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Assessment of the perspectivity of introduction of woody plants in the arid conditions of Mangystau

The introductory study and identification of promising and sustainable taxa of woody plants is important for green construction and ornamental gardening of Kazakhstan. It is important to choose sustainable crops for arid conditions characterized by extreme conditions and deficient woody plants of local flora. This article presents data on the study of the rhythms of seasonal growth and plant development. There are differences that are expressed in changing the timing of the onset of vegetation (5–10 days), flowering and fruiting (15–20 days) and reducing their duration. In the arid conditions of Mangyshlak, according to the vegetation dates, there was an increase in plant prospects for phenogroups from PP (previously the beginning and earlier the end of vegetation) to PII (previously the beginning and later the end of vegetation), a decline in CP (the middle beginning and earlier the end of vegetation) and an increase in CC (the middle beginning and the middle end of vegetation). From the 183 introduced plants 52 taxa belong to the first perspective group (high), 95 taxa — to the second group (elevated), 34 taxa — to the third (medium) and 2 taxa — to the fourth (low) of the selected 6 pheno groups. These data indicate the success of the introduction and the prospects for their further use. An electronic database on collectible woody plants is being formed on the computer program «DInCeR,» developed by the Mangyshlak Experimental Botanical Garden.

Keywords: Mangystau, arid conditions, introduction, woody plants, phenology, growth and development, perspectivity.

Introduction

The success of the introduction process depends on the correct combination of the biological characteristics of woody plants with the ecological, climatic conditions of the introduction area. In the arid conditions of Mangystau, the introduction of plants depends on a whole complex of factors: winter resistance, drought resistance, heat resistance, salt resistance, etc. [1].

The main limiting factor is the strong continental climate. According to long-term data on the climatic characteristics of Mangystau, winter is short-term, characterized by unstable snow cover and frequent thaws, but rarely cold winters. Unstable snow cover in cold winters leads to deep freezing of the soil. The average temperature of the coldest month January varies from –3 to –10 °C. In some years, sharp deviations from the norm are observed. There were cases when in January the temperature decreased until –26...–31 °C. Winter Period on Mangyshlak is the windiest period. Often, the absolute wind speed exceeds 15–20 m/s.

The very severe conditions are carried out by introduced plants in the summer. The summer months are dry and stably hot with the large amplitude of fluctuation in daily temperatures. Absolute maximum is +40–45 °C, when heating the soil to +60–70 °C. Days without sun are practically absent. The evaporability of moisture exceeds the amount of precipitation by 10–15 times, dry winds are not uncommon, with a wind speed of 15–16 m/s. The average annual air temperature is +9.6–11.5 °C, the absolute minimum is +34 °C, maximum is until +47 °C. Annual falls are 107–181 mm. There are frequent strong winds, which lead to the spread of dry winds, dust storms, and the removal of salts from the Caspian.

The soils of the territory are zonal brown, from weakly alkaline to neutral, characterized by chloride-sulfate salinization and underdeveloped profile. At a depth of up to 7–8 m, there is bedrock in the form of Sarmatian limestone, which serves as a water stop and has large cup-shaped closed depressions filled with loose rocks — a gravel mixture and a shell. Soils are poor in humus, nitrogen and phosphorus.

This brief information on some indicators of the natural conditions of Mangystau gives an idea of the main tasks facing scientific botanists, for the correct organization of the introductory process. Woody plants should have hereditary deep winter rest, have reliable cover tissues that protect them from winter drying and summer burns. They should finish growing early and retire with well-matured wood. Plants need to have high physiological frost resistance, since the absence of snow cover leads to freezing of root systems [2]. No less stringent plant conditions are encountered during the growing season. High summer temperatures and

wind conditions require intensive watering. Planting is carried out in specially prepared dug pits, beds and checks with application of soil 40–50 t/ha of organic fertilizers and sawdust.

The aim of the study is to study the features of growth and development to identify the most promising woody plants in the area of introduction in the arid conditions of Mangystau.

Methodology

Objects of investigation were 169 species of deciduous woody plants belonging to 61 genera: *Acer* — 6, *Ailanthus* — 1, *Amygdalus* — 1, *Amorpha* — 2, *Armeniaca* — 1, *Amelanchier* — 1, *Berberis* — 14, *Celtis* — 1, *Catalpa* — 2, *Caragana* — 3, *Cerasus* — 2, *Cersis* — 1, *Cladrastis* — 1, *Cotoneaster* — 8, *Cornus* — 3, *Colutea* — 1, *Crataegus* — 14, *Cydonia* — 1, *Elaeagnus* — 2, *Euonymus* — 4, *Lonicera* — 8, *Ligustrum* — 2, *Juglans* — 2, *Forestiera* — 1, *Forsythia* — 1, *Fontanesia* — 1, *Fraxinus* — 4, *Gleditsia* — 3, *Gymnocladus* — 1, *Koelreuteria* — 1, *Haloxylon* — 2, *Halimodendron* — 1, *Hemiptella* — 1, *Maclura* — 2, *Malus* — 10, *Mahonia* — 2, *Morus* — 1, *Mespilus* — 1, *Nitraria* — 1, *Pallurus* — 1, *Padus* — 5, *Platanus* — 1, *Populus* — 3, *Ptelea* — 1, *Physocarpus* — 2, *Philadelphus* — 2, *Pyrus* — 5, *Prunus* — 1, *Salix* — 3, *Sambucus* — 1, *Sorbus* — 1, *Quercus* — 2, *Rhamnus* — 4, *Rosa* — 6, *Robinia* — 1, *Rhus* — 3, *Tilia* — 2, *Sophora* — 1, *Spiraea* — 1, *Symphoricarpos* — 4, *Viburnum* — 3, *Zanthoxylum* — 1, *Ulmus* — 1, attracted for introduction in period 1990–2000. Long-term observation makes it possible to identify the most promising species in the introduction of arid conditions of Mangystau.

To compare and assess the prospects for the ranges, 65 species of North American, 56 species of the Central Asian, 62 species of the Eastern Asian floristic regions, mainly reaching the age of flowering and fruiting, were subjected.

The study of the rhythms of seasonal plant development and the prospects of introduced plants was carried out according to the phenological observation technique developed for botanical gardens [3]. Assessment of drought resistance was carried out on the scale of S.C. Pyatnitsky [4]. Winter resistance was determined visually on a 7-point scale [5]. Most attention was paid to the study of the phases of flowering and fruiting, as the main factor of decorativeness. The height and growth of plants were also taken into account.

To assess viability and perspective, the scale compiled by P.I. Lapin and S.V. Sidneva [5], supplemented by M.N. Kosaev [6], was applied. This scale includes 7 main indicators, which are determined by systematic visual observations of general and seasonal plant development. The following features were taken into account: the degree of annual ripening of shoots, winter resistance, drought resistance, preservation of habitus, self-educational ability, regular growth of shoots, ability for generative development and available methods of propagation of tested plants in the area of introduction [5, 6].

Based on the analysis of the indicators and the sum of the points, the studied plants were divided into the following perspective groups: 1) Quite promising plants (the sum of points 106–115), although they are not in their ecological optimum, usually reach their characteristic size, flower and bear fruit normally, form high-quality seeds, winter stamens, drought-resistant only in unfavorable years they can have freezing annual shoots or short-term loss of turgor leaves. 2) Perspective group (sum of points 91–105). It includes plants that mostly do not reach their inherent size, bear fruit and form germinating seeds. Usually they freeze slightly, in drought the leaves can lose turgor, which is restored during watering. 3) Less promising plants (the sum of points 76–90) are characterized by slow growth, poor fruiting; often with low seed viability, mostly systematically suffer from frost or drought. 4) Low-potential plants (the sum of points 56–75) are characterized by depressed growth, do not bear fruit or bear fruit only in favorable years, as a rule, significant winter injuries or mass burns of leaves and drying of shoots in dry periods are observed.

Results and discussion

Analysis of results of adaptation capabilities of woody plants is used for objective introductive prediction and theoretical developments related to adaptation of plants in new conditions and subsequent selection of promising assortment of woody plants [7].

According to the results of many years of introduction experience, on Mangyshlak, the natural range of introduced species mainly falls on North America (65 species from 17 families and 29 genera), Central Asia (56 species from 17 families and 29 genera) and Eastern Asia (62 species from 15 families and 24 genera).

