FORESTRY

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REGULATIONS OF SAFE AND SUSTAINABLE USE OF BIODIVERSITY OF WOODY PLANTS IN PROTECTIVE AFFORESTATION

Research article

Abstract

Due to the lack of natural woody vegetation on flat or elevated relief elements, protective afforestation is associated with the introduction of tree species of foreign origin. Uncontrolled process of enrichment of protective forest plantations woody plants in forest-poor regions leads to invasion.

The goal is the development of regulations for the selection of woody plants to safely enhance the biodiversity of protective forest plantations in the steppe and semi-desert.

It was revealed that the cluster dendrological sites of the Federal Scientific Centre of Agroecology, Complex Melioration and Protective Afforestation of Russian Academy of Sciences (FSC of Agroecology RAS) serve as a testing ground with a controlled territory for safe testing of plants. The object of research was 600 taxa, of different geographical origin and age. For defensive forest plantations of degraded ecosystems (Volgograd, Samara Oblast) 168 species of trees and shrubs are recommended.

The results of studies of generic complexes are the basis for the scheme for analyzing the prospects of woody plants and for selecting an economically important range. In dry steppe conditions, economically important groups from families *Rosaceae, Caprifoliaceae, Oleaceae, Fabaceae* are recommended for increasing biodiversity. The regulation includes the creation of a stock of planting stock. It is based on ecological compatibility, economic suitability, innovative assortment.

Monitoring of experimental populations forming a self-seeding was carried out. In arid conditions, safe methods of reproduction of woody plants have been identified. An algorithm for quantitative and qualitative improvement of the assortment of woody plants has been developed to select the best possible option and the criteria for regulating the sustainable use of the biodiversity of woody plants. They include introduction, selection, seed production and tested at the sites of the study area.

Keywords: woody plants, biodiversity, selection, enrichment, regulation, sustainable use, invasive.

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РЕГУЛИРОВАНИЕ БЕЗОПАСНОГО И УСТОЙЧИВОГО ИСПОЛЬЗОВАНИЯ БИОРАЗНООБРАЗИЯ ДРЕВЕСНЫХ РАСТЕНИЙ В ЗАЩИТНОМ ЛЕСОРАЗВЕДЕНИИ

Научная статья

Аннотация

Из-за отсутствия естественной древесной растительности на ровных или возвышенных элементах рельефа защитное лесоразведение связано с введением древесных видов инорайонного происхождения. Неконтролируемый процесс обогащения защитных лесных насаждений древесными растениями в малолесных регионах приводит к инвазиям.

Цель – разработка регламента подбора древесных растений для безопасного повышения биоразнообразия защитных лесных насаждений в степи и полупустыне.

Выявлено, что кластерные дендрологические участки Федерального научного центра агроэкологии, комплексных мелиораций и защитного лесоразведения Российской академии наук (ФНЦ агроэкологии РАН) служат полигоном с контролируемой территорией для безопасного испытания растений. Объектом исследований являлись 600 таксонов,

различного географического происхождения и возраста. Для защитных лесных насаждений деградированных экосистем (Волгоградская, Самарская области) рекомендовано 168 видов деревьев и кустарников. Результаты исследований родовых комплексов положены в основу схемы анализа перспективности древесных растений и подбора экономически важного ассортимента. В условиях сухой степи перспективны для повышения биоразнообразия экономически важные группы из семейств *Rosaceae, Caprifoliaceae, Oleaceae, Fabaceae.* Регламент включает создание фонда посадочного материала. Базируется на экологичности, хозяйственной пригодности, инновационной привлекательности.

Проведен мониторинг экспериментальных популяций, образующих самосев. В засушливых условиях выявлены безопасные способы размножения древесных растений. Разработан алгоритм количественного и качественного улучшения ассортимента древесных растений для выбора лучшего из возможных вариантов и критерии регулирования устойчивого использования биоразнообразия древесных растений. Они включают внедрение, селекцию, семеноводство и апробированы на объектах района исследования.

Ключевые слова: древесные растения, биоразнообразие, подбор, обогащение, регламент, устойчивое использование, инвазии.

