Evaluating Different Methods of Saltcedar Propagation by Cuttings Rooted in Saline Soils of Saratov Oblast Left Bank

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Abstract: Within the Saratov Oblast Trans-Volga region, the proportion of saline soils may exceed 50 %, which is very unfavorable for growing arboraceous vegetation. In such conditions, species of *Tamaricaceae* family, possessing high ornamental qualities for urban landscaping, grow quite well. The article discusses several methods of propagating *Tamarix ramosissima* Ledeb. by cuttings and their rooting in specific environmental conditions of the region. We performed a comparative analysis of these propagation techniques using explants – segments of shoots taken from upper, middle and lower parts of the branches after flowering. The timings of root formation for *T. ramosissima* under different propagation techniques were identified. The most effective way of propagation resulted in 79–83 % effectiveness of root formation. The timing of rooting in the cuttings over the summer and fall in the studied region was determined.

Keywords: *Tamaricaceae* species, *Tamarix ramosissima* Ledeb., propagation, rooting, cuttings, root formation, organogenesis, Stenofon 190, stimulant of root formation Kornevin™, Saf-Moment™ quick-acting yeast, urban landscaping.

Introduction

In the Volga region of the Russian Federation, almost 20 % of the territory is occupied by saline soils, and not all plants can grow on them. This fact is a significant obstacle for the selection of flora assortment for use in urban landscaping [1,2]. Saline soils in the Saratov Oblast are often located on shallow slopes, watersheds, around lakes and ponds, as well as on upper terraces in river valleys (above the floodplain). In the Trans-Volga region, the area of soil complexes with solonetz soils exceeds 19 % of the total area of the left-bank territories (Bulany 2010, 2011; Grishin et al. 2011; Chebotareva 2013). It has been established that saline soils on watersheds are dispersed among chernozem and kastanozem soils. For example, saline dark kastanozem soils are located in the Engels, Dergachev, Soviet, and Fedorovsky counties. Of course, a significant part of saline soils is located in the Aleksandrov Gay soil region, where they constitute the main background of the soil complex [3]. There saline soils are interspersed with light kastanozem and meadow-kastanozem soils, accounting for over 16 % of the total area of the oblast.

The proportion of saline areas can exceed 50 %, which is very unfavorable for growing woody plants [2, 4]. The profile of saline soils in a dry state is very dense, while in a wet state it is viscous, easily swelling and possessing waterproof properties. Consequently, in such areas, the provisioning of plants with moisture is worse than on adjacent zonal soils, which affects the general landscaping of human settlements. Nonetheless, there are ornamental shrubs well adapted to such problematic conditions. They are in the *Tamaricaceae* family, belonging to the ecological and physiological group of salt-releasing halophytes [5, 6, 7]. In Saratov Oblast, there are two species of *Tamaricaceae* – *Tamarix laxa* Willd. and *T. ramosissima* Ledeb. One of them, *T. laxa*, is listed in the Red Data Book of Saratov Oblast as a rare species growing on saline soils [8].

The saltcedar (*T. ramosissima*) is a very spectacular plant with sprawling thin rod-shaped stems and paniculate inflorescences of whitish, pink, purple or violet colors. It is perfect for urban landscaping as an ornamental plant. It can be used to form hedges or be included in various biogroups. It is also perfect for solitary plantings in the environment, and its ever-flowering thickets, usually located in sunny, open spaces, could be a wonderful addition to poor steppe landscapes. Saltcedar grows in harsh natural, soil and climatic conditions, with its large populations found in Aleksandrov Gay County. Hence, our experimental material for the study on propagation and rooting of saltcedar, as a typical representative of halophytes, was taken from the territory of that county. We therefore studied the opportunities of fast propagation of saltcedar planting material for the purpose of urban greening and landscaping, which allowed us expanding our understanding of the prospects of bioecological methods of growing this resistant shrub species in decorative and aesthetic directions.

The goal of our study was an assessment of various propagation techniques in the saltcedar (tamarisk) by the cuttings rooted in saline soils of the Saratov Oblast left bank area. The evaluation was conducted in terms of rapid obtaining of the planting material for urban landscaping, e.g. for designing the hedges, solitary plantings and biogroups.