Theoretically and on the basis of the experience of plant introduction on Mangyshlak, the prospect of attracted species from North America, Central and Southern Asia that showed the best adaptation capabilities was justified, having successfully passed the introduction.

The flora of the Atlantic North American region is rich in species promising for introduction to Europe and Asia, as confirmed by the experience of the introducers [8]. Botanists have long drawn attention to the amazing similarity of the flora of Atlantic North America with that of East Asia. This similarity of flora and their connections are expressed in the presence of a large number of common genera and close species. From the flora of Atlantic North America (Appalachian province), representatives of the genera *Mahonia* L., *Maclura* Nutt., *Celtis* L. have been successfully introduced on Mangyshlak. Species such as *Robinia pseudoacacia*, *Gleditsia tricanthos*, *Maclura aurantifolia* from the North American provinces on Mangyshlak, species of the genus *Amorpha* L. were successfully introduced.

The flora of the Central Asia developed as xerophilic [9]. However, at the end of the Pliocene and in the Quaternary, as a result of mountain formation and glaciation, conditions were created for the penetration of mesophilic-type woody plants from Siberia, the Caucasus, northern Iran and the Himalayas. These sources served as the basis for the formation of the flora of the Small and Central Asia. Therefore, the flora includes autochthonous and alien species [10]. Under the influence of arid conditions in the Central Asia, mesophilic plants were transformed into xeromesophytes.

The Eastern Asian flora was formed at fairly high temperatures, with strong daily and seasonal fluctuations, a very low and high degree of humidification, and moderate vegetation duration. Here the center of development of cultivated plants is formed. Many researchers consider the Eastern Asia to be the center of ancient agriculture for cultivated plants, including the primary center for the formation of forms of fruit crops of *Rosaceae* family, genera *Malus*, *Pyrus* and *Prunus*, which go far beyond the centers of origin [11–13]. It was established that the conditions, in which the evolution of plants, took place impose requirements for the conditions for its growth. This is the length of the day, temperature, vegetation duration and humidity. The approach to the introduction of plants in desert areas depends on a set of agricultural measures that allow creating the closest possible conditions of the place of introduction to the conditions of the homeland of the plant (humidification, changing the physical and chemical composition of soils, etc.). When introducing plants outside their natural range, the study of their rhythms of seasonal growth and development is of great importance [14, 15].

From 183 taxa introduced under Mangyshlak conditions, 173 taxa (94.2 %) entered the generative phase. Among the life forms there are: 90 species of trees, 93 species of shrubs; among them the North-American — 37 trees and 28 shrubs; the Central Asian — 20 trees and 36 shrubs; the Eastern Asian — 33 trees and 29 shrubs.

Based on the results of phenological observations, it was established (Tab. 1), that swelling and unfolding of buds in early-vegetating Central Asian species (*Populus alba*, *P. bolleana*, *Salix alba*) and Eastern Asian species (*Lonicera maackii*, *L. edulis*, *L. ruprechtiana*, *Padus davurica*, *Ligustrum tshonoskii*, *L. japonicum*) noted in the II-III decades of February, and for many species — in the I-II-III decades of March, except for the Northern American taxa *Zanthoxylum simulans*, *Mahonia aguifolium*, *Cladrastis lutea*, *Juglans cinerea*, *J. nigra*, *Ptelea serrate*, *Philadelphus hirsutus*, *Ph. lewisii*, *Fraxinus lanceolata*, *Amorpha fruticosa*, *A. schafranifolia*, *Crataegus rus-galli*, *Cr. kellermanii*, *Cr. lanuginosae*, *Gleditsia aquatica*, *G. triacanthos*, *Robinia pseudoacacia*, *Gymnocladus dioecus*, *Cercis canadensis*, *Celtis occidentalis*, *Forestiera neo-mexicana*, *Platanus occidentalis*, 3 species of *Crataegus*, 2 species of *Catalpa*, *Gleditsia* and *Maclura*.

The latest beginning of vegetation was noted in the first decade of April for Asian species from the genus *Pyrus*, *Crataegus*, *Fraxinus*. Species from the genera *Lonicera* L., *Fraxinus* L., *Acer* L. bloom very early. All species of *Lonicera* L., *Crataegus* L., *Berberis* L., *Cotoneaster* Medik., *Cotinus* Scop., *Caragana* L. are flowering abundantly.

Early ripening of fruits and abundant fruiting are noted all introduced plants from genus *Lonicera*. Late bloom is noted for *Koelreuteria apiculata*, *Koelreuteria bipinnata* and species of genus *Catalpa* Scop.; the latest ripening of fruits is observed for *Mespilus germanica*, *Zanthoxylum simulans*. With the onset of summer heat (end of June — beginning of July), leaves in *Acer* species (*Acer sachharum*, *Acer negundo*) and all species of *Catalpa* are burned; leaves of *Corylus avellana* are also suffer from dry air.

But, with the advent of more favorable conditions (a decline in high temperature), almost all species have young leaves, and some introducents have a secondary growth of shoots (*Quercus robur*, *Sambucus canadensis*, *Caraganda arborescens*). From mid-April, the growth of shoots of all collectible species begins, intensive growth has been observed since the third decade of April, and at the end of May — in early June, the growth of shoots in some species stops (representatives of families: *Rosaceae* and *Fagaceae*) [16].

Table 1

Comparative characteristics of the North-American, Central-Asian and Eastern-Asian introduced plants by phonological groups and perspective in the conditions of Mangyshlak

Pheno- group	Name of plant	Average height of shoots, cm	4		5		6		7	8		9	10	11	Group of perspective
			Average period of beginning and ending of flowering	Duration, days	Average period of beginning and ending of fruiting	Duration, days	Average period of beginning and ending of vegetation	Duration, days		Winter resistant	Drought resistant				
1	2	3	4	5	6	7	8	9	10	11	12				
The Northern America															
PP	<i>Acer negundo</i> L.	25, 298	31.03.-19.04.	19	10.09.-30.09.	20	28.03.-26.10.	213	I	II	II-105				
	<i>Crataegus rivularis</i> Nutt.	27, 155	23.04.-14.05.	21	30.07.-11.08.	12	20.03.-22.10.	216	I	III	I-115				
	<i>Padus serotina</i> (Ehrh) Agardh.	13, 169	11.05.-20.05.	9	25.07.-09.08.	15	21.03.-25.10.	218	I-II	II-III	III-90				
	<i>Padus virginiana</i> (L.) Mill.	12, 210	03.05.-13.05.	10	12.07.-24.07.	12	23.03.-27.10.	218	I-II	III	III-90				
	<i>Quercus imbricaria</i> Michx.	23, 400	12.04.-06.05.	24	01.10.-29.10.	28	30.03.-01.10.	185	I	II	II-101				
	<i>Crataegus combia</i> L.	11, 268	24.04.-08.05.	14	21.09.-30.09.	10	23.03.-30.10.	222	I	II	II-105				
	<i>Crataegus punctata</i> L.	5, 155	08.05.-22.05.	15	30.09.-11.10.	12	25.03.-30.10.	220	I	III	II-104				
	<i>Physocarpus opifolius</i> (L.) Maxim.	10, 87	16.05.-25.05.	10	18.08.-05.09.	19	19.03.-3.11.	228	II	II	III-90				
	<i>Quercus borealis</i> L.	10, 120	Not	Not	Not	Not	12.04.-25.10.	196	I	II	III-82				
	<i>Sambucus canadensis</i> L.	16, 200	24.05.-28.06.	34	13.08.-07.09.	26	19.03.-4.11.	229	I-II	III	III-81				
PII	<i>Viburnum trilobum</i> Marsh.	11, 185	10.05.-26.05.	16	16.09.-30.09.	14	27.03.-09.11.	227	II	II	II-92				
	<i>Zanthoxylum simulans</i> Hance	7, 170	16.05.-25.05.	10	24.10.-08.11.	15	08.04.-25.11.	235	I	I-II	I-115				
	<i>Symphoricarpos orbiculatus</i> Moench.	8, 95	02.07.-23.07.	21	08.11.-05.12.	27	23.03.-25.11.	247	I-II	I-II	II-91				
	<i>Symphoricarpos occidentalis</i> Hook.	7, 57	22.08.-29.09.	37	10.10.-30.10.	20	18.03.-28.11.	273	I-II	I-II	II-91				
	<i>Symphoricarpos microphyllus</i> Gray.	8, 140	11.06.-10.08.	60	19.10.-29.11.	40	30.03.-30.11.	245	I-II	I-II	II-91				
	<i>Symphoricarpos albus</i> (L.) Blake.	8, 135	10.06.-11.08.	66	22.10.-29.11.	38	25.03.-30.11.	230	I-II	I-II	II-91				
	<i>Rosa woodsii</i> Lindl.	7, 92	07.05.-28.05.	21	27.08.-09.09.	14	21.03.-26.11.	270	I-II	I-II	I-106				
	<i>Rosa californica</i> L.	8, 180	20.05.-31.05.	11	04.09.-17.09.	13	20.03.-22.11.	247	I	I-II	I-112				
	<i>Rosa blanda</i> Ait.	15, 153	10.05.-09.06.	30	07.09.-30.09.	23	20.03.-30.11.	254	I	II	II-105				
	<i>Crataegus collina</i> Chapm.	18, 190	12.05.-24.05.	12	05.10.-22.10.	17	25.03.-26.11.	246	I	I-II	I-110				
CP	<i>Cr. aestivalis</i> (Walter.) Torr.	12, 150	13.05.-17.05.	14	12.09.-11.10.	29	04.03.-02.11.	241	I	II	II-105				
	<i>Amelanchier canadensis</i> (L.) Medic.	9, 144	22.04.-03.05.	11	07.06.-24.06.	17	22.03.-20.11.	244	I	I-II	II-105				
	<i>Quercus rubra</i> L.	3, 90	Not (10 years)	Not	Not	Not	15.04.-28.10.	195	I	II	III-82				
	<i>Quercus macrocarpa</i> Michx.	5, 195	Not (9 years)	Not	Not	01.04.-04.12.	247	I	I-II	III-82					
	<i>Acer saccharum</i> Marsh.	11, 257	25.03.-10.04.	16	Not	Not	03.04.-28.10.	205	I-II	III	III-80				
	<i>Mahonia aquifolium</i> Nutt.	6, 54	15.04.-15.05.	30	01.07.-10.07.	11	09.04.-20.10.	194	I	I-II	II-91				
	<i>Cladrastis lutea</i> (Michx.) C.Koch.	8, 165	05.06.-17.06.	12	Not	Not	12.04.-13.10.	184	I	I-II	II-95				
	<i>Amorpha frangrans</i> L.	25, 110	10.05.-08.06.	28	16.09.-05.10.	20	03.04.-18.11.	228	I	I-II	II-98				

