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Prospects Of Employing The Ecological Method Of Plant Introduction While Establishing The Man-Made Ecosystems Of Different Designated Use.

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ABSTRACT

For establishing and reconstructing the man-made ecosystems of different designated use it is necessary to work out the range of plants characterized by the great stability, decorative value, and other commercially valuable features differentiated according to the natural environment of the region under study. While introducing plants by means of the ecological method it is necessary to pay a special attention to the theoretical selection of species composition prospective for being introduced in the region. The next important stage is singling out the factors limiting the introduction, defining the possibility of their neutralization in the region of establishing the man-made ecosystems and modeling the conditions which are optimal for keeping the introduced species in the culture. The whole research process should be based on the environmental laws, patterns, rules and phenomena directed at reducing the terms of the empiric research into developing new species and introducing them into the culture.

Keywords: plants, introduction, methods, laws, toleration, ecosystems, conditions, modeling.

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RESEARCH APPLICABILITY

Environmental problems are extremely acute in the most arid regions of our country which are the most vulnerable to the erosion processes resulting in desertification and environmental crisis. The soil and atmospheric droughts, high temperatures, severe wind conditions have a negative impact on recreational and protective plantings as well as the plantings used for beautification *(decoration)* of cities, towns and other residential areas. The flora scarcity of long-stemmed, ornamental plant species taking place in some of the regions determines the applicability of their enrichment by means of introducing new species from other regions aimed at establishing and reconstructing the man-made ecosystems of different designated use. The solution to this problem depends on the effectiveness of studies of plants introduction. These researches should include not only the theoretical justification of the starting material prospective viability while choosing new species, hybrids, forms and sorts but also they should working out the agricultural methods of their reproduction, growing and keeping in the culture while establishing the new man-made ecosystems and reconstructing the existing ones. In these circumstances a great importance is attached to defining the species tolerance to the abiotic factors whose force in the studied region exceeds the alien tolerance. It is necessary to work out the methods providing a means of neutralizing the negative impact of these factors and modeling the optimal conditions for plants growth and development. A great importance should be also attached to working out and implementing progressive agricultural methods of mass reproduction, cultivation and keeping of plants depending on the species environmental spectrum and the natural conditions in the studied region [8, 9, 10, 13]. Only in this case it becomes possible to ensure the establishment of high-performance man-made ecosystems meeting the demands of the present-day ornamental horticulture, protective afforestation and forest cultivation work [2, 3, 8-14]. Unfortunately, the environmental laws are not always applicable to the theory and practice of plants relocation [2, 3, 8, 9]. In the process of defining goals and objectives of analyzing plants introduction the researchers traditionally adhere to the thesis which was first used in the 30-ies of the 20^{th} century and which consists in directing at "searching for the most salt-, heat- and drought-resistant species and the species corresponding to the natural conditions of the region into which the plants are introduced, as well as the species characterized by the commercially valuable features" [2, 3]. The introduction methods were built up without taking into account the evolution theory, biocoenoses development, the species tolerance formation, its life form and range. The species non-existent in nature were searched for. Despite the generally known fact that the more resistant the species is to, for example, drought or soil salinity, the smaller is its biological productivity and height, this area of focus returns us to applying the method of phytoclimatic analogues in the process of plants introduction, which ensures the positive effect of species mobilization from similar natural conditions. Employing this method it is impossible to solve the problem facing introduction, ornamental horticulture and beautification [13].

Research objective

The research objective is to work out the new method of plants introduction based on the environmental laws, patterns, rules and phenomena and enabling to increase the effectiveness of introduction researches and to reduce the time necessary for establishing and reconstructing man-made ecosystems, to increase their environmental significance, productivity and stability.

