

Integrated diagnostic scales of plant introductory value for different natural zones of Kazakhstan

Akzhunis Imanbayeva^{*}, and *Ivan Belozеров*

Mangyshlak Experimental Botanical Garden of the Republic of Kazakhstan, 130000 Aktau, Kazakhstan

Abstract. A description is given of the developed in the Mangyshlak experimental botanical garden complex scales of determining the introduction value of plants as applied to the desert zone of Western (Aktau, MEBG), mountain-forest conditions of Eastern (Ridder, ABG) and the desert-steppe zone of Central Kazakhstan (Zhezkazgan, ZBG), including 24 diagnostic features, divided into four sections (groups): 1) biological stability, 2) ornamental and habitat properties, 3) reproductive capacity and 4) economic and biological and scientific importance. The detailed results of their testing on the example of 289 species and forms of aboriginal and foreign flora of 3 botanical gardens in Kazakhstan are given.

The natural and climatic conditions of the Mangystau desert cause a very low introduction selection of plants, averaging only 2-3% over the past almost 50 years. Since the very beginning of botanical development of the Mangystau region, the problem of diagnosing the prospects of plants for introduction has been acute. The available developments on this issue are mainly intended for forest and forest-steppe natural zones [1-4] and are little suitable for arid and arid climatic conditions. Most of them include a rather narrow list of diagnostic parameters (mainly without ornamental qualities of introducers) and the priority is given to the indicator of "winter hardiness", which in extra-arid habitat cannot be considered as the main one. In this regard, the Mangyshlak Experimental Botanical Garden (MEBG) set the task of compiling a regional scale to determine the introduction value of plants, which includes in its structure 24 diagnostic attributes of biological stability, ornamental, reproductive and economic, biological and scientific value [5-7].

The habitat conditions of plants in the Mangystau desert differ significantly from other geographical areas of Kazakhstan. Here beyond the ecological optimum deficiency of soil moisture and atmospheric drought is significantly beyond the limits and when diagnosing the introduction value, it is necessary to consider drought tolerance, heat resistance, salt tolerance and demandingness to soil fertility. In East Kazakhstan (Ridder, Altai Botanical Garden (ABG)) the main limiting factors are short frost-free period, return spring frosts and low winter temperatures and therefore winter hardiness and resistance to frost are the dominating index of perspective. Another area of introduction studied is located in the desert-

^{*} Corresponding author: imangarden@mail.ru

steppe belt of Central Kazakhstan (Zhezkazgan, Zhezkazgan Botanical Garden (ZBG)) and, as well as Mangystau, is arid climate, but in a less pronounced form. The amount of precipitation here is almost 2 times more, and evaporation, on the contrary, 1.5 times less. All objectively existing differences in the natural and climatic conditions of the three geographical areas of Kazakhstan were taken into account in the development of regional methodologies for assessing the prospects of plants as applied to the mountain-forest conditions of Eastern and desert-steppe zone of Central Kazakhstan.

The regional scale structurally developed for the desert zone of Mangystau includes 24 diagnostic attributes (Table 1), divided into 4 sections (groups): 1) biological stability (6); 2) ornamental and habitat properties (8); 3) reproductive capacity (3); 4) economic and biological and scientific significance (7).

The tolerance of the exotic species to environmental conditions is a sum of their drought, salt and winter resistance, tolerance to soil fertility, phytophage and gas resistance scores. When evaluating the ornamental-habitativeness, the form of growth, general decorativeness of the vegetative part, foliarity, abundance, duration and aesthetics of blossoming and fructification are taken into account. Reproductive ability is diagnosed on the basis of taking into account the success of renewal of plants under crop conditions by seed and vegetative ways. When determining the economic, biological and scientific significance, the possibility of their use in landscaping, phytomelioration, food, fodder, medicinal and technical purposes as well as their phyto-protective status is taken into account.