Continuation of Table 1

1	2	3	4	5	6	7	8	9	10	11	12
CP	<i>Diospyros virginiana</i> L.	33,160	02.07.-30.09.	90	28.10.-25.11.	28	07.04.-18.10.	196	I	I-II	II-98
	<i>Juglans cinerea</i> L.	10,119	30.04.-15.05.	16	25.08.-20.09.	25	10.04.-12.10.	186	I-II	III-II	III-83
	<i>Juglans nigra</i> L.	9,180	27.04.-13.05.	15	23.08.-18.09.	26	15.04.-23.10.	192	I-II	III-II	IV-73
	<i>Philadelphus hirsutus</i> Nutt.	9,141	26.05.-11.06.	17	12.09.-02.10.	20	01.04.-05.11.	219	I-II	II	IV-73
	<i>Ptelea serrata</i> Small.	15,168	22.05.-09.06.	15	05.09.-20.09.	15	03.04.-30.10.	210	I	I-II	III-90
	<i>Philadelphus lewisii</i> Pursh.	9,140	31.05.-11.06.	12	12.09.-05.10.	23	03.04.-08.11.	219	I-II	II	III-90
	<i>Fraxinus lanceolata</i> Borkh.	30,500	08.04.-27.04.	19	23.09.-11.10.	18	03.04.-30.10.	211	I	II	I-110
	<i>Fraxinus acuminata</i> Lam.	9,3,7	18.03.-13.04.	25	13.09.-07.10.	25	25.03.-18.11.	236	I	II	I-106
	<i>Amorpha fruticosa</i> L.	17,150	16.05.-07.06.	22	13.09.-27.09.	14	08.04.-30.10.	206	I	I-II	I-106
	<i>Amorpha schafraifolia</i> L.	16,200	18.05.-09.06.	21	16.09.-30.09.	15	09.04.-03.11.	208	I	I-II	I-106
	<i>Crataegus crus-galli</i> L.	4,157	21.05.-04.06.	11	07.10.-01.11.	24	10.04.-05.11.	209	I	I-II	II-105
	<i>Crataegus kellermanii</i> L.	9,185	07.05.-17.05.	11	03.10.-17.10.	14	07.04.-07.11.	214	I	I-II	I-110
	<i>Crataegus lanuginosa</i> Sarg.	4,188	19.05.-28.05.	10	05.10.-18.10.	13	06.04.-30.10.	207	I	III	II-98
CII	<i>Calycanthus occidentalis</i> Hook. et Arn.	12,155	25.05.-14.06	20	Not		07.04.-10.11	217	III	I-II	III-81
	<i>Gleditsia aguatrica</i> Marsh.	11,465	18.05.-27.05.	9	30.09.-17.10.	18	06.04.-20.10.	197	I	I-II	I-112
	<i>Gleditsia triacanthos</i> L.	20,560	19.05.-30.05.	11	29.09.-18.10.	19	09.04.-19.10.	193	I	I-II	I-112
	<i>Robinia pseudoacacia</i> L.	29,620	20.05.-02.06.	13	28.08.-25.09.	28	10.04.-7.11.	210	I	I-II	I-110
	<i>Gymnocladus dioecus</i> (L.) C.Koch.	6,60	20.05.-28.05.	8	Not		22.04.-21.10.	182	I	I-II	III-83
	<i>Cercis canadensis</i> L.	6,115	25.04.-08.05.	13	07.07.-23.07.	16	07.04.-28.10.	204	I-II	III	III-85
	<i>Salix fragilis</i> L.	16,125	11.04.-23.04	12	Not		13.03.-21.10	223	I-II	III	III-83
	<i>Rhus toxicodendron</i> L.	8,71	15.04.-10.05	25	14.08.-06.09.	19	05.04.-05.11.	214	I	I-II	III-88
	<i>Rhus typhina</i> L.	30,170	17.04.-13.05.	26	18.08.-08.09.	20	05.04.-10.11.	224	I	I-II	II-103
	<i>Rhus trilobata</i> L.	12,173	16.04.-11.05.	25	16.08.-07.09.	21	05.04.-10.11.	224	I	I-II	II-97
	<i>Celtis occidentalis</i> L.	5,200	21.04.-30.04.	10	10.08.-23.08.	14	05.04.-07.11.	216	I-II	I-II	III-88
	<i>Catalpa speciosa</i> Warder.	32,520	30.05.-14.06.	15	10.10.-27.10.	17	17.04.-08.11.	205	I	III	II-100
	<i>Catalpa ovata</i> G.Don.	30,210	28.05.-11.06.	14	12.10.-30.10.	18	14.04.-10.11.	210	I	III	II-100
<i>Crataegus macracantha</i> Lodd.	16,218	21.05.-04.06.	13	07.10.-01.11.	24	03.04.-25.11.	236	I	II	II-102	
<i>Crataegus phaenopyrum</i> (L.) Medic.	7,148	02.06.-13.06.	11	08.10.-20.10.	122	30.03.-10.11.	244	I	I-II	II-105	
<i>Crataegus uniflora</i> L.	5,72	26.05.-08.06.	13	11.10.-07.11.	26	01.04.-27.11.	214	I	I-II	III-88	
<i>Cornus obliqua</i> Rag.	9,138	14.05.-01.06.	16	17.08.-04.09.	18	01.04.-12.11.	246	II	II-III	III-89	
<i>Cornus amomum</i> Mill	11,92	12.05.-27.05	15	10.08.-01.09	22	16.03.-11.11	240	I-II	II-III	II-98	
<i>Gleditsia texana</i> L.	50,600	17.05.-01.03	15	13.09.-04.10	22	01.04.-28.10	211	I	I	I-112	
<i>Platanus occidentalis</i> L.	16,355	22.05.-02.06.	11	23.10.-26.11	33	10.04.-16.11.	220	I	II	II-101	
<i>Maclura aurantiaca</i> Nutt.	20,400	17.05.-31.05.	14	01.11.-26.11.	25	10.04.-30.11.	224	I	I	I-112	
<i>Maclurapomifera</i> (Rag.) C.R. Schneid.	18,121	11.05.-25.05.	14	25.09.-27.10.	33	09.04.-3.12	238	I	I	I-112	
<i>Spiraea menziesii</i> Hook	7,65	18.014-05.05	17	25.07.-17.08	23	10.03.-25.11	259	II	II	II-104	
<i>Forestiera neo-mexicana</i> Gray.	10,300	15.04.-07.05.	37	19.08.-11.09.	23	02.04.-10.11.	222	I	II	II-105	

