Efficiency of forest planting in the spring and autumn periods in the conditions of the Republic of Kalmykia

M V Kostin

Laboratory of Arid Afforestation, Institute of Forest Science of the Russian Academy of Sciences, 21 Sovetskaya Street, Uspenskoe village, Odintsovo District, Moscow Region, 143030, Russia

E-mail: mwkostin@yandex.ru

Abstract. The Republic of Kalmykia is the driest region in the south of the European part of Russia. The purpose of the study is to find a new approach to reforestation and breeding in the republic, which will ensure the increase in the survival rate of forest crops, and subsequently increase the forest cover of the region. The article analyzes data for a ten-year period in a zonal section on the survival rate of tree and shrub species cultivated in the forestry of the Republic of Kalmykia. It is concluded that carrying out forest cultivation works in the autumn period has no advantages in survival rate over the spring period and they should be carried out either in early spring (in late March and early April) on thawing soil, or in autumn, before the onset of persistent cold weather. The main factor of successful afforestation in the dry steppe and semi-desert is the correct selection of the forest area, the accuracy and quality of forest planting, agrotechnical and forestry care. Special attention should be paid to the control of locust pests, which in the conditions of Kalmykia in some years can cause significant damage to the planting of young forest crops.

1. Introduction

The Republic of Kalmykia is the driest region in the south of the European part of Russia. The soil and climatic conditions of the republic and the presence of such factors as increased evaporation, low relative humidity, the presence of constant strong winds with low precipitation, low-fertile soils create complex forest growing conditions and cause low vegetation productivity, as well as the death of forest crops created on the lands of the forest fund [1, 2].

In the forestry sector of the Republic of Kalmykia, there are problems, which solution depends on the preservation of a favorable environmental situation in the republic. In this connection, it is necessary to find a new approach to reforestation and breeding in the republic, which will ensure the increase in the survival rate of forest crops, and subsequently the increase in the forest cover of the region [3, 4].

When creating forest crops in the republic, a set of measures is used to accumulate moisture in the soil. They are two-year preparation of the soil with the use of black steam, loosening of the soil with the simultaneous destruction of weedy herbaceous vegetation in the rows of crops and row spacing in order to exclude competitors for moisture in the soil. The development of forest crops in the republic is carried out artificially by planting one-or two-year-old seedlings of hardwoods with an open root system in spring and autumn. However, despite the good survival rate of forest crops in the year of their
development, in subsequent years, the condition of crops deteriorates sharply due to the complex of negative weather and climatic factors combined with severe soil conditions [5, 6, 7].

2. Materials and methods
Despite many years of experience, the main drawback that reduces the effectiveness of steppe and protective afforestation in the southern steppes is the low percentage of survival of forest crops and the low further durability of planted forests, especially in the belt of dry steppes, semi-deserts and deserts. Most plantings are often written off before they reach the age of closure and transfer to the forested area of the state forest fund. In arid areas, conditionally forest-suitable lands are common, where forest formation is possible only if it is artificially stimulated – by promoting the formation and preservation of the forest environment. The drought resistance of plantings decreases with the increase in the aridity of the climate and the weighting of the soil composition [8, 9].

The main reason for many failures lies not in them or lack of knowledge, but in the fact that this knowledge has not been implemented in strictly justified technological regimes for the development and cultivation of plantings and, unfortunately, has not received complete scientific formalization, general recognition and dissemination. To search for the causes (critical conditions) influencing the success of protective afforestation, we have carried out the analysis of the official data on the survival of forest crops, tree and shrub species planted in spring and autumn in the context of the five forest districts of the Republic of Kalmykia, and comparison of information from long-term scientific and production experience of grassland afforestation on the influence of many other factors, evidence of water regime and condition of forest stands, including those made in the last 10-20 years [10, 11].

3. Results and discussion
Traditionally, the best time for planting seedlings and plantlets when creating forest crops is considered to be the early spring period (with the onset of phenological spring from March to April), depending on the weather conditions during this period. On the territory of the Republic of Kalmykia, winters are usually snowless, spring comes early, its duration is relatively short, and in early May, the air temperature can reach +20-23 °C [12].

The optimal timing of the spring planting period is 5-7 days in late March, early April. After that, the sun begins to actively heat the earth's surface, the soil dries up quickly and the planting of forest crops becomes meaningless, since the planted material simply does not have time to gain a foothold on the forest-cultivated area.

