
CROP PRODUCTION

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CHARACTERISTICS OF *PINUS SYLVESTRIS* L. SEEDS UNDER DROUGHT CONDITIONS IN THE STEPPE REGION OF THE CENTRAL CHERNOZEM REGION

Research article

Abstract

Monitoring the state of forest stands is an urgent task for researchers in modern environmental conditions. Scots pine is one of the main forest-forming species in the world. The article studies the quality indicators of the seeds of a pine growing in the steppe zone against the background of a spring-summer drought. The objects of research are in contrasting environmental conditions. It was found that in the studied plantations there is a very high level of empty seeds: 10-12 seeds per cone. In a plantation from an ecologically clean territory, graininess is 4.7% higher than in a plantation with anthropogenic impact. Experimental data on soil germination showed that pine seeds of the steppe region, collected under arid conditions, are absolutely not viable, germination is 0%.

Keywords: scots pine, climate, ecology, seed productivity, soil germination.

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ХАРАКТЕРИСТИКА СЕМЯН *PINUS SYLVESTRIS* L. В УСЛОВИЯХ ЗАСУХИ СТЕПНОГО РАЙОНА ЦЕНТРАЛЬНОГО ЧЕРНОЗЕМЬЯ

Научная статья

Аннотация

Мониторинг состояния лесных насаждений является актуальной задачей для исследователей в современных условиях окружающей среды. *Pinus Sylvestris* L. является одной из главных лесобразующих пород в мире. В статье изучаются показатели качества семян сосны, произрастающей в степной зоне на фоне весенне-летней засухи. Объекты исследования находятся в контрастных экологических условиях. Установлено, что в изучаемых насаждениях очень высокий уровень пустосемянности: 10-12 семян в шишке. В насаждении из экологически чистой территории полнотернистость выше на 4,7%, чем в насаждении с антропогенным воздействием. Экспериментальные данные по грунтовой всхожести показали, что семена сосны степного района, собранные при засушливых условиях, абсолютно не жизнеспособны, всхожесть равна 0%.

Ключевые слова: *Pinus Sylvestris* L., климат, экология, семенная продуктивность, грунтовая всхожесть.

1. Introduction

In the modern world, monitoring and control of the state of forest woody plants is an important task. Forests are very important for humans, nature and climate. Thanks to forest plantations, a milder climate is formed, and favorable sanitary and hygienic conditions are created. Forests contribute to the preservation of soil fertility and prevent soil destruction under the influence of external factors (weathering, leaching). Also, forest biocenoses play an important role in the preservation of flora and fauna.

Pinus Sylvestris L. is a very adaptive species, therefore it has a wide distribution area and is considered one of the main and economically valuable species. External climatic factors such as temperature and rainfall can have a great influence on the growth and development of Scots pine. Elevated air temperatures and low precipitation levels negatively affect the condition of

pine plantations. The generative sphere of pine reacts especially sharply to unfavorable climatic factors. The reproductive cycle of pine, which lasts 3 years, is badly affected by droughts and unfavorable environmental conditions [1, P. 114-130].

The trend towards climate warming, frequent droughts and the deterioration of the ecological situation in the Central Black Earth Region determine the importance of studying the generative sphere of Scots pine.

The aim of this work is to assess the state of the generative sphere of Scots pine growing in the steppe zone of the Central Chernozem region in different ecological conditions against the background of the development of spring-summer drought.

2. Objects and Methods

The research was carried out on two plantations of Scots pine growing in the south of the Voronezh region, in the steppe zone. In each stand, a random sample of 30 trees was selected. Plantation №1 is pine forest plantations located at a relative distance from the urban environment and growing in ecologically clean conditions. Plantation № 2 is a pine tree growing in a nursery in an urban environment, surrounded by roads and other businesses that have a negative impact on the environment.

Scots pine seeds were characterized according to the characteristics of seed productivity: the number of seeds in the cone, the full grain of the seeds, the number of empty seeds; on soil germination of seeds. To characterize the seeds, 15 cones were collected from each tree; each cone was placed in an individual labeled cell for further drying at room temperature until the cone fully opened. Next, the seed scales were separated and the number of full and empty seeds was counted. The total number of seeds in a cone was distributed according to productivity classes within the following ranges: I - 0-9.9; II - 10.0-19.9; III - 20.0-29.9; IV - 30 seeds or more. Seed full-grain was calculated as the ratio of the number of full seeds to their total number, the calculation results were distributed according to productivity classes within the following limits: I - no more than 24.9%; II - 25.0-49.9%; III - 50.0-74.9%; IV - 75.0% and above [2, P. 270-276]. Statistical data processing was performed using the MS Excel-2010 software package.