RESEARCH METHODS

Fundamental researches in the fields of plants botany, physiology and ecology contributed to explaining a lot of natural phenomena, laws and patterns which laid the foundation for selecting the potentially productive species depending on the natural conditions of the introduction region [1, 2, 4, 5, 6, 7, 9-14]. The laws were discovered which explained the formation of the phytocenosis biological productivity, life form, range and tolerance of species included into the phytocenosis. The researches dedicated to studying the mechanisms of plants adaptation are of special interest in the process of plants introduction. It was discovered that plants adaptation is revealed in the dynamic correspondence to the morpho-physiological structure and their adaptive reactions to the typical and major factors of the environment in which this or that species was formed. Organisms physiological adaptation lies at the basis of their adjustment to the change in the environmental factors within the plant range and is directed at preserving individuals, populations and species. Each species possesses its own ecological valence related to the impact force of this or that factor as well as its own ecological spectrum formed in the process of evolution which is proved by Charles Darwin's maxim on the species adaptiveness to abiotic factors. The selection and mobilization of aliens in the region under study calls

for working out the practical recommendations with the precise program and sequence of its implementation [7, 8]. In accordance with the evolution theory, the species biological productivity, its life form and habitus depend on the habitat ecological conditions and first and foremost on the degree of moistness and warmth provision which is confirmed by the periodic law of geographic zonality as well as by the comparative analysis of dependence of the phytocenoses and ecosystems biological productivity value from the hydrothermal conditions characteristic of them [4-7].

Thus, introducing the species into more severe forest growth conditions we will necessarily face the problem of non-conformity of the species ecological spectrum to the introduction region conditions. Most often the ecological valence limits in the introduction region will be exceeded by the moistness and warmth deficiency and also the edaphic factors closely connected with it. These problems may be solved by the ecological introduction methods and the progressive agrotechnical ways offered by us. These methods are aimed at optimizing the conditions of plants reproduction and keeping [7]. The basis for the method formation is made up by the ecological laws, rules and phenomena.

The methodological basis of the offered introduction method is the synthetic evolution theory which is the synthesis of Darwin concept of natural selection with genetics and ecology and also adopting the population as the evolution elementary unit [6, 7]. Ch.Darwin's maxim on the species adaptation results in the need for singling out the main factors limiting the introduction with the further neutralization of their negative influence on the introduced species [7]. The necessity of these actions is proved by the whole range of laws and first and foremost by the framework laws of optimum, minimum and tolerance. For example, the law of minimum (Y. Liebig) proves that the species biotic potential (its viability, organisms and population productivity) is limited by the environment factor which lies in the minimum though all the other conditions are favourable. These conclusions are also justified by the laws of periodic geographic zonality (A.A.Grigorieva, M.I.Budyko) according to which together with the change of physical and geographic belts similar landscape zones and some of their most general properties are periodically repeated. The periodicity established by the law is revealed in changing the dryness index values in different zones from 0 to 4-5, three times between the poles and equator they are close to 1. Landscapes greatest biological productivity corresponds to this value. The radiation dryness index is composed of the relation of the radiation balance to the amount of heat necessary for evaporating the annual sum of rainfall. As one may see from this law, landscapes productivity depends on the hydrothermal conditions typical of this territory. The necessity for neutralizing the negative impact of environmental forces exceeding the limits of the species tolerance by means of establishing the artificial man-made ecosystem using the material and energetic resources is proven by the ecological succession phenomenon, the process of the directed continuous succession of changing the organisms species composition in the given habitat. Only modeling the conditions in the introduction region contributing to the species natural habitat will contribute to its normal growth and development and will allow to realize its potential.

Employing the law of changeability, variability and diversity of responses to environmental factors in different species individuals makes it possible to minimize the experimental research into testing the mobilized species. The observation of seedlings, juvenile and immature plants conducted on the basis of weather conditions and the dynamics of soils water and salt conditions give the sufficient information for defining the introduced species prospects.

The work scientific novelty

In the process of introduction it is offered to pay a special attention to the species theoretical selection and grounding, as well as defining the factors limiting the introduction and exceeding the tolerance limits and possibilities of their neutralization in the region under study. For the first time ever it is offered to model the optimal conditions in the introduction region corresponding to the species natural habitat as well as to reduce the terms of empiric researches directed at the species assimilation and introduction which is justified by the ecological laws.

