International Journal of Genetic Engineering 2023, 11(1): 1-4
DOI: 10.5923/j.ijge.20231101.01

Biological Features of Introduced Plants on Saline Soils of the South Aral Sea Region and the Influence of Soil-Climatic Environmental Factors on Them

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Abstract The article presents a study of the biological and ecological features of introduced woody plants, their adaptability to anthropogenic desertification in the south of the Aral Sea region. Due to the consequences of anthropogenic impact of the Aral Sea region, there is an increase in the processes of soil salinization, an increase in the mineralization of groundwater and vegetation degradation. Thus, the shortening of the life of exotics is affected by the close occurrence of the groundwater level, which in most cases are highly saline. The closer the saline groundwater level is to the soil surface; the less exotics live.

Keywords Introduced woody plants, Aral Sea region, Salinization, Landscaping, Anthropogenic impact, Soil salinization

1. Introduction

The South Aral Sea (Republic of Karakalpakstan) is located at the junction of such large deserts as the Ustyurt Plateau, northwestern Kyzylkum, from the southwest it is closely adjacent to the Zaunguz Karakum desert and the new desert Aralkum, formed as a result of anthropogenic impact. It is characterized by a sharply continental climate and intense insolation, increased dryness of the air and a small amount of precipitation.

It is known that a change in external conditions causes morphophysiological changes in organisms aimed at adapting to new conditions [7].

The study of biological features of introduced plants is of great importance for the successful solution of acclimatization problems. Almost always, during the introduction of plants, they fall into unusual conditions and are forced to adapt to them throughout the entire period of ontogenesis. Significant discrepancies in the biological properties of the introducers and the ecological conditions of the culture site require increased expenditure of vital resources for adaptation.

The aim and objectives of the study.

The aim of the study was to study the biological and ecological features of introduced woody plants, their adaptability to anthropogenic desertification in the south of the Aral Sea region.

Objectives: to study the features of the rhythm of growth and development; to determine the entry of woody plants into the generative phase; to establish the life expectancy of woody plants depending on environmental factors.

2. Methods

One of the methods of studying introduced plants is a comparative study of the rhythms of seasonal development. This makes it possible not only to establish the timing of the passage of various phases of development, but also to assess durability and productivity.

Objects: introduced woody plants.

3. Results

The research was carried out in the Botanical Garden under the Karakalpak Branch of the Academy of Sciences of the Republic of Uzbekistan and in cities and settlements of the Republic of Karakalpakstan.

The south of the Aral Sea region is characterized by a sharply continental climate and intense insolation, increased dryness of the air, low precipitation. The great distance from the oceans - the main sources of moisture, high summer temperatures, a long period of drought – are the main reasons for the formation of large desert areas here. The lack of

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Received: Jan. 16, 2023; Accepted: Feb. 2, 2023; Published: Feb. 15, 2023
Published online at http://journal.sapub.org/ijge

moisture in the soil and air in combination with high temperature is the main factor determining the direction of soil–forming processes and the vital activity of plants and animals.

The study of the seasonal rhythm of the development of woody plants is of great importance for the successful solution of gardening problems. In the individual development of woody plants, age-related changes are closely related to seasonal ones. The latter are rhythmically repeated annually throughout the entire, sometimes very long, life of the plant.

The rhythm of seasonal development in plants arose in the process of evolution as an adaptation to the pronounced annual change of climatic phenomena.

The rhythm of seasonal development of woody plants in Karakalpakstan has been poorly studied. S.K. Kabulov (1981) studied the seasonal development of species of the genus Acer, and T.O. Otenov (2) studied seasonal phenomena in Padus species.

Plant growth is a very reliable criterion for the adaptation of a species, reflecting the bioecological characteristics of species due to their systematic affiliation, origin, evolutionary history and climatic conditions of the point of introduction.

Studies have shown that plants in desert regions are characterized by the highest intensity of linear growth during mesothermal periods of the year. In summer, with the onset of heat and drought, this process noticeably slows down or stops.

