white and green	white and green	white and green	white and green
17.	The consistency of the fruit flesh		soft	moderately hard	moderately hard	moderately hard	moderately hard
18.	The juiciness of the fruit		high	average	average	average	average
19.	Bone size, cm	length	2.3	2.3	2.0	2.1	1.9
		width	0.7	0.6	0.6	1.0	0.7
20.	Bone shape		narrowly elliptical	narrowly elliptical	narrowly elliptical	broadly elliptical	narrowly elliptical
21.	Bone mass, g		0.4	0.4	0.4	0.6	0.4
22.	Time of fruit maturity		average	average	average	average	average

2. Biometric difference of selected samples of jujube (parameters of leaves, fruits, seeds are averaged)

№ s / n	Samples (number)					
	Khorol large-fruited	4–5–15	4–5–17	5–5–5	5–5–15	5–5– 17
1.	235	155	148	144	160	182
2.	vigorous	small stature	small stature	small stature	small stature	average height
3.	215	202	205	200	200	200
4.	9	2	5	6	5	6
5.	84.0	42.0	44.0	24.0	47.0	59.0
6.	1.1	0.7	0.7	0.5	0.6	0.7
7.	5.5	4.3	5.2	3.7	6.2	6.5
8.	16.0	18.0	13.4	16.5	17.0	16.0
9.	6.6	4.9	4.9	4.1	4.7	4.5
	3.3	2.2	2.0	2.1	2.2	1.9
10.	egg-like	egg-like	egg-like	egg-like	egg-like	egg-like
11.	0.9	0.5	0.5	0.3	0.4	0.5

12.	3.0	2.6	2.4	2.0	2.4	2.5
	3.9	2.8	2.8	2.8	3.0	3.0
13.	pear-shaped	round	round	elliptical	elliptical	round
14.	round	round	round	round	round	notched
15.	14.0	10.1	8.2	6.2	8.6	9.6
16.	white-green	white-green	white- green	white-green	white-green	white-green
17.	moderately hard	moderately hard	moderately hard	moderately hard	moderately hard	moderately hard
18.	average	average	average	average	average	average
19.	2.3	2.0	1.9	2.0	2.0	1.9
	0.9	0.8	0.7	0.7	0.8	0.8
20.	narrowly elliptical	narrowly elliptical	narrowly elliptical	narrowly elliptical	narrowly elliptical	narrowly elliptical
21	0.6	0.5	0.4	0.3	0.3	0.5
22.	late	average	average	average	average	average

The most important elements of the novelty of the samples:

- short stature: 4–5–17;
- small number or absence of thorns: 4–5–5, 4–5–8, 4–5–15;
- size of the fruiting shoot: 4–5–9;
- size of the leaf blade: Khorol large-fruited;
- fruit sizes: 4–5–5, Khorol large-fruited, 5–5–15, 5–5–17;
- main form of fruit: Khorol large-fruited;
- fruit weight: 4–5–5, Khorol large-fruited, 4–5–15, 5–5–17;
- fruit juiciness: 4-5-3.

Conclusions

The main method of selection of *Z. jujuba* in the Khorol Botanical Garden is selection and hybridization. The criterion for their evaluation for the difference was the biometric description of plants. Among 50 documented samples of *Z. jujuba*, 11 were identified, which are characterized by a number of biometric indicators and, in our opinion, are suitable for distribution. The selected samples are economically valuable material for further selection and orcharding of the forest-steppe zone of Ukraine. The natural and climatic conditions of the forest-steppe of Ukraine contribute to the cultivation of selected samples on distinctive grounds, because they are characterized by high vegetative productivity and fruiting. The spread of the species in the forest-steppe zone of Ukraine, as well as the use of *Z. jujuba* fruits will make it possible to supplement the diet of the population with valuable biologically active substances.

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