FINDINGS AND DISCUSSION

As a result of longitudinal researches conducted in different natural zones of the Russian Federation and Kazakhstan, the method of introducing woody plants was worked out and tested which lies at the basis of

establishing highly-effective stable man-made systems of different designated use. The method consists in the successive solution of the program questions making up four stages of research: 1) setting objectives and practical tasks; 2) the theoretical selection of the species composition advantageous for the introduction; 3) modeling the environmental conditions corresponding to the species natural habitat; 4) the species mobilization and assimilation in the introduction region, i.e. their introduction to the culture.

The first stage of introduction research consists in setting objectives and practical tasks. Objectives and tasks may imply working out and introducing into the culture of the ornamental range of plants for beautification of cities, towns, workers' settlements, industrial sites, implantation along highways and railways, fired-protective afforestation, sand-dune stabilization, gully and river banks afforestation, developments of forest plantations, parks, tree nurseries and botanic gardens. This stage includes studying the introduction region natural conditions and its material and energetic resources endowment. It goes without saying that it is useful to tap into the introduction expertise available in the neighboring regions as well as the species composition of the flora economically valuable species. On the basis of the information obtained the scopes of implantations are determined and implantation far-reaching plans are worked out. It is necessary to pay a special attention to the water resources endowment of the region. Practice shows that implantations are often left without any irrigation which leads to their untimely demise. Implantations on large territories (green zones around cities and towns, sand stabilization) can result in ground waters level reduction. It may have a negative impact on the pastures productiveness. Taking water resources from rivers and water reservoirs for large-scale irrigation also leads to the negative consequences. Positive results of using wastewater for irrigation were obtained. In Mangyshlak peninsula (Kazakhstan) the atomic reactor was built for desalinizing the Caspian Sea waters, Employing the drip irrigation and growing plants in containers are also aimed at the rational use of water resources.

The second stage consists in the theoretical selection and grounding of the reference species composition advantageous for introduction. At present the advantageous floristic sources for introducing the reference species into different areas of Russia have been found. They are Circumboreal, East Asian, Atlantic and North American, Rocky Mountains, Madrean, and Iran-Turanean floristic areas being a part of the Holarctic Kingdom. Thus, the advantageous sources for obtaining reference introduction species are the floras belonging to the moderate physical and geographic belt of the globe. Among the floristic sources the species possessing a wide geographic range and xeromorphic features are of the greatest interest.

However, one should not forget that the species tolerance is reversely proportional to its biological productivity. The higher is the salt- and drought-tolerance of the species, the lower are its habitus, life-form and ornamentation features. Further researches consist in defining the main ecological factors limiting the species introduction. To do this the species ecological spectrum is defined and the most important factors whose force in the introduction area will exceed the tolerance limits are revealed. This problem is solved by comparing the conditions of the species natural habitat with the introduction region conditions first and foremost according to such parameters as hydrothermal conditions and the temperature absolute minimum. The species whose introduction is limited only by the moistness deficiency can be subject to mobilization into the introduction area. Moistness deficiency and other abiotic factors connected with it can be eliminated by agrotechnical methods (irrigation, full-scale reclamation, fertilization etc.). It does not seem possible to neutralize the negative effect of the minimal temperatures exceeding the limits of the species tolerance. To compare the environment conditions in the introduction area and the species natural habitat conditions alongside with some other necessary information it is useful to employ hydrothermal indices. The information on the radiation balance value, gross humidifying and the temperature absolute minimum registered for the compared regions is necessary. The species inhabiting the areas with warmer climates where the temperature absolute minimum is higher than in the introduction area are unpromising for mobilization and further study.

Theoretical selection and grounding the reference species composition advantageous for further introduction makes it possible to proceed to the third stage of the experiment – modeling the environment conditions in the introduction area which correspond to the species natural habitat.