The combined effect of moisture deficit and high temperature on plant growth has not been studied enough, which is largely due to methodological difficulties. In the course of evolution, the aborigines have developed adaptations to unfavorable environmental factors. Moreover, depending on specific conditions, the same physiological or morphological factor can play a different role in plant life.

The adaptation of introduced plants to physiological drought and to soil salinization occurs by suppressing the growth of the aboveground part of the plant. They have a reduced overall height, crown size, trunk diameter. Therefore, in the conditions of the south of the Aral Sea, non-district trees acquire a stunted shape than in comparison with other points of growth (Jollybekov et al. 1996).

The species studied by us differed in terms of the timing, duration of growth and the amount of growth. Foreign plants, in the desert areas of the south of the Aral Sea region, grow most intensively in the spring. At this time, adult plants provide almost all of their annual growth. Young plants grow intensively in the summer months. In the desert areas of the southern Aral Sea region, plants often grow a second time, apparently this is due to favorable growth conditions after the end of spring growth. The pause and duration between the first and secondary growth varies in different species, and repeated growth can last much longer than the first.

In the desert areas of the south of the Aral Sea region, plants enter fruiting much earlier. For example, oak trees in the European part of the CIS begin to bear fruit at 30-60 years old, and in Central Asia often at 6. In the conditions of Karakalpakstan, woody plants enter the time of fruiting and seed-bearing at different ages, depending on their species and life form. So, trees from the genera of Maple (Acer), Lokha (Elaeagnus), Gledichia (Gleditschia), etc. they enter this period from 5-7 years of age and older; low trees are tall shrubs from genera: Sea Buckthorn (Hippophae), Bird cherry (Padus), Amorpha (Amorpha), Irgi (Amelanchier), etc. from 3-5 years old, and low shrubs from the genera Barabaris (Berberis), Meadowsweet (Spirea), Roses (Rosa), Dereza (Lycium), etc. from 2-3 years old.

Experiments have shown that woody plants of vegetative origin enter the time of flowering, fruiting and seed-bearing 2-3 years earlier than plants grown from seeds.

In the conditions of the south of the Aral Sea region, the duration of fruit ripening may be reduced. The fruits of foreign plants ripen in Nukus on average a month earlier than in Alma-Ata and two months earlier than in Moscow. Consequently, in the conditions of the deserts of the southern Aral Sea region, plants are characterized by greater precocity than in areas with moderate temperature and high humidity of the air and soil.

Due to the consequences of anthropogenic impact of the Aral Sea region, there is an increase in the processes of soil salinization, an increase in the mineralization of groundwater and vegetation degradation. Thus, the shortening of the life of exotics is affected by the close occurrence of the groundwater level, which in most cases are highly saline. The closer the saline groundwater level is to the soil surface, the less exotics live.

Salinization of the soil reduces osmotic pressure and makes it difficult to transport water to the shoots and leaves located above the tier. There is a so-called physiological dryness. This factor is the cause of premature drying of the apical shoots, which is typical for the plantings of the Nukus Botanical Garden (Otenov, Otenova, 2004).

Observations have shown that the most acclimatized plants are white Acacia (Robinia pseudoacacia), common Gleditchia (Gleditschia tricanthos), Catalpa (Catalpa), etc. they live no more than 45-50 years, after which new plantings are required.

Woody plants, which grow in mountainous and foothill areas in areas of natural distribution, have been severely affected by the rise in the groundwater level. Eastern willow (Salix australis), Bolean Poplar (Populus bolleana), Pennsylvania ash (Traxinus pensylvanica), Catalpa bignonioides (Catalpa bignonioides), Canadian purple (Cercidiphyllum canadensis) do not withstand increased salinization of the soil.

Relatively more resistant to salinization were the squat elm (Ulmus pumila), Gleditschia prickly (Gleditschia triacanthos), and from shrubs-Amorpha shrub (Amorpha fruticosa), Dereza (Lycium), Adelia novomexican (Forestiera neomexicana), Rose hips (Rosa), Barberries (Berberis), etc.