All forest planting works in the republic are carried out with the use of bare-rooted seedlings, grown from local seeds or purchased in neighboring regions. Bare-root seedlings are seedlings grown in the open ground and dug out of the ground with bare roots.

Seedlings of this type are planted in a permanent place before the beginning of the growing season or at its end, i.e. at quiescence. In the spring, seedlings and bare-root seedlings are planted in the period from the moment the soil is ready for mechanized work and until the leaves bloom on the plants being planted. During this period, the planting material is able to quickly take root on the forest-cultivated area and quickly adapt to new growing conditions [13, 14].

In the arid conditions of the south, the spring planting season, as mentioned earlier, is limited to a few days and is highly dependent on current weather conditions. The autumn period of planting seedlings and plantlets is longer. It begins when the soil is saturated with moisture and the average daily air temperature drops to 10 °C. The duration of the autumn period of forest planting in Kalmykia is from one to two months, depending on the weather conditions of the year. As a rule, during this period, planting is carried out by seedlings that have finished growing (at quiescence) and are prepared for winter. The survival of plants at this time is less painful, and rooting takes no more than two weeks.

According to the Ministry of Natural Resources and Environmental Protection of the Republic of Kalmykia, for the period from 2010 to 2019, 8093.2 hectares of forest plantations were developed, of which only 281.3 hectares, which is 3.5%, were transferred to the forested area. This is an extremely low indicator, but not the final one, and it does not allow to draw final conclusions about the
effectiveness of forest planting in the republic, since most of the young plantings planted have not reached the age of closeness.

Provided by the Ministry of Natural Resources and Environmental Protection of the Republic of Kalmykia data on the volume of development, cancellation, survival of forest crops for 2010-2019 in the context of the five forest areas not talking about the advantage of autumn before spring planting, survival of forest crops in different years varies from 0 to 92% of them (data) do not reflect many other factors, namely, the exact timing of planting in spring or autumn; the weather conditions preceding and accompanying the planting; isopropanol sections of reforestation; the presence or absence of technological failures silvicultural works; the quality, quantity and timing of agrotechnical and forestry care; the amount of damage to forest crops from insects, diseases, and damage to agricultural livestock. In other words, the presented data do not reveal the exact causes of the forest crops mortality, which in the conditions of the Republic of Kalmykia are very diverse and often have a spontaneous nature.

For example, significant damage to the planting of young forest crops in some years is caused by locust pests. Most of all, the plantings of the Siberian elm in the southern regions of the republic suffer from this. The area of forest crops inhabited by locusts for the period 2016-2020 only in the territory of the Elistinsky forest area amounted to 2115.25 hectares, of which 425.5 hectares had to be written off, which is more than 20% of the total affected area and indicates the need to recognize the status of a forest pest for locusts in the Republic of Kalmykia and, accordingly, to develop counter-measures.

![Figure 1. Locust damage to young plantings of Russian olive (a) and Siberian elm (b) in the Yashkul region of the Republic of Kalmykia, 2020.](image)

Also, the survival rate of forest crops, especially in low-income areas, is greatly influenced by the quality of planting material, the conditions of its storage before planting and its transportation. This is especially true in the case of purchasing seedlings of forest crops from third-party nurseries located more than a thousand kilometers from the landing site.

Seedlings must meet the criteria set out in Annex 26 of the "Rules of Reforestation", approved by Order of the Ministry of Natural Resources and Ecology of the Russian Federation No. 188 of 25.03.2019 and All Union State Standard R 58004-2017 "Reforestation. Technical conditions". The seedlings must be accompanied by documents certifying their origin, varietal and sowing qualities of
forest plant seeds (passport for planting material, certificate of seed quality). If a quarantine phytosanitary regime is established on the territory of the planting material growing, the seedlings must be additionally provided with a quarantine certificate.