1. Introduction

A feature of the arid region of Russia is the lack of natural tree vegetation on flat or elevated elements of relief. The beginning of afforestation in the arid zone dates back to the fifties of the nineteenth century. In the 30-ies of the twentieth century a wide scale of protective afforestation was received in the steppe zone. In recent years, it has spread to the dry steppes and semi-deserts. The history of steppe and semi-desert afforestation is associated with the introduction of tree species of foreign origin.

Experimental stations of the All-Russian Research Institute of Agroforestry (now the Federal Scientific Center for Agroecology of the Russian Academy of Sciences) have accumulated material on the introduction of tree species into arid regions during this period. In recent years, an unfavorable situation has developed for the growth and development of woody vegetation. After the cold winters (1971/72, 2005/06) and droughts (1972, 1975, 1996, 1998, 1999, 2010), protective forest planting in considerable areas are drying up.

Enrichment of dendroflora is intended to improve protective forest plantations. Enrichment of dendroflora is a process of quantitative and qualitative expansion of the assortment and selection of the best possible option [1, 4].

In some countries and regions, there are approved lists of potentially invasive species that cannot be imported, grown or distributed through sale. The big problem is the preservation of collections and the prevention death of exotic plants than the problem of the escape of plants from collections to the environment [7]. Collectible plots serve as a good testing ground with a controlled area where it is possible to safely test plant species that pose a potential threat and develop appropriate recommendations.

Modern composition of protective forest ecosystems arid zones of Russia dendrologic are not complete (about 45 and 33 taxa trees - shrubs) [4, p 37]. Dendroflora enrichment is aimed at developing nursery economically valuable shrubs [3].

Multifunctionality of plantating is ensured by the expansion of biological and genetic diversity in time and space; creating a multi-tiered structure; by differentiated selection of trees and shrubs [6].

The purpose of research - development of the rules of selection of introduced trees and shrubs to enhance biodiversity and enrichment dendroflora of protective forest plantations by economically valuable plants.

2. Objects and methods

The basis of the research is the collections of clusters of the FSC of Agroecology RAS, located in different soil and climatic conditions:

- Kamyshinsky Arboretum (cadastral № 34: 36:0000:14:0178),
- Kulundinsky Arboretum (№22:23:010003:14)
- Povolzhsky Arboretum (№ 63:23:0908001:0002; 63:17:0000000:0236),
- Volgogradsky Arboretum, Federal State Unitary Enterprise "Volgogradskoye" (34:34:000000:122, 34:34:060061:10).

Over a large area, which conducted the study of introduction, climatic conditions is not equivalent (Table 1).

Table 1 – Characteristics of cluster section

Cluster section	Year of bookmark	Air temperature, ° C			Relative air humidity, %	Amount of precipitation, mm	Soil type	Humus content, %
		medium	max	min				
Volgogradsky	1962	7,6	+43	-35	41	350	light chestnut medium loamy	0,8-1,2
Kamyshinsky	1931	5,4	+41	-39	40	386	dark chestnut sandy loam	1,5-2,5
Povolzhsky	1950	3,7	+40	-45	46	395	ordinary medium loamy chernozems	5,0-6,0
Kulundinsky	1977	1,9	+41	-50	50	270	chestnut light loamy	1,4-2,5

The xerothermal regime of the climate in the research areas determines the arid orientation of the assortment selection for protective forest plantings.

On the basis of a multi-year complex study of biological potential and economic suitability of tree species, a regulation and a scheme for determining the assortiment of economically important plants have been developed [2, 6].

3. Results and discussion

Resources for rationalizing nature management, combating drought and desertification include 600 taxa of woody plants of different ages and geographical origin. They are concentrated in the collections funds of cluster sites of the FSC of agroecology RAS [5, 6]. On the basis of complex studies (biological potential and economic feasibility), representatives of families *Rosaceae, Caprifoliaceae, Oleaceae* and *Fabaceae* are perspective for increasing the biodiversity of degraded ecosystems (Figure 1).