The winter hardiness of plants is the most significant indicator when deciding on the prospects of introducing each species into the culture in the test area. As is known, the success of introduction into culture largely depends on the correspondence of the rhythm of development of the introduced plant to the nature of seasonal changes in the new habitat. This correspondence is determined either by the similarity of the climatic conditions of the old and new habitat, or by the adaptive ability of the plant itself.

As the analysis shows, the climate of Karakalpakstan in terms of thermal, water regime and vegetation is close to such classic fruit growing zones as California, North Africa and the Middle East. At the same time, due to the sharply continental climate of Central Asia and the south of the Aral Sea region, low temperatures are possible in winter (-32 degrees C), which is not observed in the above-mentioned areas.

We will consider the winter hardiness of cultivated plants in the south of the Aral Sea region using the example of Armeniaca vulgaris.

The cause of apricot crop failure is most often the death of flower buds from recurrent cold. At the same time, in states of deep rest, apricot flower buds easily tolerate frosts up to -27 degrees C. Only lower temperatures during this period cause freezing of apricot flower buds of southern varieties. The frost resistance of apricot trees at rest is quite high. They can tolerate frosts below -30 degrees C without major damage to the skeletal part and annual shoots, but at the end of winter, after the release of the stem tissues and branches from a state of rest, apricot trees freeze out at -25 degrees C.

The peculiarities of winter in the Nukus region also lie in the fact that at this time of the year there is a great dryness of the air. This leads to the fact that along with freezing, there is also desiccation, which can not always be distinguished from freezing. Sometimes, perhaps, both of these factors work together. Therefore, there are many mesophytes and mesoxerophytes among non-hardy species of woody plants.

The experiments have shown that in the conditions of the city of Nukus, plant species that are of southern origin and mainly moisture-loving exotics of the Mediterranean, southern Europe, Asia and Southern North America are not hardy. These include: Walnut (juglans regia), Manchurian oak (J.mandshurica), Silk acacia (Albizzia julibrissin), Low almond (Amygalus nana), Cercis canadensis, Rod-shaped broom (Spartium junceum), Sakhalin velvet (Phellodendron sachalinensis), Southern dorn (svidina) (Cornus australis), Kirgazon Manchurian (Aristolochia manshuriensis), the tree of Christ (Paliurus spinachristi), Lunar seedling Daurian (Menispermum dahuricum), etc.

Winter and frost-resistant plants include: Semenov Maple (Acer Semenovii), K.Tatarsky (A.tataricum), Shrubby Amorpha (Amorpha fruticosa), Ili Barberry (Berberis iliensis), B.Common (B.vulgaris), Caucasian Carcass (Celtis caucasus), Altai Hawthorn (Grataegus Altaica), B.Songarsky (G.Songarica), Buckthorn (hippophae rhamnoides), Gleditchia Vulgaris (Gleditchia triacanthos), G.Texana, white acacia (Robinia psendoacacia), Squat elm (Ulmus pumila), Orange Maclura (Maclura aurantica), as well as native species of woody plants in which damage from low temperatures is not observed (Otenov, Grokhovatskiy et al., 2009).

However, the seasonal rhythm of frost resistance of woody and shrubby plants and its dependence on various exogenous and endogenous factors has not been fully studied.

The solution of such a complex problem as the winter hardiness of woody and shrubby plants is possible only as a result of a set of measures that include such basic elements as breeding and selection of resistant species, the development of a system of special agricultural equipment.

Almost always, during the introduction of plants, they fall into unusual conditions and are forced to adapt to them throughout the entire period of ontogenesis. Significant discrepancies in the biological properties of the introducers and the ecological conditions of the place of culture require an increased expenditure of vital resources for adaptation, which accelerates the onset of old age.