Before transportation, the excavated planting material must be tied in bundles of 50-100-200 pieces. (depending on the age and size of the seedlings) and store in a heeling-in (an earthen ditch of the appropriate depth), at the place of their cultivation. No special preparations are required for their transportation. For short distances (up to 8-10 hours), seedlings are transported to the landing site in cars without packaging. The roots of planting material do not dry out and is not weather-beaten, seedlings, tied in bundles, pull out of heeling-in before sending, and if the car is equipped with an open body, they are placed obliquely to the rear board and covered with a tarpaulin, in the car with an enclosed body they are placed horizontally, the roots to the roots. It is also recommended to sprinkle the laid seedlings with cool water. After the delivery, the planting material should be immediately planted, or, if the planting is postponed, placed in a heeling-in in a shaded, cool place, laying the bundles at a small angle. It is important to observe that the roots are well covered with soil or wet sawdust. They can also be stored in the glacier, dusted with snow previously prepared in winter. It is not necessary to delay the time of planting, as the plants must take root before the onset of frost (in the case of autumn planting) or before the soil dries up (in the case of spring planting). Dried seedlings should be placed in a water tank for 5-6 hours before planting. Before planting, the roots are dipped in a clay chatterbox, and after planting, they are watered abundantly.

When sending over long distances or long-term shipment of seedlings, the possibility of drying out of the roots should be excluded. To do this, they are packed in a hard or soft container. To prevent mechanical damage during the transportation, the planting material is placed in plywood boxes with holes for air passage. It is tightly laid, having previously dipped the roots in a clay chatterbox or wrapped in wet burlap. As a soft package, it is desirable to use matting, in plastic bags with an excess of moisture, the roots can get stuck. In a soft package, the roots of the seedlings are shifted with a layer of wet straw or moss. The delivered material must be immediately unpacked and buried, spilling plenty of water. During the transportation, it is necessary to protect the planting material from overheating. Its presence at high temperatures can cause premature budding, which will reduce the survival rate after planting on the forest area.

However, the main factor of successful afforestation in the conditions of the Republic of Kalmykia is the correct selection of the forest area. You can plant plants from year to year on unsuitable land or not suitable (not corresponding to the biology) planted tree species, but the result will be equally deplorable. In the case of repeated decommissioning of forest crops on the same area, it is necessary to conduct comprehensive soil surveys to assess the degree of forest suitability of this territory and, based on the final conclusion, transfer this land to the category corresponding to its characteristics. Up to the exclusion from the forest fund.

Conducting such a study should be trusted specialized scientific organizations of forest areas, which are able to identify a number of other confounding factors and assign recommendations for silvicultural reclamation area, or to correct the technology for moisture saving, tree-planting and maintaining works.

At present, numerous studies established that the most fertile and forest-suitable areas in the territory of the Republic of Kalmykia are located in the Ergeninsky Upland, where the creation of protective forest stands is one of the main land reclamation measures in the organization of rational land use. Afforestation here has a rich, more than two-hundred-year history. Most of the plantings were created and preserved in hollows, dry valleys, gullies, river valleys, etc. in areas with a developed microclimate and receiving additional moisture due to surface runoff and underground water.

In the middle of the XX century, mass landings were carried out in flat conditions of high ground – along the route of the state protective forest strip Volgograd-Elista-Cherkessk. The plantings in meso- and micro-depressions with the predominance in the composition of petiolate oak showed the greatest viability. In these areas, you can also grow multifunctional full-fledged plantings from other valuable species of trees and shrubs – robinia, gledichia, poplars, pears, apple trees, loch, hawthorn, irga and many others.
If it is necessary to create plantings on low-and conditionally forest-suitable areas (with soils of different degrees of salinity), the most drought- and salt-resistant types of trees and shrubs should be used. For these purposes, we recommend Siberian elm, leatherback scumpia, Tatar honeysuckle, golden currant and other large and medium-sized shrubs. On automorphic overgrown sands and low-power sandy loam light chestnut soils, preference should be given to forest crops from Crimean pine or common pine. It is recommended to plant juzgun, tamarix, and teresken on open sands to secure them. In general, when creating protective forest stands for various purposes, it is necessary to rely on existing regulatory documents of regional significance ("Recommendations for the creation of protective forest stands in the conditions of semi-desert and desert of the Republic of Kalmykia", 2018; "Recommendations for the creation of anti-erosion stands on the sands of semi-desert and desert zones of the Republic of Kalmykia", 2018). The success of creating plantings is largely determined by the quality of project documentation and survey work, which, in turn, depends on the level of their scientific and regulatory support used in the design.