Groups for practical use	Family, genus
Forest meliorative Decorative Fruit plants Medicinal Honey	*Rosaceae (Aronia, Amelanchier, Crataegus, Malus, Rosa, Sorbus)* *Berberidaceae (Berberis, Mahonia)* *Elaegnaceae (Shepherdia)*
Forest meliorative Decorative Nitrogen-fixing Honey	*Fabaceae (Amorpha, Caragana, Astragalus)*
Forest meliorative Decorative Honey	*Caprifoliaceae (Lonicera, Sambucus),* *Oleaceae, (Forestiera, Ligustrum)* *Rosaceae (Amygdalus, Spiraea)*

Figure 1 – Economically important family groups

One of the most important and large by taxonomic composition is the *Rosaceae* family (Figure 2).

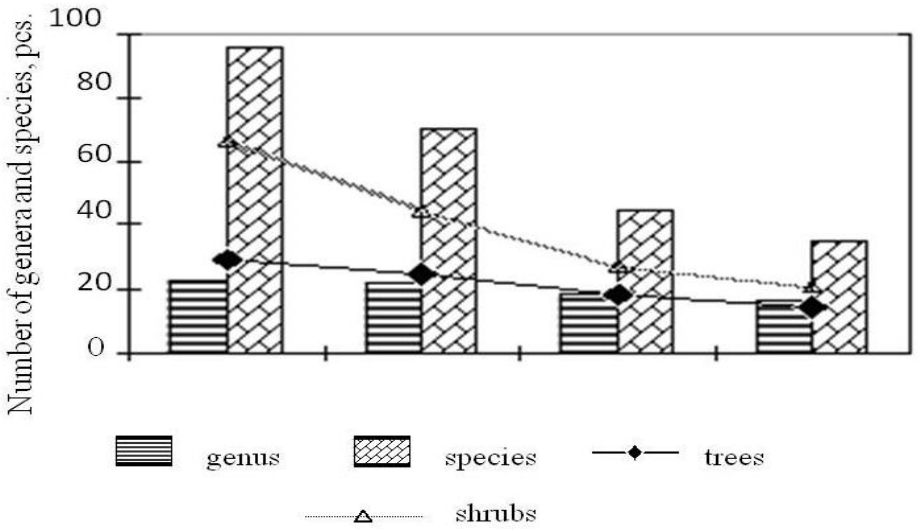

Figure 2 – Resources representatives of *Rosaceae* family in clusters:
1 - Volgogradsky, 2 - Kamyshinsky, 3 - Povolzhsky, 4 - Kulundinsky

The trees and shrubs of the Rosaceae family are the basis of fruit growing and ornamental horticulture (*Malus, Pyrus, Cerasus, Armeniaca*). Good honey plants – *Cotoneaster, Rosa, Spiraea*. Medicinal plants – *Crataegus, Aronia, Sorbus*. Suitable for protective forest plantations are *Chaenomeles, Cotoneaster, Amelanchier, Amygdalus, Crataegus, Rosa, Spiraea, Sorbaria*.

Conservation and use of woody plants includes ecological-biological, adaptive-landscape and economic principles (Figure 3). The practical value of the results is indicated in the implementation mechanism. Measures for conservation and use have been tested in the collections the FSC of agroecology RAS (Volgograd).