Table 1. Complex diagnostic scale of plants introduction value in arid conditions of Mangystau

No.	Indicator, attribute	Estimated options and conditions	Points
1. BIOLOGICAL STABILITY - maximum 50 points			
1.1	Drought tolerance	Very low to very high	0-15
1.2	Salt tolerance	From non-salt-tolerant to the most salt-tolerant (halophytes)	0-10
1.3	Winter hardiness	Highly winter-resistant to non winter-resistant	8-0
1.4	Requirement for soil fertility	From undemanding to very demanding	6-0
1.5	Phytophagous resistance	High to very low	6-0
1.6	Gas resistance	Gas-resistant to non-gas resistant	5-0
2. DECORATIVE AND HABITUAL PROPERTIES - maximum 20 points			
2.1	Growth form and longevity	From trees to annuals	4-0
2.2	Original growth form	Expressed - not expressed	1-0
2.3	General decorativeness of the vegetative part	From very high to very low	3-0
2.4	Deciduousness	From coniferous evergreens to deciduous	3-0
2.5	Intensity (abundance) of blossoming	Expressed to not expressed	1-0
2.6	Blossom duration, days	10 to 25 or more	0-2
2.7	Blooming aesthetics	Very high to very low	4-0

No.	Indicator, attribute	Estimated options and conditions	Points
2.8	Fruiting ornamentation	Very high to very low	2-0
3. REPRODUCTIVE ABILITY - maximum 10 points			
3.1	Propagated by seeds	From good to not breeding	6-0
3.2	Propagated vegetatively	From good to not breeding	4-0
3.3	Propagated under special conditions	Good to bad	2-0
4. ECONOMIC - BIOLOGICAL AND SCIENTIFIC VALUE - maximum 20 points			
4.1	For landscaping purposes when creating:	From woodlands and groves to not applicable	14-0
4.4	as fodder	Very valuable to not applicable	8-0
4.5	as medicinal	Very valuable to not applicable	7-0
4.6	as a technical	Very valuable to not applicable	5-0
4.7	Phytoconservation status	Petering out to safe	11-0

The scale is 100-rated into 10 classes (groups) of introducers' value - from "not valuable" (I class, 0-10 points) and "very low" (II class, 11-20 points) to "very high" (IX class, 81-90 points) and "maximum high, benchmark" (X class, 91-100 points).

To check the objectivity of the estimation of the perspective of plants, initially the scale was tested on the example of 31 representative of native and 124 representatives of foreign dendroflora of different growth form, decorativeness, stability and economic importance. As a result, the taxa are quantitatively distributed into classes almost symmetrically in relation to the index of "average" perspective, which includes 23,9% of the studied introduced plants. "Extremely low" value was detected for 2.6% of species; "very low" - 4.5; "low" - 9.7; "reduced" - 16.8; "increased" - 22.6; "high" - 14.2 and "very high" - 5.8%.

When developing methodological approaches to assessing the prospects of plants in the mountain forest belt of Eastern Kazakhstan (ABG), taking into account the objective differences in natural and climatic conditions with the desert zone of Mangistau region, a complex scale instead of salt tolerance includes diagnostic trait frost resistance, which ranking into groups is accepted by analogy with the classification of woody plants by frost tolerance A. I. I. Kolesnikov [8], but as applied to transitional seasons by A.A. Vinokurov [9]. The latter believes that for the climate of this region the late return of cold weather in spring limits the growth processes and formation of the assimilative apparatus and development of generative organs of plants, and early autumn frosts prevent introducers to gradually undergo hardening and preparation for the winter period. According to this author, the lowest indicators of resistance to sharp temperature fluctuations are characteristic of thermophilic taxa of southern geographical origin and plants undergoing initial introduction tests in new environmental conditions. Ten points, or 20% of the sum of biological resistance parameters, were allocated to the index of frost resistance. In addition, the scale compared to Mangistau increased exactly twice the number of points for winter hardiness (16 in total), and by 2 points for phytophagous resistance (Table 2). In turn, the specific weight of drought tolerance was reduced by more than two times, the importance of the trait of demanding plants to soil fertility was reduced by two points. The total point estimation of gas

resistance remained unchanged, as well as all estimation traits of ornamental and habitat properties; reproductivity and possibilities of useful application.