Thus, it can be concluded that the survival rate and, in the future, the stability of forest crops depends not only on the period of planting, but also on many factors, of which the choice of the most suitable area, the accuracy and quality of forest planting, agrotechnical techniques and forestry care play an important role. It is necessary to strictly observe the deadlines for the implementation of planting works provided for in the project documentation. Also, when carrying out forestry work, it is necessary to meet the requirements for the transportation and storage of planting material, which ensure its viability.

4. Conclusion

Data on the survival rate of forest crops in the conditions of the Republic of Kalmykia do not show the advantage of autumn plantings over spring ones. Forestry work should be carried out either in the early spring period (end of March, beginning of April) - on thaw-frozen soil, or in the autumn period, before the onset of persistent cold weather, provided that the soil is sufficiently soaked by autumn rain. The main factor of successful afforestation is the correct selection of the most suitable area and high-quality implementation of a complex of agrotechnical (moisture-saving) and forestry measures. An important factor for low-income areas is the quality of the planting material, the conditions for its storage before planting and its transportation. Obtaining a negative result if all the conditions are met indicates the need for a comprehensive survey of the territory, experience in creating and conducting maintenance work, to determine the degree of influence of the natural factor and adjust the technology of laying forest crops. A special attention should be paid to the control of locust pests, which in the conditions of Kalmykia in some years can cause significant damage to the planting of young forest crops, up to their complete write-off. In the southern regions of European Russia, locusts should be recognized as a forest pest and a technology (program) should be developed for its monitoring, preventive measures, and control to increase the percentage of steppe forest stands conservation.

References
[1] Maslov Yu M 2003 History and prospects of afforestation in Kalmykia Vestnik RAEN 3 60-65
[2] Mattis G Ya and Kryuchkov S N 2003 Afforestation in Arid Conditions (Volgograd: All-Russian Research Agroforestry Institute) p 292
[3] Ivonin V M, Tanyukevich V V and Lobov N E 2009 Adaptive Forest Reclamation of Steppe Agrolandscapes ed V M Ivonin (Novocherkassk) p 284
[4] Sapanov M K and Sizemskaya M L 2011 Climate-dependent changes in herbaceous vegetation on solonchakous solonetzes of the Northern Caspian Lowland Biology Bulletin 38(10) 1031-1036
[5] Bogun A P and Tsembelev M A 2012 Ways of forest-agrarian development of arid landscapes of Kalmykia Bulletin of Integrated Studies of Arid Territories 1(24) 25-32
[6] Manaenkov A S and Kostin M V 2017 Experience of scientific research on improving the efficiency of afforestation in the southern steppes of Russia Forestry Information: Electronic Network J. 3 92-102
[7] Yerusalimsky V I and Rozhkov V A 2017 Multifunctional role of protective forest stands Bulletin of the V V Dokuchaev Soil Institute 88 121-137

[8] Sizemskaya M L, Bykov A V, Kolesnikov A V, Kostin M V, Kulakova N Yu, Sapanov M K 2019 Results and prospects of studying protective forest stands in arid regions of the European territory of Russia Bulletin of the Volga State Technological University. Series: The Forest. Ecology. Nature Management 4(44) 92-101

[9] Yerusalimsky V I and Rozhkov V A 2017 Multifunctional role of protective forest stands Bulletin of the V V Dokuchaev Soil Institute 88 121-137

[10] Kostin M V and Manaenkov A S 2017 Productivity and life expectancy of artificial oak culture (Quercus robur L.) in Northern Ergeni, Kalmykia IOP Conf. Series: Earth and Environmental Science 226 012057

[11] Sapanov M K and Sizemskaya M L 2020 Climatogenic limitations of arid reforestation Forest Science 1 46-54

[12] Agro-Climatic Resources of the Kalmyk ASSR 1974 (Leningrad: Hydrometeoizdat) p 172

[13] Lepesko V V, Belyaev A I, Pleskachev Yu N, Fomin S D, Pugacheva A M and Rybashlykova L P 2019 Monitoring of the state and ecological-meliorative effect of tree-shrub and ordinary plantings on pastures in arid conditions of the Northern Caspian Region IOP Conf. Series: Earth and Environmental Science 341 012103

[14] Sarychev A N, Pleskachev Yu N, Ivantsova E A and Onistratenko N V 2019 Efficiency of windbreak forest belts for the cultivation of winter grain crops Bulgarian J. of Agricultural Science 25(3)