The lifespan of woody plants is of great importance in landscape gardening, not only for economic, but also for aesthetic reasons, since old, powerfully developed trees are of greater decorative value than young ones. However, woody plants have unequal longevity.

Fast-growing species (poplars, willows) are usually less durable than slow-growing ones (oak, maple). However, there are exceptions to this rule. Thus, the oriental sycamore, elms and common ash are fast-growing trees, at the same time, and are very durable.

In the conditions of Karakalpakstan, an abundance of light and heat, a long growing season ensures the rapid growth of tree introducers. The strategy of adaptation of introducers in our conditions is expressed in shortening the growth period and strengthening its pace.

Along with the decrease in growth, the life expectancy of the introducers also decreases. When examining foreign plants in gardens and parks of Nukus and settlements of Karakalpakstan, it was found that Acer tataricum, Robinia pseudoacacia, Ailanthus altissima, Fraxinus pensylvanica, Gleditshia triacanthos trees aged 40-60 years are very rare and in small numbers.

Data on the longevity of some woody and shrubby plants in nature and culture (Nukus) are presented in Table 1.

It has been established that the most short living woody plants in the conditions of the botanical garden were willow rod-shaped (Salix viminalis), Berlin poplar (Populus berolinensis), T. deltoides (P. deltoides), common chestnut (Aesculus hippocastanum), beginning to dry out or drying out already at 8-10 years of age, from bushes of Amorpha shrub (Amorpha fruticosa), species rosehip (Rosa), black currant (Ribes nigra), and others which have been living here for 13-15 years (Otenov, Grokhovatskiy, Otenova et al., 2008).

Aging can give a plant a number of developmental benefits. Aging of an entire plant is obviously one of the ways to adapt to unfavorable environmental conditions, for example, to increasing competition with neighboring plants, to too low or too high temperatures, or to lack of water.

Moreover, aging, apparently, can contribute to faster evolution, since it accelerates the change of generations, i.e. the "turnover" of genetic material.

Table 1. Data on the longevity of some woody and shrubby plants

Types	Maximum durability in natural conditions (years)	In conditions of Nukus
Sycamore Oriental	600-800	60
White poplar (silver)	300 and more	50-60
Common ash	300 and more	50-60
Elm trees	300 and more	60
Pear	200-300	60-70
Honey locust	200	50-60
Mulberry	100-150	40-100
Home apple tree	100-150	50
Eastern Biota	100 and more	40 and more
Common juniper	100 and more	40 and more
Common cherry	100-150	16-20
Willow white	80-100	13-15
Tatar maple	50 and more	45-50
Narrow - leaved loch	50 and more	60
Common quince	50 and more	40
Privet ordinary	50 and more	20
Black currant	25-30	13-15
Amorpha	15-20	13-15

Environmental conditions have a strong influence on the durability of trees and shrubs. The durability of green spaces is particularly sharply reduced in unfavorable city conditions due to air pollution with dust, smoke and harmful gases, soil poverty with nutrients and contamination with harmful impurities, as well as deterioration of water and air regime of the soil as a result of its compaction and the installation of asphalt and concrete pavement impervious to water and air.

Studies show that woody plants in Nukus are two times less durable compared to Tashkent – this is the result of the negative influence of soil salinity and strong mineralization of groundwater in the south of the Aral Sea region.

Thus, the introducers adapt to the conditions of Nukus by reducing the growth in height, the width of the annual rings and reducing life expectancy by 2-3 times. This can be considered as an individual adaptation to compensatory modification regulations. The "price" of compensation for growing in such harsh soil and climatic conditions is measured by a reduction in life. Among the introducers stand out: Squat elm, Pennsylvania ash, Moisture-loving ash, whose "price" of compensation is relatively lower than that of other introducers.

In the south of the Aral Sea region, the groundwater level, soil salinization and dry air are among the limiting factors of the longevity of woody plants. The close occurrence of groundwater, which in most cases is highly saline, leads to a reduction in the life expectancy of exotics.

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