3. Results

The research was carried out in the steppe zone of the Central Black Earth Region. The climate of this region is characterized by high air temperatures, low precipitation and frequent droughts [3, P. 119-130]. The collection of materials for the study was carried out in 2019. This year was characterized by atmospheric and soil drought lasting 7 weeks. The period of drought in the study region fell in May-June. This period fell on the stages of early embryogenesis of Scots pine.

An analysis of the number of seeds in a cone of two Scots pine plantations growing in contrasting environmental conditions is shown in Figure 1. Based on the results of an assessment of the number of seeds in a cone, it was found that in Scots pine growing in a nursery in an unfavorable ecological environment 20% of trees belong to the lowest class I productivity, where the number of seeds in the cone does not exceed 9.9 pieces. Among the trees growing in ecologically clean territory, not a single pine tree belongs to the lowest class. Most of the pines - 60%, growing in ecologically clean territory belong to the III productivity class, where the purely seeds range from 20.0-29.9 pieces per cone. Among the trees growing under the influence of anthropogenic load in the nursery within the city, most of the pines (40%) belong to the II productivity class, where the number of seeds in a cone is from 10 to 19.9 pieces.

Thus, it has been established that the number of seeds in the cones of common pine forest crops is higher than in the nursery from the urban environment.

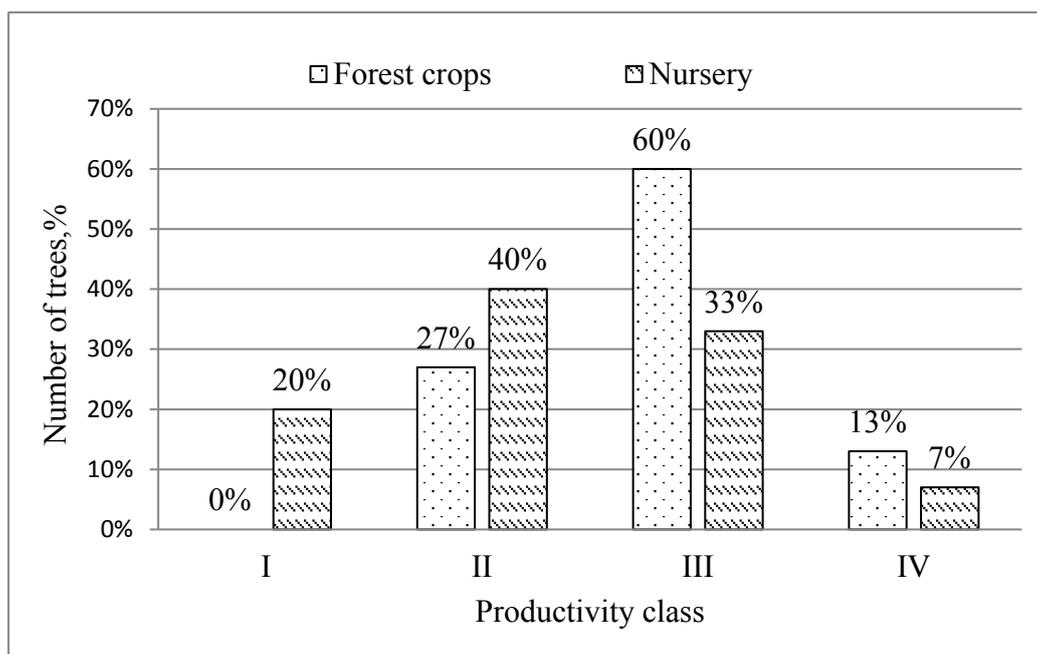


Figure 1 – The number of seeds in a cone in the studied plantations of *Pinus Sylvestris L.*

Figure 2 shows the distribution of trees in the studied plantations by productivity classes according to seed full-grain. Most trees growing in an ecologically clean zone - 53% belong to the II class of productivity, where the full-grain content of seeds is

25.0-49.9%. In the plantation from the urban environment, the majority of trees (50%) also belong to the II class. Very few pines belong to the highest IV class, where the seed grain size is more than 75%, there are very few pines: in forest crops growing in ecologically favorable territory, 17% of trees belong to this class, and in the nursery not a single tree belongs to the highest class. Differences in seed full-grain are reliable according to Student's t-test.