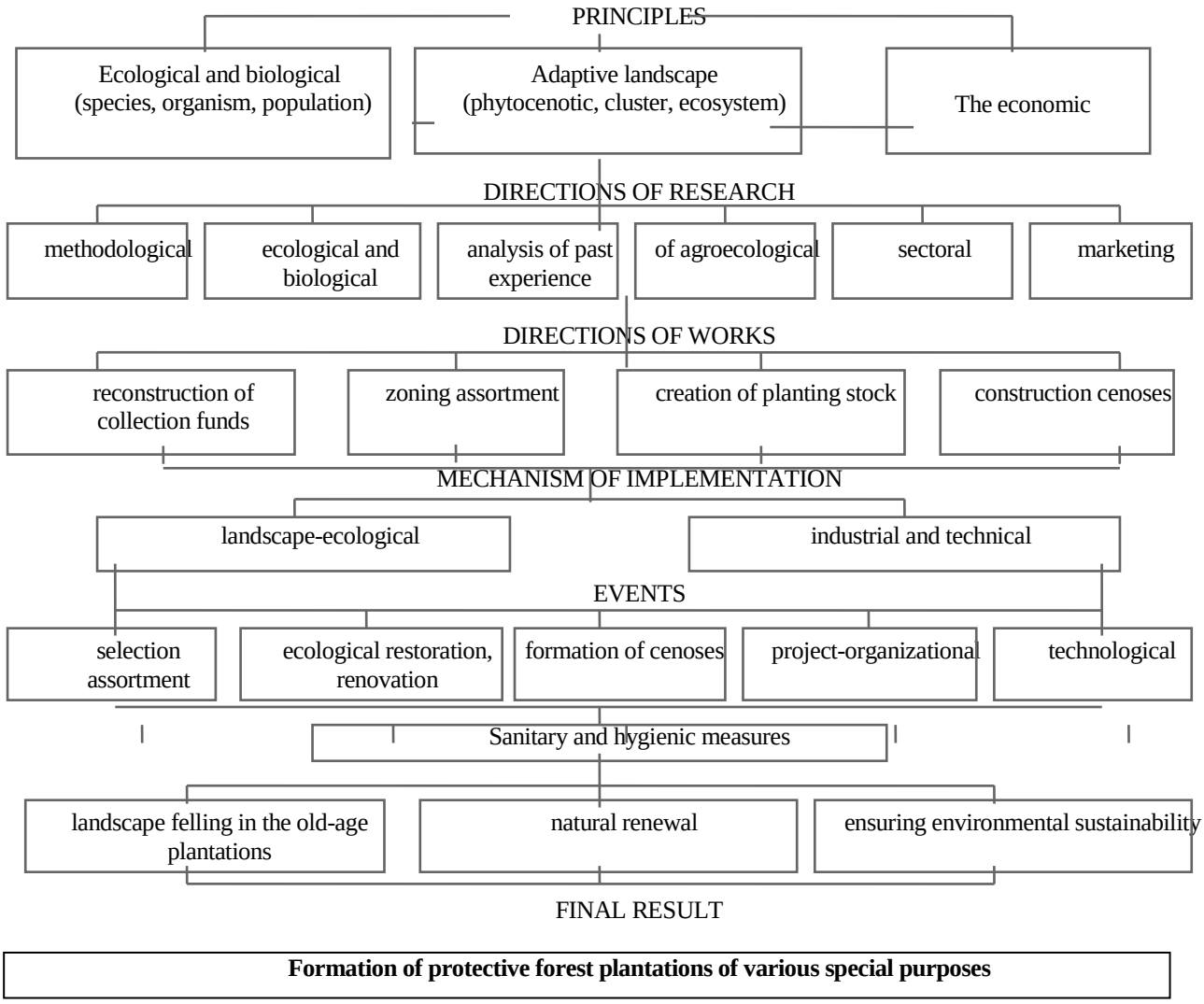

Figure 3 – The scheme of regulation of enrichment and sustainable use of biodiversity of trees and shrubs

The regulation of the enrichment of the biological diversity by economically important plants in agrolandscapes makes it possible to obtain food raw materials. Preserves soil fertility, reduces energy consumption, mineral fertilizers and pesticides and increases the ecological capacity of the territories.

The main method of increasing the biodiversity of plantings is to create a stock of planting material and introduce it into the culture of artificial cenoses. The formation of multifunctional forest plantations - landscaping, environmental protection, ravines, pastures, is carried out on the basis of the regulations of measures.

Scientifically grounded principles for creating planting stock of the species and form diversity of economically important trees and shrubs include:

– ecological and biological principle (optimization of resources and expansion of biodiversity of economically important woody plants, selection of an adaptive gene pool, scientific seed breeding and seed production, zoning of assortment);

– landscape-organizational principle (balance of interaction of plants, natural and anthropogenic factors to reduce degradation, creation of seed base, nursery);

– economic principle (increase of production efficiency of planting material, formation of innovative product, analysis of potential demand and government purchases).