Continuation of Table 1

1	2	3	4	5	6	7	8	9	10	11	12		
				The Central Asia									
PP	<i>Malus sieversii</i> (Ledeb.) M. Roem.	5, 650	23.04.-04.05.	12	20.06.-10.09	83	24.03.-18.10	196	I	III	II-100		
	<i>Cerasus frutescens</i> Pall.	8, 130	22.04.-02.05.	10	10.06.-30.06.	20	24.03.-15.10.	193	I	I-II	II-105		
	<i>Cerasus tianchanica</i> Pojark.	12, 170	19.04.-28.04.	9	06.06.-30.06.	24	23.03.-15.10.	194	I	I-II	II-104		
	<i>Caragana grandiflora</i> (Bieb.) DC. Prodr.	12, 110	17.04.-03.05.	16	29.04.-10.06.	40	26.03.-15.10	195	I	I	II-105		
	<i>Salix alba</i> L.	54, 510	19.03.-18.04.	30	21.05.-05.06.	15	25.02.-20.10.	233	I-II	I-II	II-93		
PC	<i>Berberis ilicifolia</i> M.Pop.	22, 110	02.05.-28.05.	26	15.07.-19.08.	35	24.03.-17.10	207	I	I-II	II-103		
	<i>Haloxylon aphyllum</i> (Minkm.) Ijtin.	23, 180	14.04.-10.05.	26	24.09.-25.10	31	14.03.-10.11	241	II	I	II-97		
	<i>Haloxylon persicum</i> Bunge.	24, 210	20.04.-10.05.	20	28.09.-26.10	28	16.03.-02.11	231	II	I	II-97		
	<i>Elaeagnus angustifolia</i> L.	33, 370	15.05.-14.06.	29	5.08.-7.09.	32	29.03.-28.10	216	II	I	I-106		
	<i>Elaeagnus oxycarpa</i> Schlecht.	40, 580	12.05.-29.05.	17	08.09.-6.10.	28.	30.03.-30.10	216	II	I	I-106		
	<i>Cotoneaster melanocarpus</i> Fisch.	45, 210	11.05.-09.06.	29	13.09.-04.10.	21	18.03.-8.11.	234	I	II	I-112		
	<i>Halimodendron halodendron</i> (L.) Voss.	23, 160	10.05.-30.06.	50	1.07.19.07.	18	30.03.-30.10	215	I	I	II-105		
PII	<i>Acer semenovii</i> Rgl. et Herd.	28, 520	05.05.-26.05.	21	20.08.-10.09.	20	25.03.-23.11	243	I-II	I-II	I-106		
	<i>Berberis oblonga</i> (Regel) Schneid.	31, 160	01.05.-15.05.	16	30.08.-26.09.	26	18.03.-04.12.	261	I	I-II	II-103		
	<i>Berberis turcomanica</i> Karel.	14, 155	04.05.-17.05.	14	26.08.-28.09.	32	16.03.-04.12	263	II	I-II	II-100		
	<i>Berberis nummularia</i> Bge.	23, 150	07.05.-18.05.	12	23.08.-19.09.	36	24.03.-05.12	256	I	I-II	II-105		
	<i>Berberis karkarakiensis</i> Korn. et Potap.	18, 90	05.05.-22.05.	17	24.08.-27.09.	33	20.03.-10.12	266	I	I-II	II-103		
	<i>Lonicera karelinii</i> Bunge.	20, 270	28.04.-20.05.	24	21.06.-18.07.	28	12.03.-25.11.	258	I	I-II	II-103		
	<i>Lonicera korolkowii</i> Stapf.	19, 265	28.04.-15.05.	19	18.06.-16.07.	29	15.03.-17.11	247	I	I-II	II-103		
	<i>Lonicera lanata</i> Pojark.	13, 240	30.04.-25.05.	26	22.06.-18.07.	27	12.03.-07.12.	269	I	I-II	II-103		
	<i>Lonicera microphylla</i> Willd.	21, 465	28.04.-15.05.	18	12.06.-08.07.	27	10.03.-30.11.	265	I	I-II	II-103		
	<i>Lonicera tatarica</i> L.	19, 275	28.04.-20.05.	23	15.06.-12.07.	28	05.03.-29.11.	270	I	I-II	II-103		
	<i>Viburnum opulus</i> L.	13, 245	20.04.-10.05.	21	18.08.-01.09.	13	21.03.-26.11.	251	I	II	III-89		
	<i>Cornus meyeri</i> L.	8, 125	17.05.-30.05.	14	11.08.-29.08.	18	30.03.-30.11.	245	I	II-III	III-84		
	<i>Caragana aurantiaca</i> L.	12, 145	25.04.-17.05.	22	05.06.-16.06.	11	15.03.-29.11.	258	I	I	II-104		
	<i>Caragana turkestanica</i> Kom.	11, 300	20.04.-10.05.	21	10.06.-22.06.	12	21.03.-05.12	260	I	I-II	I-108		
	<i>Colutea paulsenii</i> Freyn et Sint.	14, 165	06.05.-25.05.	20	23.07.-18.07.	25	26.03.-19.11.	239	I	II	II-101		
	<i>Cotoneaster insignis</i> Pojark.	41, 205	07.05.-30.05.	24	11.09.-03.10.	22	21.03.-05.12.	260	I	I-II	I-112		
	<i>Cotoneaster multiflorus</i> Bunge.	42, 175	29.04.-21.05.	23	21.08.-26.09.	36	16.03.-06.12.	265	I	I-II	I-112		
	<i>Cotoneaster oliganthus</i> Pojark.	26, 160	10.05.-05.06.	25	23.07.-14.08.	20	15.03.-25.11.	255	I	I-II	I-112		
	<i>Cotoneaster pseudomultiflorus</i> M.Pop.	35, 170	06.05.-04.06.	28	19.08.-11.09.	23	24.03.-25.11.	249	I	I-II	I-112		
	<i>Cotoneaster racemiflorus</i> (Desf.) C.Koch.	20, 126	06.05.-05.06.	30	27.08.-20.09.	24	05.03.-23.11.	257	I	I-II	I-110		
	<i>Cotoneaster ignavus</i> C.Koch.	13, 120	11.05.-07.06.	27	17.08.-10.09.	23	16.03.-27.11	256	I	I-II	I-110		
	<i>Crataegus alma-atensis</i> A.Pojark.	12, 200	29.04.-15.05.	17	07.07.-11.09.	35	19.03.-25.11.	251	I	I-II	I-110		