Thus, the indicators of the studied populations are close in terms of seed fullness: most of the studied trees (about 50%) from forest crops and nursery belong to class II and have a low percentage of full grain. However, in a plantation from an ecologically clean environment, there are trees with high indicators, which means that the full-grain content is higher in good ecology.

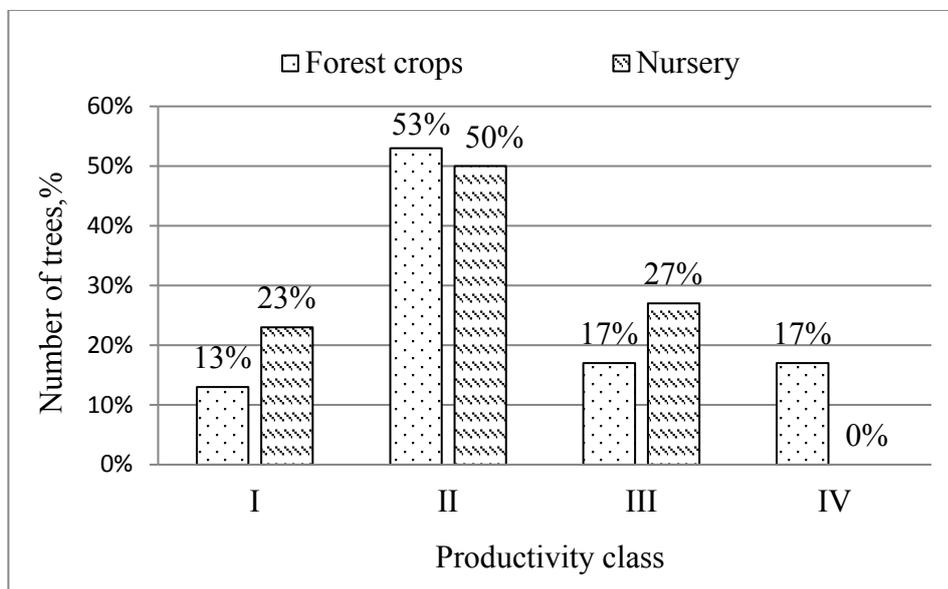


Figure 2 – *Pinus Sylvestris L.* seeds full-grain in the studied plantations

Figure 3 shows the results of the soil germination test. As a control, seeds of the population of the drought-resistant variety pine Ostrogozhskaya [4, P. 104-109] of the same dry year of 2019 were used.

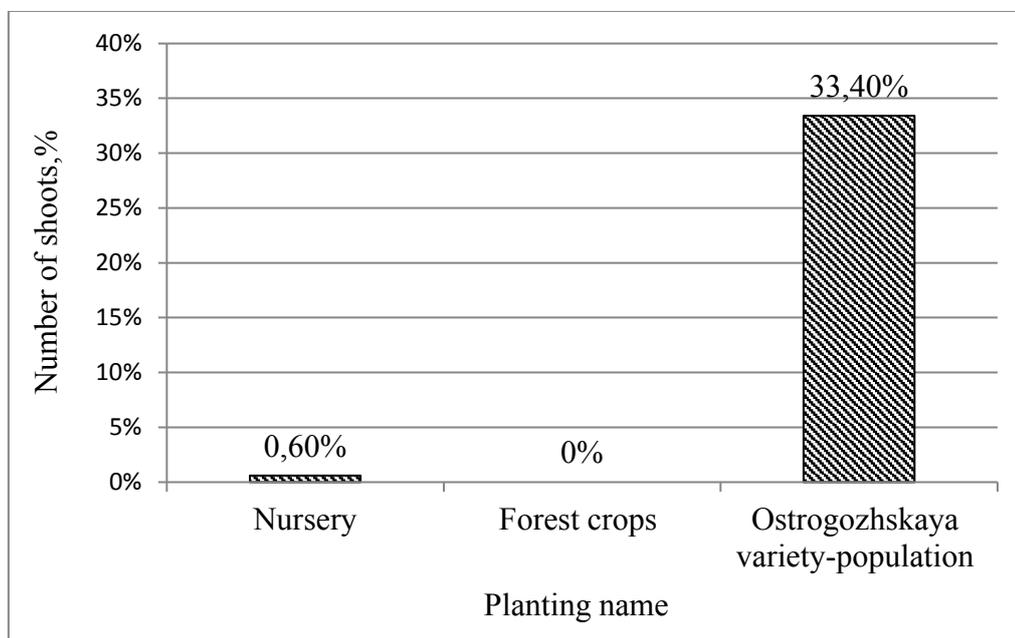


Figure 3 – *Pinus Sylvestris L.* soil germination of the studied plantations

The figure shows that seeds from the studied territories of the steppe zone, both from an ecologically clean territory and from a polluted environment, did not germinate. In contrast to the drought-resistant variety, the Ostrogozhskaya pine, where the soil germination of seeds in a dry year was 33.4%.