Materials and Methods

The study was conducted in the form of a test for rapid root formation and rooting in summer time. The test was carried out during the growing season of 2018–2019. Due to the fact that the cultivation of tamarisks from seeds is problematic and is used solely for selection purposes, we used various methods of cuttings. Our study object was saltcedar (*Tamarix ramosissima* Ledeb.), as a more resistant species of *Tamaricaceae* family with natural populations within the territory of Aleksandrov Gay County of Saratov Oblast. Explants, i.e. the segments of saltcedar shoots cut off after the flowering of the plant became the material for the study. The study material was sampled from the aboriginal populations in the Aleksandrov Gay County, where soil samples were taken from salinized areas. Twigs were clipped off and divided into 15–20 cm cuttings [9]. We employed the propagation method *sensu* Butenko (1999), based upon middle and lower parts of the twigs. However, we also included the upper woody parts of the shoots into our study.

In the study area, we also tested the method of biological control, which includes a system of observations on plant development and growth and investigation of the plant needs in specific environmental conditions at different stages of the organogenesis. The number of cuttings participating in the experiment for each elementary systematic unit (ESU) was recorded in a field journal. In the course of the study, we used the etiolation method, which helped preventing the outflow of carbohydrates and growth agents (auxins) from the shoots [8]. Etiolation was carried out by wrapping the shoot with foil, paper, or black non-woven material 2–3 weeks before grafting. In the shoot, a redistribution of metabolism occurs, and the efficiency of rooting increases [10]. However, we applied this method not before, but rather after cuttings, and directly on the wrapping of the shoot segments (see propagation method 1).

We had 340 cuttings, including 100 from the upper shoot sections, 120 from the middle parts, and 120 from the lower segments. Since, in the process of harvesting cuttings, it is important to ensure the preservation of moisture in the tissues, which determines the success of their further rooting, therefore, after grafting at the site of material collection, the shoot segments were immediately placed into bottles with filtered water.

We tested several methods of determining rapid root formation in saltcedar. In *the method 1*, the middle and lower parts of the shoots of this shrub were used. Then the sample from saline soils, on which saltcedar grows was diluted in distilled water. We filtered the water and dipped the cuttings into it for an hour or two. Then the growth stimulant Kornevin™ was added and left for another 36 hours. Consequently, etiolation was conducted: peat moss (*Sphagnum sp.*) with bactericidal properties was placed on a strip made of Stenofon 190 material with foil. The cuttings were dipped a second time with the Kornevin™ growth stimulant and laid out on a tape every 2–3 cm, and then covered with moss. At the end of these actions, the entire resulting structure was twisted into a roll and secured with threads. The rolls were placed in a tall tray pre-cut from a 5-liter plastic water bottle. The rest of the upper part covered the entire resulting structure to form some kind of a greenhouse. Water was poured into a tray and added periodically, as the cuttings absorbed it.

Our experiments were conducted in 2019. In the same year, tests were carried out on the second and third methods of root formation. In *the method 2*, the saltcedar cuttings, obtained by dividing the upper and middle segments of shoots and branches, were placed separately in glass containers with filtered water, (i.e., the upper ones – in one container, the middle ones – in another). The containers were wrapped with foil to protect them from daylight and electric light, and left in a room at a temperature of 27–29˚C, two meters away from the southern window.

In *the method 3*, yeast was used. The acceleration of root formation occurred due to the release of vitamin B1, biotin and meso-inositol alcohol into the water by yeast cells. These substances penetrated into the cytoplasm of rooted plants and activated the processes of regeneration in their tissues [11]. In the method 3, saltcedar cuttings were pre-soaked for 12 hours in a solution of water and Saf-Moment™ quick-acting yeast (QAY) at the concentration of 10 g per 200 ml. Then, after washing off the cuttings under running water, just as in the second method, they were placed in glass containers wrapped with foil, and set in the same place, at the same temperature and lighting. Moreover, as in the method 2, the upper and middle parts of the shoots were split among separated containers.

The method 4 used saltcedars after flowering, their twigs cut about 50 cm long. A trench was created at the rate of 1 m^2 / 5 specimen plants. Expanded clay was laid at the bottom as a 5-cm layer. In one case, humus was added to the soil, and in the other, the soil was loosened, and then the stem cuttings were planted to a depth of 20 cm, dipping them into the Kornevin™ growth stimulant, and then watering daily 20 liters per stem cutting. This method was tested in 2019. The rest of the upper part covered the entire resulting structure to organize a kind of greenhouse. Water was poured into a tray and poured in as the cuttings absorbed water. The tests were carried out in 2019.