The introduction of trees and shrubs for protective forest stands of different purposes allows solving specific tasks of agroecological regulations related to the problem of desertification and soil degradation [4]. The experience of implementation in the arid belt of Russia has shown that out of several thousand trees and shrubs tested there, it is possible to successfully grow just over 300 species. Among them there are species that provide medicinal and technical raw materials, feed, fruits, honey, phytoncid plants and many meliorative forest species.

Over time, some of the introduced species began to bear fruit. Reproduction of plants without human help led to intrusion, i.e., unauthorized distribution, the formation of new plant communities with their participation, their introduction into local phytocenoses, and in some cases even the displacement of Aborigines. An uncontrolled naturalization process can lead to significant disturbances in local phytocenoses, especially in grassy vegetation.

To overcome fundamental disagreements on this problem it is necessary: to differentiate the enrichment of dendroflora taking into account the limiting factors of plant growth and development and the ecological and economic effect; in various environmental conditions, conduct special experiments on model objects; generalize and analyze all incoming information [4, 8].

Significant progress in recent years has been achieved in the field of modeling of the invasive process. Models show that there is no simple dependence of community biodiversity and its resistance to invasions, and the prediction of the result of the invasive process requires careful biological and mathematical analysis of the situation in each specific case.

Observation of the behavior of wood introducents is assessed by the degree of development in with the possible production of reproduction.

According to the scheme (Figure 4), relative assessment and analysis is performed in comparison with the local species. The high degree of adaptation of most species is due to the fact that in the process of evolutionary development, plants have the ability to adapt to a wide range of climatic parameters variability. These species have great scientific and practical value as multipurpose plants and are represented by polymorphic generic complexes (*Crataegus, Rosa, Lonicera*).

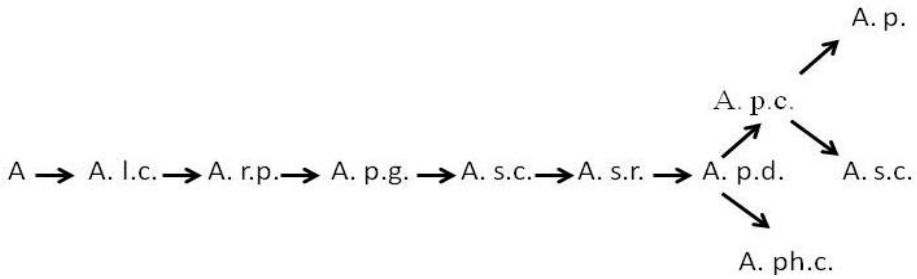

Figure 4 – Analysis of the prospects of woody plants for the purpose of selection of the adapted gene pool for protective afforestation

A – is the original area; **A. l.c.** – the area of a long culture, when the introducent exists for a long time in the region of introduction with different degrees of vitality; **A. r.p.** – the range of resistance to climatic factors at the level of plasticity, when the introducent retains all its biological properties; **A. p.g.** – area of preferential growth of introductions before the local ecologically replaceable form, species; **A. s.c.** – area, further limited by soil conditions; **A. s.r.** - area of sufficient reproduction; **A. p.d.** – area of sufficient resistance against pests and diseases; **A. p.c.** – the area of pure culture; **A. p.** – the area of plantation culture; **A. ph.c.** – the area of mixed phytocenotic culture; **A. s.c.** – area of silvicultural culture (taking into account the economic effect)

4. Conclusion

The procedure for selecting multi-purpose woody plants is determined by the assessment of the potential of natural resources and the following features of trees and shrubs:

* Biological stability (wide range in natural conditions with high environmental plasticity);
* stability in phytocenoses (compatibility of species in phytocenosis, durability of phytocenoses);
* economic value (fodder, medicinal, technical, food, honey);
* stabilization of the environment (soil-protective, soil-improving, resource-reproducing and landscape-forming).

In assessing the bioecological potential of plants and determining the prospects for species of generic complexes, the cluster approach is the basis for selecting an assortment.

The development of criteria for the regulation of the provision and sustainable use of the biodiversity of woody plants includes the introduction, selection, seed production and nursery. They are necessary for the formation of protective forest stands of different purposes for the stabilization of agro- and urbolandscape in conditions of desertification and degradation.

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Conflict of Interest

None declared.

Конфликт интересов

Не указан

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