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Forest Amelioration Practice in the Steppe Zone of Aragats Mountain Range Located in the Central Region of Armenia

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ABSTRACT

The current article is devoted to the study of establishing anti-erosion forest crops in various soil-climatic and growing conditions. As a result of the research more prospective varieties of tree and bush species have been revealed, which are to be investigated in conditions of the Armenian highlands. The planting materials with open and closed root systems have been tested, where the best outcome was fixed in those of the closed root system. Agrotechnical system has also been developed, the survival capacity and preservation rate of various forest species have been determined. The best planting terms have been revealed and biometrical indexes of different varieties have been described.

Introduction

The forest ecosystem is one of the key components of structural and functional aspects in the natural and spatial agricultural complexes. Therefore, forest plantations performing different functional roles are established to fill the gap. It means that regardless of the outcome, implementation of landscape changes is associated with different ecological consequences.

Anyway, those anthropogenic processes are different from natural processes in view of consequences and spatial-temporal development. The man-made natural economic complexes may show very high productivity. Moreover, in addition to their main function those complexes can perform another structural role, i.e. ecological co-function which is characteristic to forest plantations. Although those complexes may obtain descriptive indices and natural ecosystem quality only thousands of years later, yet after decades of their establishment anti-erosion, climate regulation and other functions can be already implemented.

For this purpose we made an attempt to establish a forest plantation in the central region of Armenia, on the slopes of Aragats mountain range where the soil records very high sensitivity to erosion. Accordingly, this area was selected to prevent future erosion of the land and enhance its agro-climatic conditions.

The area is located between meadow-steppe landscape zones, in the administrative areas of 6 rural communities.Besides, in a range of plots of Ara, Hnaberd, Poqr Mantash, Saralandj and Kuchak land sites one of the landscapes is characterized by direct transition from a steppe to a meadow zone with no forest in its spectrum. In another plot of Kuchak and Lusagyugh the sites that have been selected for plantation activities were previously forest zones later converted into steppe areas (Mulkidjanyan, 1972).

The tree planting was planned in areas with various degrees of erosion or where soils were prone to erosion. When selecting areas according to the abovementioned criteria we have adopted a long-term perspective through estimating possible formation of a new landscape spectrum with the scope of future projects and tree planting potential.

Plantation areas have been selected based on three main criteria, namely:

- degree of soil erosion or sensitivity to erosion,
- storm control and climate regulation in agro-landscape,
- site conditions for forest growth.

Regarding the last criteria information was obtained and analysis was done on soil characteristics of the site including soil humus content and levels of mineral nutrients, mechanical composition and structural condition of the soil, also climatic aspects, such as temperature and moisture content, wind direction, slope angle and snow cover, seasonal range of temperature with latitude, as well as irrigation potential.

For the selected areas moderately warm and dry, moderately cool, humid climate zones are typical, where the annual sum of temperatures above 100 C is from 2000^0 C to 2500^0 C, and the number of days with similar temperatures is 75 -130 days, frost-free period ranges from 120 to 160 days. The lowest possible air temperature is - 32^0 C – 38^0 C and the highest possible temperature is + 30^0 C – +34 ^{0}C.

The annual sunshine duration is about 2400 hrs. The annual atmospheric precipitation ranges from 600 to 700 mm, air humidity coefficient is 0.4 – 0.6, i.e. the area is sufficiently humid or is humid from light to episodic drought frequencies (likelihood of extreme drought years reaches 59 %).

Materials and methods

The selection of tree and shrub species for planting was mostly based on forest growth conditions.

Large-scale forest amelioration activities have been implemented in this region since the mid half of the last century. However, plantations established during those years were mostly comprised of monodominant species: dominant species were Caucasian pine (Pinus hamata), pine ordinary (Pinus silvestris) and several other pine species (Khurshudyan, 1968).

In view of several disadvantages of monodominant plantations, we have developed draft schemes of mixed plantations which have not been applied in this area before. Tree species have been selected from the prospective list of tree and shrub species specially designed for this region (Ghazaryan, et.al, 1976)- Caucasian oak (Quercus macranthera), Caucasian pine (Pinus hamata), birch (Betula Liwinowii) and common ash (Fraxinus excelsior) in a very limited quantity.