The introduced species should differ from the representatives of the natural flora by habitus, productivity, ornamentation and other economically valuable features. Within the moderate physical and geographic belt these species can be found in the regions where the hydrothermal index value exceeds the one in the introduction region. In the process of modeling the conditions corresponding to the introduced

species natural geographic range depending on the edaphic conditions we first and foremost face a number of key problems which must be necessarily solved before the species mobilization or implantation.

These problems should be revealed and solved in the process of implementing the first three stages of the introduction research. In arid regions the formation and development of implantations is possible only in conditions of irrigation. However, it is necessary to bear in mind that irrigation leads to one of the two variants of developing the processes happening in the soil root layers. When the natural drainage, the soils high filtration, their great depth and the aquiclude deep bedding are available, soil desalinization will be observed that will have a positive impact on the formation of edaphic conditions and the introduced species growth and development. In this case the question of the degree of the introduced species salt tolerance is not that acute. Unfortunately, this way of processes development caused by the cultures systematic irrigation is observed quite rarely in the regions with salinized soils and the closely lying aquiclude. Most often the natural drainage is unavailable. In this case irrigation leads to increasing the ground waters level and developing the processes of secondary salinization and soil bogging. The study of the introduced species salt tolerance does not enable to solve this problem.

Thus, during the third stage of research it is necessary to forecast the development of the processes connected with the implantation irrigation and if necessary to conduct the full-scale reclamation and establish the drainage systems. Only after the solution of these problems it is possible to proceed to the fourth stage of research consisting in the mobilization and assimilation of species in the introduction area and their inclusion into the culture.

The research tasks foreseen by the first stage consist in the species mobilization and experimental testing, their ecological assessment and defining the degree of advantageousness for being introduced into the culture. Employing ecological patterns of changeability, variability and diversity of response reactions to environmental factors which are in force in some of the species makes it possible to reduce the experiment terms to from two to three years for bushes and from four to five years for trees. In accordance with the pattern, young plants possess the narrowest ecological valence. Therefore phenological observations of young plants are highly informative. Visual observations of seedlings, juvenile and immature individuals during their vegetation periods and especially during the periods of extremely high temperatures, air dryness, as well as of their overwintering results provide rather objective information on the possibility of cultivating this plant in the introduction area.

Within the whole period of the introduced species testing the studies aimed at working out the scientifically ground and advantageous technologies of the species reproduction and the effective agrotechnical methods of keeping them in culture should be carried out. These methods and technologies enable the individuals of the given species to realize their prospective opportunities. In the process of plants reproduction and growing the planting material the implementation of drip irrigation, planting hydro-isolated check plots with permanent moisturizing fed by the drainage and the container method of plant growing are of great practical interest. Employing containers with the perforated inner wall enabling to regulate water conditions as well as the method of generative reproduction of a number of woody species in winter period using warm premises were successfully tested. The concluding step in the fourth stage is introducing advantageous species into the culture. This stage consists in growing and delivery to organizations dealing with beautification, protective afforestation, forest plantations and planting material of the species that have successfully undergone the test output as well as in conveyance of the developed practical recommendations of their reproduction and keeping in the culture.

Results validity

Is ensured by analyzing a large scope of the obtained factual material in the field of plants introduction and establishing the man-made ecosystems of different designated use in the world and in Russia, a large scope of the authors' own experimental researches conducted using the contemporary methods in the field of ecology and biology in different soil and climatic conditions from desert and semi-desert to the steppe, forest-steppe and forest zones. The research material was processed using the computer programs of Microsoft Excel 2010.

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CONCLUSION

The introduction ecological method and progressive agrotechnical methods of reproducing and keeping plants (using the container method of growing plant materials, drip irrigation and seeds planting into the hydro-isolated check lots with the permanent moisturizing fed by the drainage) are successfully tested in a number of regions in Russia and Kazakhstan. This method may be successfully used not only for creating tolerant, ornamental and productive implantations but also to solve the questions connected with preserving biodiversity and the recruitment of rare and endangered species.

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