It should be noted that in the second and third methods, the leaves were left on the cuttings. Data for each year of study were compared and analyzed using comparative methods, based on conventional scientific methodology and using appropriate analytical tools.

Results and Discussion

As a result of our experiments, we discovered that root formation occurred unevenly with each method. However, the third method yielded the best outcomes (Table 1).

From Table 1, it is explicit that, when the *first method* was used, the first roots were appearing only on days 21–28 after initiation of the experiment, while the growth was observed already on day 15. After 5–7 days (that is, during the first week), roots formed on the cuttings prepared *via* the *third method*, 0.2–0.7 cm long and 0.5 mm thick. The *second method* yielded root formation on days 12–14, but they were shorter than the roots on the cuttings prepared by the third method: their length was 0.1–0.3 cm, and the thickness was below 0.5 mm. In the *fourth method*, the development of the roots on the lower segments of the shoots began on days 15–18, given regular watering.

The foliage, which we purposefully did not remove, dried up and fell off by itself, and the first new foliage appeared on the cuttings prepared *via* the third method on day 15. Therefore, the *third method* of root formation in saltcedar cuttings proved to be 1.5 times more effective. Table 1 also demonstrates that the number of live cuttings from the upper parts of the shoots decreased: while at the beginning there were 100 of those, then in the fourth week of testing there were just 68 pieces left, i.e. 32 cuttings dried up. This fact proved that, although the upper segments of the shoots are able to form roots, a third of them are likely to perish, which would negatively affect productivity.

TABLE 1.
Root Formation in Saltcedar (*Tamarix ramosissima* Ledeb.) Cuttings with and Without Growth Biostimulants (GBS): Kornevin™ (K) or Saf-Moment™ Quick-Acting Yeast (SM QAY)

Timing of root formation, weeks	Cutting type (part of a shoot)	Cutting sample sizes	Methods of root formation in cuttings and proportion of first roots (% of the total)				Length of a new growth, mm
			Method 1	Method 2	Method 3	Method 4	
			Water + GBS K	Water, no GBS	Water + GBS SM QAY	Water + soil + GBS K	
1 (1–7 days)	Upper	50	None	–	15	None	–
	Middle	30	–	30	40	–	–
	Lower	30	–	40	60	–	–
2 (8–14 days)	Upper	36	None	28	50	None	–
	Middle	30	–	56	67	–	–
	Lower	30	–	63	86	–	–
3 (15–21 days)	Upper	36	None	46	53	None	–
	Middle	30	–	62	70	–	1.5+2.0
	Lower	30	25	70	94	50	2.5+3.0
4 (22–28 days)	Upper	34	None	47	58	None	–
	Middle	30	50	68	76	42	3.0+5.0
	Lower	30	62	79	98	70	3.5+6.0

In the fifth week, cuttings prepared by the *first*, *second* and *third* methods were planted within the Engels County, into dark kastanozem solonetz soils, in slightly shaded places, the planting depth was about 20 cm with a 5 cm of expanded clay drainage layer. Watering was conducted once a day, in the evening, with water expenditure up to 5 liters per cutting. The survival rate of saltcedar cuttings was quite successful, because 30–36 days after planting 78–83 % of cuttings grew by 7–10 cm, while 83–85 % of the specimens planted in a lowland grew by up to 15 cm by the end of the growing season. The cuttings, prepared by the fourth method, rooted faster, i.e. within 28–32 days, but with a lower survival rate, since just 70–73 % of cuttings displayed growth, while the rest died. We assumed that this was due to unfavorable weather conditions, despite regular and abundant watering. The average temperatures for the Engels County in 2018 are presented in Figure 1.

Figure 1 shows that the difference between the maximum and minimum temperatures during the growing season (April-October) reached 36.9 °C. The year was characterized by short winter, with multiple occasions of snow melting. The distinctive features of that year were a sharp temperature rise in April to 27.9 °C, and high fall temperatures until the end of September. This factor influenced the survival rate of the cuttings prepared *via* the fourth method of root formation.

The maximum and minimum climatic indicators for 2019 are presented in Figure 2.

Figure 2 implies that 2019 was warmer than previous years. Minimum temperature in the coldest month did not fall below –21 °C. The hottest month was June with the maximum temperature reaching 36 °C, and the minimum temperature of 26 °C. Until November, temperatures reached 16 °C, and even in December it had a positive daytime value up to 4.4 °C. Saltcedar cuttings of the second and third method of root formation were planted in June. However, survival rate of the cuttings was higher, given that the development of saltcedar plant cuttings, prior to planting them in open ground, proceeded in rather warm conditions, i.e. they did not experience a stressful state, plus were watered regularly and abundantly.