As requested by the community population we have also used berry shrubs which will provide an extra source of income for the community.

Results and discussions

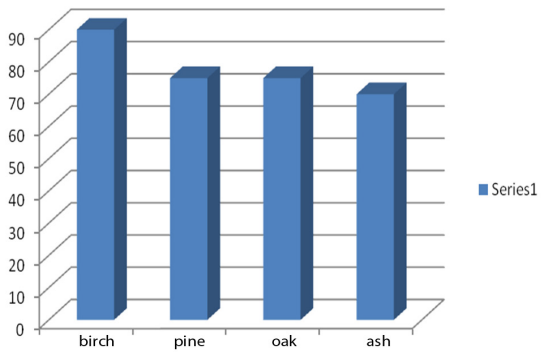
Planting material

For the establishment of plantations container-grown and bare root seedlings were used. Since this was test planting our objective was also to compare seedling production via different root systems and test their effectiveness.

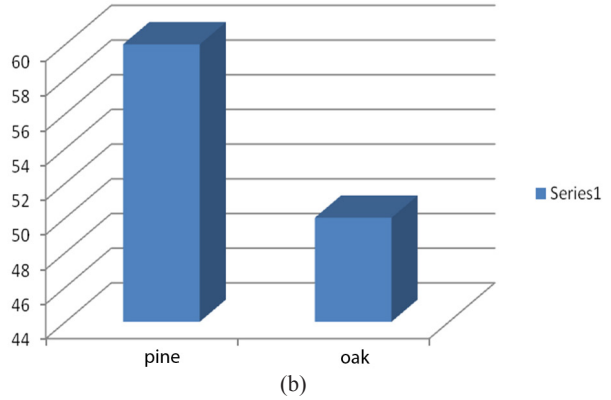
Among the tested tree species containerized production of birch seedlings has shown the highest survival rate in all planting plots. Survival rates of container-grown birch, pine, oak and ash seedlings are depicted in the diagram 1(a).

Accordingly, birch shows the highest survival rate (90 %), while in case of pine and oak the survival rate is only 75 % and in case of ash it makes 70 %.

We have tested only two species with bare root system which are pine and oak seedlings. The results of their survival rates are presented in the diagram 1(b).



(a)



(b)

Figure 1. Seedling survival rates (a) containerized production and bare root production (b) *(composed by the authors)*.

Survival rate of bare root seedlings was quite low: oak's survival rate was 50 % and pine's survival rate was 60 %. The decline in the growth of pine seedling was recorded mainly in the Saralandj community site where seedlings were affected also by fungal diseases.

Age of the seedlings

For measuring the optimum age of the seedlings, we have used a limited number of 4-5-year old seedlings only in Kuchak community site, while seedlings growing in all the other sites were 2 years old. The findings validated the results of the earlier conducted tests (Ghazaryan, Harutyunyan, Khurshudyan, Grigoryan, 1974) which testify that at the given age pine has shown very low survival rate. Thus, the further use of seedlings of this age is not suitable for afforestation of eroded slopes.

Type of land preparation

In our studies we have put a special emphasis on the land preparation method. The planting activities have been done by digging holes or trenches. Considering the age of seedlings, we have used 0.3 x 0.3 x 0.3 m sized holes, and trenches with 0.4 m width, 0.3m depth and 10 m length and 2 m interrow spacing.

The choice of land preparation method did not affect the seedling growth, though the advantage of using trenches was that seedlings were in a more favorable condition during the second half of vegetation cycle when humidity decreased.

The monitoring was done in Lusagyugh and Ara communities where over 80 % of dried out plants were planted in holes. Even by visual observation it was evident that the plant's root humidity in trenches retained longer, assimilation was not interrupted, and plants overcame the dry period. Thus, the plant has maintained its balance.

Planting period

Containerized nursery production of seedlings was not commonly used in Armenia. Since this was a new practice to be applied in the dry climate of Armenia's central region, we did observations on the planting period with a focus on summer planting potential.