Continuation of Table 1

1	2	3	4	5	6	7	8	9	10	11	12
ПП	<i>Crataegus transcaspica</i> Pojark.	29, 260	06.05.-26.05.	20	05.08.-27.08.	22	27.03.-30.11.	248	I	I	I-110
	<i>Populus diversifolia</i> Schrenk.	47, 650	7.04.-8.05.	31	14.05.-20.06.	35	15.03.-10.11.	241	I	I-II	I-106
	<i>Populus bolleana</i> Lauche.	48, 900	20.03.-13.04.	30	09.04.-25.04.	16	19.02.-15.11.	264	I	II	I-106
	<i>Populus alba</i> L.	47, 660	20.03.-18.04.	29	Not		19.02.-10.11.	263	II	II	II-98
	<i>Rosa beggeriana</i> Schrenk	28, 195	10.05.-07.06.	27	13.08.-15.09.	32	14.03.-28.11.	259	I	I-II	I-113
СР	<i>Armeniaca vulgaris</i> L.	9, 350	08.04.-28.04.	20	8.06.-15.07.	38	01.04.-30.09.	189	I	I-II	I-110
	<i>Amygdalus communis</i> L.	12, 240	03.04.-20.04.	17	25.07.-20.08.	27	01.04.-20.10.	214	I	I-II	I-108
	<i>Pyrus tadchikistanica</i> Zapr.	22, 270	19.04.-02.05.	13	20.08.-30.09.	40	04.04.-15.10.	225	I	III	II-98
	<i>Morus nigra</i> L.	39, 400	03.05.-08.05.	15	10.05.-20.06.	30	18.04.-01.11.	198	I	I-II	I-112
	<i>Nitaria schoberi</i> L.	43, 150	16.05.-14.06.	28	10.06.-18.07.	38	3.04.-20.10.	201	I	I	I-112
СШ	<i>Koelreuteria apiculata</i> Rehd et Wils.	22, 390	13.06.-02.07	20	03.08.-01.09	29	26.03.-08.11	225	II	I-II	I-112
	<i>Koelreuteria bipinnata</i> Franch.	25, 760	08.06.-09.06	29	06.08.-26.08	20	24.03.-07.11	223	II	I-II	I-115
	<i>Rhamnus sintonisii</i> Rech.	21, 140	10.05.-24.05.	15	1.06.-25.08.	55	27.03.-8.10	197	I	I	II-102
	<i>Crataegus turkestanica</i> L.	8, 165	08.05.-26.05.	18	12.09.-07.10.	25	10.04.-4.11.	201	I	I-II	I-108
	<i>Cydonia oblonga</i> Mill.	18, 350	24.04.-11.05.	17	10.07.-25.10.	105	06.04.-23.10.	201	I	I-II	I-115
	<i>Prunus spinosa</i> L.	7, 185	15.04.-23.04.	9	26.05.-10.07.	65	30.03.-09.10.	195	I	I-II	II-100
	<i>Fraxinus sogdiana</i> Bunge.	22, 700	27.03.-15.04.	19	16.09.-08.10.	22	04.04.-12.11.	222	I	I-II	I-112
	<i>Fraxinus syriaca</i> Boiss.	21, 380	30.03.-15.04.	16	17.09.-11.10	24	03.04.-12.11.	221	I	I-II	II-105
	<i>Mespilus germanica</i> L.	9, 210	06.05.-25.05.	20	26.10.-18.11.	23	03.04.-23.11.	234	I	I-II	II-105
	<i>Paliturus spina-christi</i> Mill.	11, 165	21.05.-10.06.	21	02.08.-27.08.	25	30.03.-20.11	236	I	I-II	II-101
	<i>Rhamnus arguta</i> Maxim.	12, 140	30.04.-12.05.	13	26.07.-20.08.	25	29.03.-17.11.	234	I	I-II	II-102
	<i>Rhamnus dolicoxylla</i> L.	13, 220	05.05.-16.05.	11	28.07.-19.08.	22	27.03.-20.11.	237	I	I-II	II-102
The Eastern Asia											
PP	<i>Berberis amurensis</i> Rupr.	23, 130	01.05.-16.05.	16	26.08.-25.09.	30	13.03.-12.10.	212	I	I-II	II-103
	<i>Berberis bretschneideri</i> Rehd.	28, 110	25.04.-14.05.	20	27.08.-01.10.	35	07.03.-23.10.	229	I	I-II	II-103
	<i>Berberis koreana</i> Palib.	22, 115	02.05.-15.05.	13	21.08.-01.09.	11	09.03.-22.10	227	I	I-II	II-101
	<i>Berberis poiretii</i> Schneid.	25, 90	02.05.-15.05.	13	25.08.-28.09.	30	13.03.-23.10.	231	I	I-II	II-103
	<i>Lonicera maackii</i> Rupr.	11, 201	11.05.-28.05.	17	05.07.-28.07.	23	22.02.-01.10	220	I	I-II	II-103
	<i>Euonymusbungeana</i> Maxim.	19, 260	10.05.-11.06.	31	19.09.-11.10.	22	05.03.-11.10	220	I-II	I-II	II-103
	<i>Euonymusjaponica</i> Mig.	18, 160	23.06.-13.07.	21	22.10.-18.11.	27	07.03.-03.10	210	III	II-III	III-76
	<i>Euonymusoxyphylla</i> Mig.	18, 185	30.04.-19.05.	20	13.09.-05.10	22	11.03.-15.10.	218	I	II	II-105
	<i>Euonymus maackii</i> Rupr.	20, 260	10.05.-12.06.	32	19.09.-12.10.	23	05.03.-15.10.	224	I-II	I-II	II-103
	<i>Malus baccata</i> (L.) Borkh.	4, 470	23.04.-07.05.	14	20.06.-15.09.	55	22.03.-15.10.	209	I	I-II	I-106
	<i>Malus floribunda</i> Siebold.	38, 420	21.04.-12.05.	21	27.05.-10.09.	103	29.03.-22.10.	209	I	I-II	II-96
	<i>Malus halliana</i> Koehne.	18, 330	30.04.-12.05.	13	18.06.-20.09.	94	28.03.-05.10.	193	I	I-II	III-88
	<i>Malus manshurica</i> (Maxim.) Komar.	10, 520	24.04.-07.05.	13	10.06.-25.09.	105	16.03.-23.10.	220	I	I-II	III-88
<i>Malus sargentii</i> Rehder.	9, 230	14.04.-11.05.	27	28.05.-10.09.	105	27.03.-16.10.	204	I	I-II	II-96	