For the winter, all plants were covered with sawdust and pine branches. They survived the winter cold at the rate of 85–87 %. The remaining 13–15 %

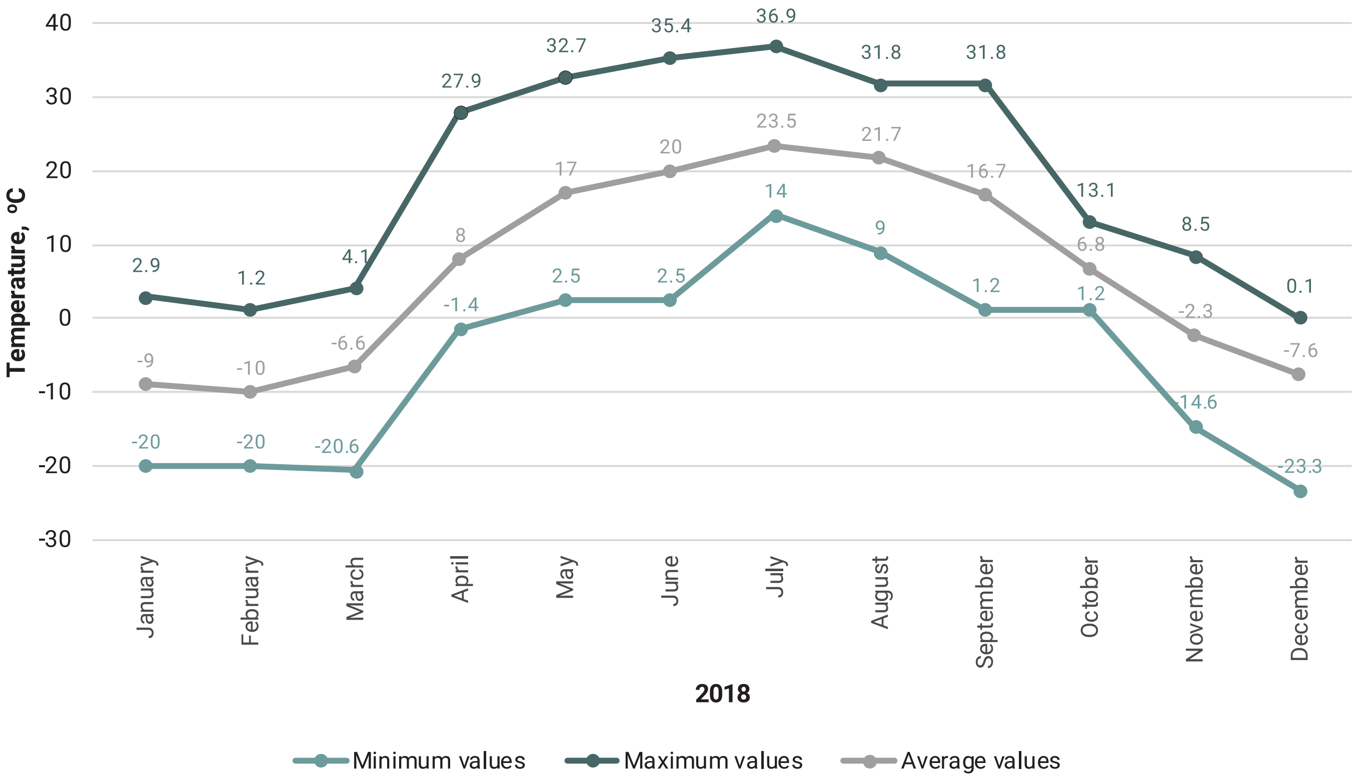

Figure 1. Average monthly temperatures in Engels County in 2018

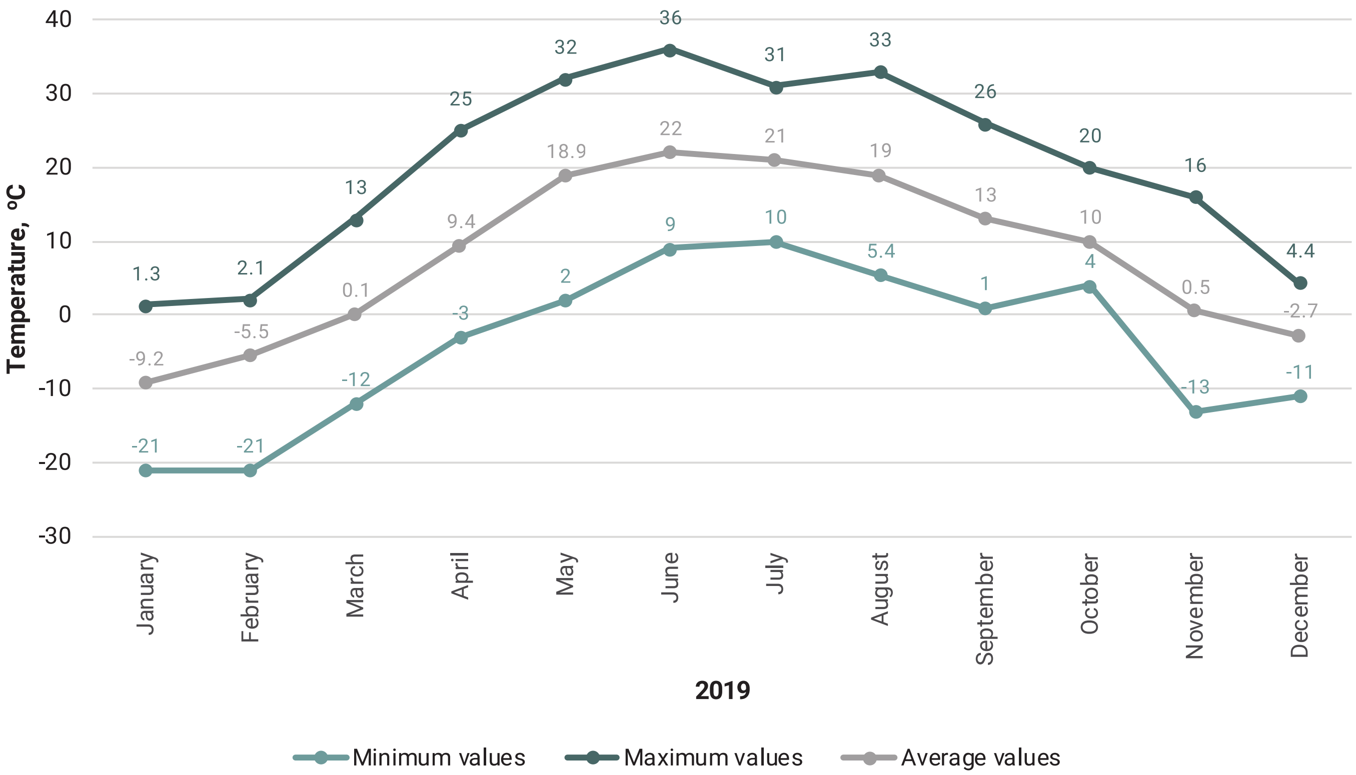

Figure 2. Average monthly temperatures in Engels County in 2019

had slight stability problems (dried out or frozen off tips). These findings confirmed high frost and heat resistance of *Tamarix ramosissima* Ledeb. shrub.

Conclusion

Thus, according to the results of the study, the following conclusions can be drawn: 1) We established that root formation in the cuttings of *Tamarix ramosissima* Ledeb. occurred 1.5 times more intensively when using the quick-acting yeast Saf-Moment™ as a growth stimulant; 2) We determined that the cuttings from the upper segments of the shoots were capable of rooting, but one-third of those perished; 3) We identified that use of the first three methods of root formation in saltcedar cuttings yielded higher effectiveness (79–83 %) than in case of the fourth method (70–73 %); 4) We discovered that good survival rate of saltcedar cuttings in the open field was influenced by warm climatic conditions and abundant regular watering, which prevented them from experiencing stress; 5) It was noted that saltcedar cuttings, rooted in summer and fall, overwintered successfully at the rate of 85–87 %, while remaining 13–15 % had slight hardiness problems (they had dried out or frozen off tips).

We therefore believe that the best results can be obtained by preparing *Tamarix ramosissima* Ledeb. cuttings in summer, using middle and lower segments of the shoots and a growth stimulant - quick-acting yeast Saf-Moment™, and this technology can be launched in order to quickly obtain planting material for organizing various types of landscaping in urban and rural settlements of Saratov Oblast left bank area.

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