In Lusagyugh community 6000 saplings of birch, oak and pine were planted in containers during the last ten days of June (after the solstice). The seedlings were irrigated three times and a single-dose nitrogen fertilizer was applied. In the autumn of the same year the monitoring results based on simple cross-calculations have shown 90 % plant survival.

Annual growth

In summer, 2016, measurements were done in all plantations established during 2014 – 2015 to determine the annual growth for seedlings of all involved tree species.

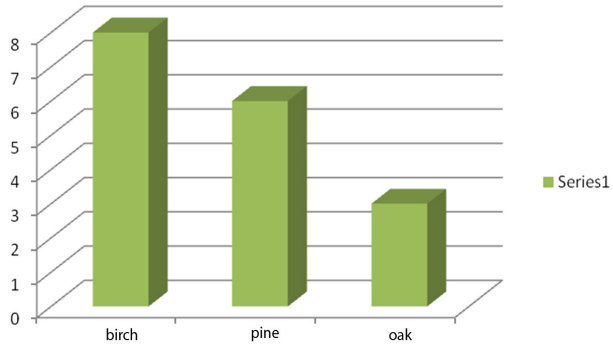


Figure 2. Annual growing indices of seedlings *(composed by the authors)*

The measurement results indicated that birch and pine have shown the best growing rate with mean annual growth of 8 cm and 6 cm, and maximum growth of 22 cm and 35 cm. The oak has shown a low growing rate with mean annual growth of 2–3 cm which is accounted for biological characteristics of this tree species.

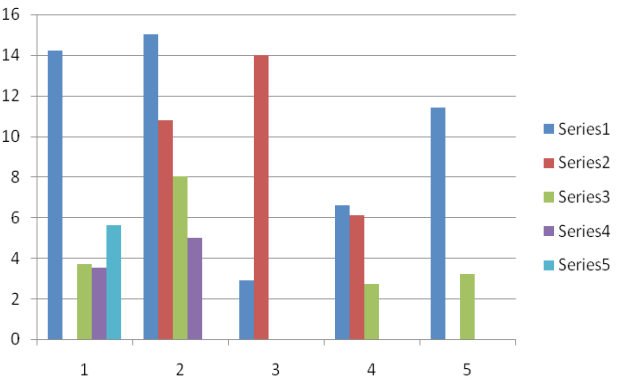


Figure 3. Annual growing indices of tree species in different communities for 2017 *(composed by the authors).*

The annual growing dynamics of tree seedlings was also observed during the summer 2017.

The maximum pine growing rate in Lusagyugh has made 19 cm and in Ara it is 22 cm. The highest growing index for oak has been registered in Ara community with the average growth of 8cm and maximum growth of 13 cm. In general, birch has demonstrated good results everywhere; maximum growing index has been observed in Ara community which makes 19 cm and in Saralandj it makes 17 cm. Ash and map, used (mainly for testing purposes) in very limited quantities, have shown average growing capacity.

Conclusion

Below we offer some recommendations based on the results of our study on forest amelioration and soil protection in the steppe zone of Aragats mountain range located in the central region of Armenia and on comparison of our findings with the previously conducted forest planting practices.

1. In Aragatsotn and Shirak marzes (regions), despite insufficient local growing conditions for tree species (low temperatures in winter, lack of humidity during the 2nd half of vegetation cycle, eroded and degraded soil) there is a great potential for creating forest vegetation along the eastern, north-eastern and northern slopes of mount Aragats as well.

2. Instead of using the old practice of monodominant plantations it is recommended to form sustainable mixed plantations in the site, mainly comprised of pine-birch, oak-pine and oak-birch-pine stands and include wild fruit-bearing species. It is also recommended to use berry species which give fruits in the second growing year.

3. Tree planting potential increases to a great extent when using container-grown seedlings, by producing good results even if planting is organized during early summer.

4. On the sunward slopes it is recommended to use the method of planting in trenches and carry out maintenance activities for effective and promising results.

5. Irrigation is crucial in tree planting requiring special treatment in windy sites during late summer periods and dry years.

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