4. Conclusions

After analyzing the signs of seed productivity of *Pinus Sylvestris L.*, as well as soil germination of pine seeds, we can conclude that the seeds are of very low quality.

In terms of full-grain size and the number of seeds in a cone in pine forest plantations growing in a relatively ecologically clean area, the number of trees belonging to higher productivity classes is higher than in a nursery from an urban environment. This suggests that the unfavorable ecological situation in the study region negatively affects the seed productivity of pine.

Based on the results of the experiment to determine soil germination, it can be concluded that the seeds we collected are not viable. The quality of seeds was influenced by the spring-summer drought, which coincided with the stages of early embryogenesis. The quality of seeds is also influenced by the climate of the steppe zone of the study region: pine plantations here have a weakened vital state [5, P. 77-80].

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

References

1. Иванов В.П. Влияние погодных условий на женскую генеративную сферу сосны обыкновенной (*Pinus sylvestris* L.) / В.П. Иванов, С.И. Марченко, Ю.В. Иванов // Вестник Томского государственного университета. Биология. – 2015. – № 3 (31). – С. 114-130.
2. Кузнецова Н.Ф. Особенности семеношения сосны обыкновенной на территории ЦЧР в засуху 2010 г. / Н.Ф. Кузнецова // Хвойные бореальной зоны. – 2012. – Т. XXX. № 3-4. – С. 270-276.
3. Молчанов А.А. Лес и климат / А. А. Молчанов. – М. : Наука, 1961. –280 с.
4. Кузнецова Н.Ф. Оценка селекционного материала и сортоиспытание засухоустойчивого сорта сосна Острогжская / Н. Ф. Кузнецова // Труды КубГАУ. – 2020. – № 85. – С. 104-109.
5. Сердюкова А.П. Оценка состояния защитных лесных насаждений сосны обыкновенной в засуху 2019 года в степной зоне Воронежской области / А. П. Сердюкова // Вестник Мичуринского государственного аграрного университета. – 2020. – № 4 (63). – С. 77-80.

References in English

1. Ivanov V.P. Vliyaniye pogodnykh usloviy na zhenskuyu generativnuyu sferu sosny obyknovennoy (*Pinus sylvestris* L.) [Influence of weather conditions on the female generative sphere of Scots pine (*Pinus sylvestris* L.)] / V.P. Ivanov, S.I. Marchenko, Yu.V. Ivanov // Vestnik Tomskogo gosudarstvennogo universiteta. Biologiya. [Tomsk State University Journal of Biology] - 2015. - № 3 (31). - P. 114-130. [in Russian]
2. Kuznetsova N.F. Osobennosti semenosheniya sosny obyknovennoy na territorii TSCHR v zasukhu 2010 g. [Peculiarities of Scots pine seed production on the territory of the Central Black Earth Region during the drought of 2010] / N.F. Kuznetsova // Khvoynyye boreal'noy zony [Conifers of the boreal zone]. - 2012. - Vol. XXX. № 3-4. - P. 270-276. [in Russian]
3. Molchanov A.A. Les i klimat [Forest and climate] / A. A. Molchanov. - M.: Nauka, 1961. –280 p. [in Russian]
4. Kuznetsova N.F. Otsenka selektsionnogo materiala i sortoispytaniye zasukhoustoychivogo sorta sosna Ostrogzhskaya [Assessment of breeding material and variety testing of a drought-resistant variety Ostrogzhskaya pine] / N.F. Kuznetsova // Trudy KubGAU [Proceedings of the Kuban State Agrarian University]. - 2020. - № 85. - P. 104-109. [in Russian]
5. Serdyukova A.P. Otsenka sostoyaniya zashchitnykh lesnykh nasazhdeniy sosny obyknovennoy v zasukhu 2019 goda v stepnoy zone Voronezhskoy oblasti [Assessment of the state of protective forest plantations of Scots pine in the drought of 2019 in the steppe zone of the Voronezh region] / A.P. Serdyukova // Vestnik Michurinskogo gosudarstvennogo agrarnogo universiteta [Bulletin of Michurinsky State Agrarian University].-2020. - № 4 (63). - P. 77-80. [in Russian]