Table 2. Composition and correlation of scores between diagnostic attributes of "Biological resistance" of the Complex scales of diagnosis of plant introduction value in different natural zones of Kazakhstan

Order No.	Indicator, attribute	Natural area, botanical garden, city					
		desert, MEBG, Aktau		mountain-forest zone, ABG, Ridder		desert-steppe, ZBG, Zhezkazgan	
		points	%%	points	%%	points	%%
I. BIOLOGICAL STABILITY							
1.1	Drought tolerance	15	30	7	14	10	20
1.2	Salt tolerance	10	20	-	-	8	16
1.2	Frost-resistance	-	-	10	20	-	-
1.3	Winter hardiness	8	16	16	32	14	28
1.4	Requirement for soil fertility	6	12	4	8	5	10
1.5	Phytophagous resistance	6	12	8	16	6	12
1.6	Gas resistance	5	10	5	10	7	14
	Total:	50	100	50	100	50	100

In compiling a comprehensive scale for the desert-steppe conditions of Central Kazakhstan (ZBG) the composition of the group of traits "Biological tolerance" remained unchanged compared with the Mangystau desert zone, but the ratio between them on the sums of evaluation points has changed significantly. Taking into account less expressed aridity of climate 10 points (Table 2) instead of 15 for Mangystau region for drought tolerance and 8 (10) for salt tolerance. The soil fertility requirement is estimated at 5 points compared to 6 for use in MEBG. On the contrary, the gas tolerance score due to the strong gassiness of Zhezkazgan increased by 2 points (7). The number of points for winter hardiness is almost doubled in comparison with Mangystau (14 points in total). Specific weight of phytophagous resistance remained at the same level - 6 points. The other evaluative attributes of ornamental and habitat properties; reproductive ability and possibilities of useful application of plants were left unchanged similarly to the version of the scale for MEBG.

In total, the objectivity of the developed regional methods was tested for the ABS by the example of 74 species and forms of deciduous woody plants from 3 families and 3 genera; for the ZBG - 60 species, varieties and forms of coniferous, deciduous and creeping woody plants from 6 families and 6 genera. According to the modified trait group "Biological tolerance", woodiest plants were included in both ABG and ZBG classes with "medium" (respectively, 23 and 22 names) and "high" (26 and 35) tolerance. The difference between plants in biological resistance is mainly due to the difference in frost and winter-hardiness in the ABG, and in the ZBG - in drought tolerance, which is determined by natural and climatic conditions of these areas of introduction.

The taxa in ABG were distributed by value indices as follows: low (IV class, 31-40 points) - 4 (5,4%); reduced (V class, 41-50 points) - 21 (28,4%); average (VI class, 51-60

points) - 26 (35,1%); increased (VII class, 61-70 points) - 27 (36,4%) and high (VIII class, 71-80 points) - 6 (8,1%).

The ranking of plants of the collection fund of ZBG by classes of perspective is somewhat different: reduced (V class, 41-50 points) - 10 (16.7%); medium (VI class, 51-60 points) - 25 (41.7%); elevated (VII class, 61-70 points) - 22 (36.7%) and high (VIII class, 71-80 points) - 3 (5.0%).

Thus, the regional scales for the three climatic zones of Kazakhstan tested in detail on the example of the diagnostic prospects of woody plants for 289 species and forms of introducers, including 74 - in the ABG, 60 - ZBG and 155 - MEBG. It was found that within the limits of this sample of taxa with mostly rather high biological stability, a considerable scatter of evaluation scores was observed, which confirms the complexity, objectivity and rather high reliability of the scales, coinciding with the general tentative opinion of introducers on the value of this or that species.

During the study period, all the scales composed were adapted to electronic shells of the multifunctional computer program "DInCeR", which, apart from diagnostics of the introduction value of plants, was performing the functions of input, storage and export in various formats of various registration, taxonomic, geographic and ecological-biological information.

Further improvement and introduction of comprehensive diagnostic scales of plant introductory value and software for computers in the practice of introduction studies in different regions of Kazakhstan will greatly simplify the creation of information databases; will quickly search for taxa and generally expand the possibilities of working with information about exotic species, and reduce costs for the selection of differentiated by natural conditions of their assortment to create green areas of different functional purposes.

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