Continuation of Table 1

1	2	3	4	5	6	7	8	9	10	11	12
PP	<i>Malus sikkimensis</i> (Wenz.) Koehne.	10, 180	04.05.-16.05.	12	25.06.-15.09.	84	30.03.-15.10.	202	I	I-II	II-96
	<i>Malus sylvestris</i> (L.) Mill.	10, 260	28.04.-08.05.	10	16.06.-12.09.	86	30.04.-13.10.	198	I	I-II	III-88
	<i>Malus zumi</i> (Matsum.) Rehdert.	1,5, 350	30.04.-10.05.	11	26.05.-02.09.	96	29.03.-20.10.	203	I	I-II	II-96
	<i>Pyrus serotina</i> Rehdert.	16, 350	16.04.-06.05.	20	28.05.-10.09.	102	27.03.-08.10.	196	I	I-II	II-103
	<i>Sorbus sibirica</i> L.	27, 325	02.05.-13.05.	11	27.08.-17.10.	51	15.03.-18.10.	218	I	II	II-96
	<i>Salix dasyclados</i> Wimm.	16, 310	15.03.-27.03.	12	11.04.-23.05.	43	07.03.-22.10.	227	I	II	III-90
	<i>Berberis regeliana</i> Koehne ex Schneid.	21, 88	30.04.-18.05.	19	20.08.-03.09.	14	07.03.-25.10.	232	I	I-II	II-103
	<i>Berberis jamesiana</i> Forrest et w. Sm.	20, 80	28.04.-17.05.	16	26.08.-02.10.	36	05.03.-25.10.	234	I	I-II	II-103
	<i>Berberis sieboldii</i> Mig.	18, 115	27.04.-15.05.	19	24.08.-11.09.	18	17.03.-25.10.	223	I	I-II	II-101
	<i>Berberis thunbergii</i> DC.	27, 210	25.04.-12.05.	18	01.09.-02.10.	32	03.03.-22.10.	235	I	I-II	II-103
	<i>Cornus alba</i> L.	10, 115	12.05.-27.05.	15	09.08.-12.10.	23	05.03.-25.10.	234	I-II	I-II	III-89
	<i>Cotoneaster lucidus</i> Schlecht.	27, 110	21.04.-12.05.	21	21.08.-19.09.	28	04.03.-30.10.	239	I	I-II	II-101
	<i>Gleditsia japonica</i> Mig.	24, 250	Not	Not	Not	Not	06.04.-03.11.	212	I	I-II	III-88
	<i>Forsythia ovata</i> Nakai.	15, 155	18.03.-10.04.	23	26.08.-09.10.	44	19.03.-07.11.	229	I	I-II	II-101
	<i>Ligustrum japonicum</i> L.	39, 205	20.05.-03.06.	14	26.09.-22.10.	27	27.02.-28.10.	239	I	I-II	II-96
	<i>Ligustrum tshonoskii</i> Decne.	9, 135	15.05.-02.06.	18	18.10.-04.11.	26	27.02.-06.11.	247	I	II	II-104
	<i>Malus hupehensis</i> (Pamp.) Rehdert.	13, 280	24.04.-08.05.	14	09.06.-20.09.	101	24.03.-25.10.	216	I-II	I-II	II-105
<i>Padus grayana</i> Schneid.	19, 350	15.04.-29.04.	14	19.06.-05.07.	17	02.03.-28.10.	239	I-II	I-II	II-105	
<i>Padus asiatica</i> Kom.	33, 300	09.04.-28.04.	19	16.07.-09.08.	24	10.03.-27.10.	231	I	II - III	II-105	
<i>Padus davurica</i> L.	12, 150	08.04.-23.04.	15	08.06.-06.07.	28	27.02.-26.10.	241	I	II - III	II-105	
<i>Koelreuteria paniculata</i> Laxm.	14, 225	11.06.-01.07.	20	06.08.-27.08.	21	24.03.-09.11.	226	I	I-II	I-115	
<i>Hemiptella davidii</i> (Hance) Planch.	20, 250	05.05.-17.05.	12	20.07.-29.08.	39	21.03.-30.10.	224	I	I	I-112	
<i>Rhamnus ussuriensis</i> Ja Vassil.	8, 115	02.05.-17.05.	15	22.07.-18.08.	26	15.03.-04.11.	233	I	II	II-102	
<i>Salix rorida</i> Laksch.	21, 180	14.04.-27.04.	13	25.05.-09.06.	15	18.03.-29.10.	223	I	II - III	III-83	
PII	<i>Acer truncatum</i> Bunge.	12, 275	Not	Not	Not	Not	17.03.-15.11.	243	I-II	III	III-79
	<i>Acer ginnala</i> Maxim.	15, 185	28.04.-13.05.	16	21.07.-17.08.	27	20.03.-10.11.	232	I	I-II	I-106
	<i>Acer pictum</i> Thunb.	13, 250	Not	Not	Not	Not	19.03.-25.11.	251	I	III	III-77
	<i>Berberis souliana</i> L.	2, 95	10.04.-01.05.	21	02.10.-05.11.	33	05.03.-23.11.	263	I	I-II	III-74
	<i>Crataegus chlorosarca</i> Maxim.	18, 330	23.04.-10.05.	17	19.07.-04.08.	15	01.03.-14.11.	257	II	II - III	II-105
	<i>Lonicera edulis</i> Turcz. ex Freyn.	20, 270	20.04.-18.05.	29	13.06.-09.07.	27	20.02.-18.12.	298	I	I-II	II-103
	<i>Lonicera ruprechtiana</i> Regel et Herd.	19, 260	20.04.-17.05.	27	13.06.-05.07.	23	20.02.-21.11.	270	I	I-II	II-103
	<i>Viburnum burejaticum</i> Regel et Herd.	10, 195	17.04.-05.05.	18	14.08.-06.09.	23	15.03.-25.11.	254	I	II - III	III-83
	<i>Sophora japonica</i> L.	26, 490	18.07.-08.08.	21	15.10.-18.11.	34	26.03.-16.11.	233	I	I-II	I-112
	<i>Ligustrina pekinensis</i> Rupr.	11, 265	15.05.-06.06.	12	23.09.-21.10.	29	15.03.-15.11.	245	I	I-II	II-103
	<i>Physocarpus amurensis</i> Maxim.	13, 190	08.05.-20.05.	12	13.08.-01.09.	18	09.03.-11.11.	230	I	I-II	II-101
<i>Spiraea japonica</i> L.	11, 80	10.06.-15.07.	35	21.08.-04.09.	15	03.03.-02.12.	270	I	I-II	II-99	
<i>Ailanthus altissima</i> (Mill.) Swinge.	43, 520	01.06.-22.06.	22	25.08.-19.09	25	23.03.-21.12.	271	I	I-II	I-110	

End of Table 1

1	2	3	4	5	6	7	8	9	10	11	12
ПП	<i>Rosa rugosa</i> Thunb.	18, 165	02.05.-26.05.	24	08.08.-08.09.	30	10.03.-20.11.	252	I	I-II	I-110
	<i>Rosa ussuriensis</i> L.	37, 135	11.05.-30.05.	19	03.09.-01.10.	28	04.03.-01.12	269	I	I-II	I-112
СР	<i>Tilia ledebouriana</i> L.	4,5, 230	09.06.-22.06.	13	08.08.-30.08.	22	01.04.-18.10	202	I	III	II-103
	<i>Tilia mongolica</i> L.	5,5, 210	06.06.-20.06.	14	24.07.-20.08.	27	01.04.-05.10	188	I	III	II-103
	<i>Pyrus lindleyi</i> Rehder.	13, 350	19.04.-04.05.	15	30.05.-20.09.	111	07.04.-5.10.	183	I	III	II-98
	<i>Fraxinus rhyncophylla</i> Hance.	11, 180	Not		Not		03.04.-23.10.	205	I	III	III-79
СС	<i>Pyrus bretschneideri</i> Rehder.	15, 480	10.04.-04.05.	24	25.05.-20.09.	115	06.04.-24.10.	206	I	I-II	II-93
	<i>Fontanesia fortunei</i> Carr.	22, 260	09.05.-04.06.	25	26.09.-30.10.	35	01.04.-10.11.	223	I-II	I-II	II-105
	<i>Ulmus pumila</i> L.	42, 650	10.04.-25.04.	15	25.04.-10.05.	16	30.03.-29.10.	214	I	I	I-115
СШ	<i>Gleditschia caspica</i> Desf.	26, 500	18.05.-02.06	14	12.09.-05.10	23	04.04.-30.10	240	I-II	I-II	I-112
	<i>Zizyphus jujuba</i> Mill.	16,320	03.06.-03.07	31	27.08.-30.09	34	15.04.-29.11	228	I-II	I-II	I-112

During observations of plant growth and development in the conditions of the Mangyshlak Experimental Botanical Garden, it was established that the beginning of plant vegetation depends on weather conditions. The considered introducents of deciduous dendroflora are conditionally divided into pheno groups by the dates of onset and termination of vegetation. The studied introducents according to the development dates from the beginning of swelling to the onset of mass leaf fall according to the method of S.N. Makarov [16], with some changes in local natural conditions introduced into the culture, were divided into 6 pheno groups. Under the conditions of Mangyshlak, introducents quite early begin vegetation. Those who began growing from the end of February to March 30 are classified as early; from April as secondary; from May as late. Accordingly, introducents, whose end of vegetation is noted until October, 20, are considered as early; from October, 25 to November, 10 — as average; after November, 10 — as late.

Phenogroup PP has 5 species of the North American (*Acer negundo*, *Crataegus rivularis*, *Padus serotina*, *Padus virginiana*, *Quercus imbricaria*) and the Central Asian (*Malus sieversii*, *Cerasus fruticosa*, *C.tianschanica*, *Caragana fruticosa*, *Salix alba*) — 2.73 %; from the Eastern Asia — 20 species (species from genera *Berberis*, *Malus*, *Euonymus*, also *Lonicera maackii*, *Pyrus serotina*, *Sorbus sibirica*, *Salix dasyclados*) — 10.9 % of total number of the studied introduced species. The age of plants is 15–26 years, which is quite enough to determine the success of plants in introduction. All of them are characterized by the rapid end of the growth of shoots and their complete dressing. The average vegetation duration is 185–231 days. All species are winter-resistant; belong to the first and second groups of perspectives. Some species from the genera *Padus*, *Malus* and *Salix dasyclados*, due to poor drought resistance, belong to the third perspective groups. Introduced plants this group annually give a good increase in shoots — 12–45 cm; full-fledged seed products. In culture, it is very well propagated by seeds of local reproduction *Acer negundo*, which is successfully used in green building.

Fenogroup PC has 31 species, from them the North American 6 species (*Crataegus combia*, *Crataegus punctata*, *Physocarpus opulifolius*, *Sambucus canadensis*, *Viburnum trilobum*, *Quercus borealis*), the Central Asian 7 species (*Berberis iliensis*, *Cotoneaster melanocarpus*, *Halimodendron halodendron*, by 2 species from genera *Haloxydon* and *Elaeagnus*); the Eastern Asian 18 species (*Cornus alba*, *Cotoneaster lucidus*, *Gleditsia japonica*, *Forsythia ovata*, *Malus hupehensis*, *Koelreuteria paniculata*, *Hemiptella davidii*, *Rhamnus ussuriensis*, *Salix rorida*, 3 species from genus *Berberis* and *Padus*, 2 species of genus *Ligustrum*) — 16 % from common species composition. Plants are characterized by a timely end to the growth of shoots, giving an annual average shooting ability of 5–45 cm, an increase in the main shoots and complete lignification. All species are characterized by the beginning of vegetation on an equal footing with the first group, but the end is slightly later. Plants bloom stably and bear fruit, except for the Eastern Asian species *Gleditsia japonica*. The average duration of flowering and fruiting for the most introducents is 10–35 days; the vegetation duration is 216–247 days. The most species of this group (70 %) do not freeze, only for the Northern American, as *Sambucus canadensis*, *Physocarpus opulifolius* in the cold winter years there is a freezing of 50 % of the shoots of annual growth. In summertime from this group at the Northern American species (*Crataegus punctata*, *Physocarpus opulifolius*, *Sambucus Canadensis* and *Viburnum trilobatum*) and the Eastern Asian one species (*Cornus alba*) partially burn leaves and some loss of turgor of leaves is observed.

According to the perspective, plants from this group are assigned to 2 and 3 prospect groups, except for the North American species *Crataegus combia*, the Central Asian species *Elaeagnus angustifolia*, *Elaeagnus oxycarpa*, *Cotoneaster melanocarpus* and the Eastern Asian species *Koelreuteria paniculata*, which belong to the 1st group.

Phenogroup PII has 53 species, among them 11 taxa are the Northern American (*Zanthoxylum simulans*, *Symphoricarpos orbiculatus*, *S. occidentalis*, *S. microphyllus*, *S. albus*, *Rosa woodsii*, *R. californica*, *R. blanda*, *Crataegus collina*, *Cr. aestivalis*, *Amelanchier canadensis*); the Central Asian are 27 taxa (*Acer semenovii*, *Cornus meyeri*, *Colutea paulsenii*, 2 species of genus *Caragana*, 4 species of genus *Berberis*, 5 species of genus *Lonicera*, 6 species of genus *Cotoneaster*, *Crataegus alma-atensis*, *C.transcaspica*, *Populus alba*, *P.bolleana*, *P.diversifolia*, *Rosa beggeriana*); the Eastern Asian are 15 species (*Ailanthus altissima*, *Berberis souliana*, *Crataegus chlorosarca*, *Viburnum burejaticum*, *Sophora japonica*, *Ligustrina pekinensis*, *Physocarpus amurensis*, *Spiraea japonica*, 3 species of *Acer*, 2 species of *Lonicera* and *Rosa*) — 28 %.

Vegetation duration is 230–270 days. The growth of plant shoots lasts longer, but the timing of shoots growth does not differ from the average dates for Mangyshlak. Despite the late end of vegetation, plants from these groups are mostly winter-resistant, slight freezing of annual shoots is noted in species from the genera *Rosa*, *Symphoricarpos*, *Berberis*, *Lonicera* and *Cornus meyeri*. Every year they give an outgrowth of

shoots of 7–29 cm, only in the Central Asian species *Populus alba*, *Populus bolleana*, *P. diversifolia* and the Eastern Asian species *Ailanthus altissima*, the annual increase is 43–48 cm. Introduced plants from this group give full seeds. So, *Ailanthus altissima* is very well propagated by seeds of local reproduction, gives self-seeds, also it is successfully used in green building. Most plants from this group are mainly shrubs; belong to the 1–2 perspective groups. Plants from this group can freeze slightly, drought-resistant, flowering duration is 10–66 days, almost all species bear fruit. But, despite 25 years of age, the Eastern Asian species *Acer truncatum*, *Acer pictum* in Mangyshlak do not bloom and do not bear fruit.

Phenogroup CP has 17 species, among them the Northern American 10 species (*Acer saccharum*, *Mahonia aguifolium*, *Cladrastis lutea*, *Quercus gambelii*, *Quercus rubra*, *Quercus macrocarpa*, *Juglans cinerea*, *J. nigra*, *Amorpha frangrans*, *Diospyros virginiana*), the Central Asian (*Armeniaca vulgaris*, *Amygdalus communis*, *Pyrus tadchikistanica*) and the Eastern Asian (*Tilia ledebouriana*, *Tilia mongolica*, *Pyrus lindleyi*, *Fraxinus rhyncophylla*) — 9 %. The average vegetation duration is 173–225 days. Among taxa, the North American species *Acer saccharum* singly blooms, but does not bear fruit, and 3 species (*Quercus gambelii*, *Quercus rubra*, *Quercus macrocarpa*) have not reached the age of the generative phase, do not bloom, and accordingly do not bear fruit. The North American species *Cladrastis lutea* flower, but does not bear fruit. The Eastern Asian species *Fraxinus rhyncophylla*, despite its full age (more than 30 years in culture) does not bloom and does not bear fruit. Species of the genus *Juglans* and *Tilia* burn strongly in the summer and most leaves and young shoots lose turgor, and in other species only in the afternoon there is some loss of turgor leaves. All species of this group have low self-educational ability (annual increases in shoots are 5–13 cm).

By parameters of perspective, the Northern American species are mainly assigned to 2nd group. The absence of flowering and fruiting of *Acer saccharum* and 3 species of *Quercus*, despite their high winter resistance, attributed them to the 3 perspective group (less promising); and *Juglans cinerea*, *J. nigra* — to the 4th perspective group (little promising). The Eastern Asian species were assigned to the 2nd perspective group, excepting *Fraxinus rhyncophylla*, which belongs to the 3rd perspective group. The Central Asian species (*Armeniaca vulgaris*, *Amygdalus communis*) are very promising, reproduce well with seeds, give self-settling, and are successfully used in landscaping.

The CC phenogroup has 28 species (the Northern American — 17 species: *Ptelea serrata*, *Philadelphus hirsutus*, *Ph. lewisii*, *Fraxinus lanceolata*, *F. acuminata*, *Salix fragilis*, *Amorpha fruticosa*, *A. schafranifolia*, *Robinia pseudoacacia*, *Crataegus crus-galli*, *Crataegus kellermanii*, *C. lanuginosae*, *Gleditsia aquatica*, *G. triacanthos*, *Gymnocladus dioecus*, *Cercis canadensis*, *Calycanthus occidentalis*; the Central Asian — 8 species: *Morus nigra*, *Cr. turkestanica*, *Cydonia oblonga*, *Koelreuteria apiculata*, *K. bipinnata*, *Prunus spinosa*, *Nitraria schoberi*, *Rhamnus sintonensis*; the Eastern Asian — 3 species: *Pyrus bretschneideri*, *Fontanesia fortunei*, *Ulmus pumila*) — 3 %.

Plants from this group begin and end vegetation in the average period with a vegetation duration of 182–223 days, with complete blanketing of shoots, frost is not observed. Plants of all species retain their inherent form of growth, have an average shoot-formed ability (5–15 cm); excepting the Northern American species — *Gleditsia triacanthos* (30 cm), *Robinia pseudoacacia* (29 cm), *Fraxinus lanceolata* (20 cm) and *Koelreuteria apiculata* (35 cm); the Eastern Asian species *Ulmus pumila* (42 cm), which have a high shoot-formed ability, annually give full seeds. Local reproduction plants are obtained from seeds, which are successfully used in landscaping. The drought resistance of the most promising species from the CC pheno group is 1 and 2 points, with the exception of some (*Crataegus lanuginosae*, *Cercis canadensis*, *Salix fragilis* — 3 points). Most plants mainly belong to the 1st and 2nd group of plant prospects, except for 2 species of the genus *Philadelphus* and species *Cercis canadensis* (not drought resistant), *Gymnocladus dioecus*, *Salix fragilis* and *Calycanthus occidentalis* (only bloom, but do not bear fruit), therefore belong to 3rd. In the Eastern Asian species *Ulmus pumila* in recent years, in early July, leaves are damaged by pests (ilm leaf). This species, despite the very high drought resistance, is assigned to the 2nd perspective group.

Phenogroup CII has 25 species (the Northern American — 17 species: *Rhus toxecodendron*, *Rh. typhina*, *Rh. trilobata*, *Celtis occidentalis*, *Catalpa speciosa*, *Crataegus macracantha*, *Cr. phaenopyrum*, *Cr. uniflora*, *Cornus obliqua*, *Maclura aurantiaca*, *M. pomifera*, *Forestiera neo-mexicana*, *Platanus occidentalis*, *Gleditsia texana*, *Cornus amomum*, *Padus serotina*, *S. menziesii*; the Central Asian: *Fraxinus sogdiana*, *Fraxinus syriaca*, *Mespilus germanica*, *Paliurus spina-christi*, *Rhamnus arguta*, *Rhamnus dolichophylla*; the Eastern Asian species: *Gleditschia caspica*, *Zizyphus jujuba*) — 13 %.

The duration of vegetation is 204–246 days, with an average vegetation onset, a late end, almost before frosts (December) and a later change in leaf color and leaf fall. Plants of all species of this group have low

(5–10 cm) and medium (12–25 cm) shoot-forming ability, only 2 species of the genus *Catalpa*, species of *Cotoneaster*, *Rhus typhina*, the Central Asian species *Fraxinus sogdiana* and the Eastern Asian species *Gleditschia caspica* have high shoot-forming ability (25–32 cm). Basically, the tops of annual shoots freeze slightly in plants of this group, except *Rhus typhina* and *Cornus obliqua*, in which 50 % of the ends of annual, biennial and older shoots freeze in cold winters. Plants of this group are mainly drought-resistant, with the exception of species from the genus *Catalpa*, which in hot, dry summers the leaves burn up and lose turgor, but, with a decline in high temperatures, they recover. Plants from this pheno group mainly belong to 1st and 2nd perspective groups.

The highest indicators (106–112 points) scored species of the most promising group: taxa of the Northern American flora (*Acer negundo*, *Gleditsia triacanthos*, *Robinia pseudoacacia*, *Fraxinus lanceolata* and species of genus *Lonicera*, *Rosa*, *Amorpha*, *Crataegus*); the Central Asian flora species (*Acer semenovii*, *Armeniaca vulgaris*, *Amygdalus communis*, *Berberis iliensis*, *B.oblonga*, *Morus nigra*, *Nitraria schoberi*, *Koelreuteria apiculata*, *K.bipinnata*, *Fraxinus sogdiana*, *Populus diversifolia*); species from the Eastern Asian flora (*Acer ginnala*, *Ailanthus altissima*, *Malus baccata*, *Koelreuteria paniculata*, *Hemiptella davidii*, *Sophora japonica*, *Spiraea japonica*, *Rosa rugosa*, *Zizyphus jujube*).

Conclusion

The dynamics of the development of introduced plants varies significantly depending on climatic factors. A comparative analysis of phenological observations made it possible to establish some differences, which are expressed in the change in the timing of the onset of individual phenophases and a significant reduction in their duration. So, for cold spring and humid, moderately hot summer growing periods, later (from the second decade of March) extended onset dates (until the third decade of November) and the duration of phenophases are characteristic. In warm spring, arid and hot summer years, phenophases are more compressed (from the 3rd decade of February to the 1st decade of November). The difference in the timing of the beginning of vegetation is 5–10 days, flowering and fruiting — up to 15–20 days. The intensive growth of shoots of woody plants begins from the 1st decade to the 3rd decade of April; the earliest start date of the phase was noted in March, before the onset of summer extremely high temperatures, the most recent — at the end of June, growth lasts until June-August. Flowering in different species begins from the 2nd decade of April to the 3rd decade of May, on average for 10–25 days. Extreme flowering dates are at the beginning of March and the end of June. The beginning of ripening of fruits is noted from July to the 1st decade of November with a difference of 45–50 days between species. The beginning of the leaf fall begins in mid-September, the end of the leaf fall — from November 15 to 20 with a difference between species of 15–20 days.

Among 183 deciduous woody plants, which have undergone introduction tests, 52 species (28.96 %) belong to the first group (the highest) of perspective (among them the Northern American — 16 taxa, the Central Asian — 25 taxa, the Eastern Asian — 11 taxa); 95 species (54.1 %) — to the second group (high) of perspective (among them the North American — 28 taxa, the Central Asian — 29 taxa, the Eastern Asian — 38 taxa); 34 species (16.9 %) are assigned to the 3 group (average) of prospects (among them the Northern American — 20 taxa, the Central Asian — 2 taxa, the East Asian — 12 taxa); 2 Northern American species (6.6 %) — to the fourth (low) group. According to the vegetation dates, there was an increase in plant prospects in Mangyshlak conditions for pheno groups from PP to PII, a decline in CP and an increase in CC; flowering and fruiting of most species indicates the success of their introduction and high prospects for further use.

For form an electronic DB developed by the Mangyshlak Experimental Botanical Garden, the computer program «DInCeR» introduces information on biology and ecology, registration number, year of involvement, donor-organization, type of reproductive material, number of copies, occupied area. The specified computer program on indicators «Stability,» «Decoration,» «Reproducibility» and «Application» using the regional scale on collectible tree species diagnoses the introductive value of plants [17].

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A.A. Иманбаева

Маңғыстаудың аридті жағдайында ағаш тектес өсімдіктерін интродукциялаудың перспективасын бағалау

Ағаш өсімдіктерінің перспективалы және тұрақты таксондарын интродукциялық зерттеу және анықтау Қазақстанның жасыл құрылысы мен сәндік бағбандылығы үшін маңызды қолданбалы мәнге ие. Жергілікті флораның төтенше жағдайлары мен ағаш өсімдіктерінің тапшылығымен ерекшеленетін арид жағдайлары үшін тұрақты дақылдарды таңдау маңызды. Мақалада өсімдіктердің маусымдық өсу ырғағы мен дамуын зерттеу бойынша деректер берілген, олар вегетацияның басталу мерзімдерінің өзгеруінен (5–10 күн), гүлдену және жеміс беру (15–20 күн) мен олардың ұзақтығының қысқаруының өзгерісін көрсетті. Маңғышлақтың аридті жағдайында вегетация мерзімі бойынша ЕЕ-ден (вегетацияның ерте басталуы және ерте аяқталуы) ЕК-ке (вегетацияның ерте басталуы және кеш аяқталуы) дейін фенотоптар бойынша өсімдіктердің перспективалық сандарының өсуі, ОЕ-ден (вегетацияның орта басталуы және ерте аяқталуы) құлдырау мен ОО-дан (вегетацияның орта басталуы және орта аяқталуы) өсу байқалады. 183 интродуценттерінің ішінен 52-і таксонды перспективалықтың бірінші тобына (жоғары), 95-і — екінші топқа (жоғары), 34-і — үшінші топқа (орташа) және 2-і — төртінші топқа (төменге) жатады, бұл өсімдіктер интродукциясының сәттілігін және оларды одан әрі қолданудың перспективалылығын көрсетті. Коллекциядағы ағаш тектес өсімдіктер бойынша Маңғышлақ эксперименталдық ботаникалық бағы әзірлеген «DInCeR» компьютерлік бағдарламасында электрондық деректер базасы қалыптастырылуда.

Кілт сөздер: Маңғыстау, аридті жағдайлар, интродукция, ағаш өсімдіктері, фенология, өсуі мен дамуы, перспективасы.

А.А. Иманбаева

Оценка перспективности интродукции древесных растений в аридных условиях Мангистау

Интродукционное изучение и выявление перспективных и устойчивых таксонов древесных растений имеет важное прикладное значение для зеленого строительства и декоративного садоводства Казахстана. Важное место занимает выбор устойчивых культур для аридных условий, отличающихся экстремальными условиями и дефицитом древесных растений местной флоры. В статье представлены результаты по исследованию ритмов сезонного роста и развития растений. Установлены различия, которые выражаются в изменении сроков наступления начала вегетации (5–10 дней), цветения и плодоношения (15–20 дней) и сокращении их продолжительности. В аридных условиях Мангышлака по срокам вегетации отмечено нарастание баллов перспективности растений по феногруппам от РР (раннее начало и раннее окончание вегетации) до РП (раннее начало и позднее окончание вегетации), спад в СР (среднее начало и ранее окончание вегетации) и нарастание в СС (среднее начало и среднее окончание вегетации). Из 183 интродуцентов 52 таксона относятся к первой группе перспективности (высокая), 95 — ко второй группе (повышенная), 34 — к третьей (средняя) и 2 — к четвертой (низкая) из выделенных 6 феногрупп, что свидетельствует об успешности интродукции и перспективности их в дальнейшем применении. Формируется электронная база данных в компьютерной программе «DInCeR», разработанной Мангышлакским экспериментальным ботаническим садом, по коллекционным древесным растениям.

Ключевые слова: Мангистау, аридные условия, интродукция, древесные растения, фенология, рост и развитие, перспективность.

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