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Growth peculiarities and age dynamics of *Quercus robur L.* formation in steppe region conditions

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Abstract

English oak (*Quercus robur)* is one of the main tree species in Russia's steppic silviculture. The research investigated the growth and age dynamics of *Quercus robur* formations in steppe region conditions. Research was carried out in the steppe area of the Volgograd and Rostov regions in the south of Russia. Insufficient precipitation and higher temperatures in arid years has led to a decrease in shortened the growing season. and increase of difference of its continuance among species of different geographical origin. The study found regularities of growth and stand formation, variants characterized by resistance, longevity and productivity in conditions of the steppe area of Russia are developed. In conditions of dry oak stands of *Quercus robur* growth rates were lower than *Acer platanoides* and *Tilia cordata*. Thus, by regulating stand density, it is possible to increase the quality class of oak plantations greatly. The best results were obtained when acorns from the Buturlinovsky forest farm of Voronezh region (Shipov Forest) were used. A good companion for *Quercus robur* is *Acer platanoides*. *Acer platanoides* creates the second layer in an oak plantation by the age of 35-50 years. It shades the soil and prevents turf formation by making lateral shading for trees. *Quercus robur* favors their faster growth in height. The results of this research can be applied in forest and park architecture to improve recreational and protective plantations.

Key words: Growth regularities; *Quercus robur*; mixture schemes; chestnut soils; recreational plantations.

1. Introduction

There are about 600 species in the *Quercus* complex in temperate and tropical zones of the northern hemisphere. There are 19 natural species in Russia and the Commonwealth of Independent States, while about 50 have been introduced. *Quercus robur* (English oak) is one of the main tree plants in steppe silviculture in Russia. It is characterized by resistance to droughts and dry winds. It is known for its longevity and valuable wood (Kruzhilin, 2008; Kulygin *et al.*, 1998; Matvienko, 2002).

Oak forests in Russia occupy about 7.2 million ha. About half of this acreage is of seedage origin. The most well-known are the forests of the Tula region, Tellerman o=Oakery (Borisoglebsky district, Voronezh region), and The Shipov Forest (the forest stand in the Voronezh region). In the southern areas of the Olkhovsky district in the Volgograd region, there are *Quercus robur* trees which were planted at the end of the 17th century. They create an "alley" on the right bank of the floodplain terrace for the Ilovlya River. Preserved specimens can reach a height of 17 m and have a stem width of 1.6m (Matvienko, 2002; Matvienko, 2003; Taran, 2007; Semenyutina, 2013;).

In 1878, the first steppe forest plantations in the Rostov region, namely the Donskoy Forest Farm, were oak (*Quercus*), elm (Ulmus), ash (Fraxinus) and other shrubs. From 1894 to 1907, *Quercus robur* cultivation was increased to 50% with the addition of *Acer platanoides*, *Fraxinus excelsior*, *Tilia cordata*, and sometimes *Acer campestre*. From 1937 to 1965, about 200 variant test cultures of *Quercus robur* were introduced. Kruzhilin (2008) and Matvienko (2003) report that forest cultures of *Quercus robur, Juglans nigra*, and *Pinus* species were introduced later.

Quercus robur is the most valuable tree species for silviculture in the southern Russian steppe regions of Volgograd (Rostov) because of its longevity. The trees can reach significant sizes and can grow in different soil conditions.

Steppe areas are known for their dry soil, which makes growing many varieties of trees difficult. With a broader understanding of best silviculture practices and a more accurate inventory of the long-lived *Q. robur* stands, higher production of valuable species can be obtained. In addition, the landscape will be significantly improved environmentally and aesthetically.

2. Materials and methods

This study investigated the growth and age dynamics of the *Quercus robur* formation in steppe area conditions in southern Russia in the Volgograd and Rostov regions. Investigators looked at the arboretum plantations of the Federal Scientific Centre of Agroecology, the complex reclamation and steppic silviculture of the Russian Academy of Sciences, and the Donskoy Experimental Forest Farm.

The Rostov region has black and southern humus soils. The average annual air temperature is 8.0-8.2° C. The absolute minimum temperature is 34-36° C . Absolute maximum temperature is 39-40° C above zero. The annual precipitation is 350-386 and 409-457 mm, moisture coefficient is 0.11-0.33 and 0.33-0.44 respectively (Semenyutina, 2002; Kruzhilin, 2008; Kulik & Semenyutina, 2008; Semenyutina, 2013).

Dark chestnut and chestnut soils dominate the Volgograd region. The average annual air temperature is 5.4-7.6° C, the absolute minimum temperature is 35-39° C and the absolute maximum temperature is 41-43° C.

Test areas were established to define main inventory indices. Sizes of the test areas were chosen so that at least 140-200 trees of *Quercus robur* grew there. Tree height was measured with a hypsometer. Diagrams were created to indicate heights. Diameters of tree trunks were measured with calipers at a height of 1.3 m. Calculation of average diameters was done according to the sum of the basal areas by the common forestry inventory method. The growth class was defined in accordance with the system quality class scale (Ivonin & Pen'kovsky, 2003; Taran, 2007).

Cultivation of soil for cultures was unstriped to a depth of 27-30 cm. Cultures of *Quercus robur* were created in spring by acorn seeding and planting of seedlings. Codominant (accompanied) tree species were introduced by planting seedlings.

In order to accurately calculate results, $M \pm m_M$, the variation coefficient ($\pm$C,%), test accuracy ($\pm$P,%) were calculated as in previous research by Ivonin & Pen'kovsky (2003) and Taran (2007). A comparison of the Student's T Distribution (t_{fact} and t_{table}) was calculated using three confidential layers: P=95, 99 and 99.9%.

3. Results and discussion

Development of tree and shrub plants is defined by their adaptive reactions. These reactions give insight into how certain species handle changing environmental conditions. This allows researchers to understand if plant growth cycles are appropriate for the time period and local climatic conditions Kulik & Semenyutina, 2008; Semenyutina & Kostyukov, 2013; Semenyutina *et al*., 2016; Semenyutina *et al.*, 2016b; Semenyutina *et al.*, 2016c,).

Species of different origin have equal terms of phenologic phases in steppe region conditions. It is connected with fast increase of positive air temperatures in spring and summer. Insufficient precipitation and higher temperatures in drought years shorten the vegetative period and increase difference of its continuity among species of different geographical origin. During years of favorable weather conditions, this difference is insignificant (Semenyutina, 2002; Semenyutina *et al*., 2015; Semenyutina *et al.*, 2016b).

Moisture shortage in soil during vegetation period limits biological productivity and lowers the resistance of tree plants, and it retards growth and development. Growth processes take place only if there is a sufficient water supply and a high level of protoplasm saturation provided by water. Semenyutina (2013) and Semenyutina and Kostyukov (2013) recognize growth processes as the most perfect system of self-regulation.

Growth of tree species in steppe regions begins early, namely, in the second ten-day period of April. The whole sprout is formed in the process of open growth. It takes place during the most favorable spring season among all species. The soil is adequately saturated during this period (up to 15-17% of absolute dry weight). The average air temperature is 15.1-17.6° C. Most species' growth stops when the weather is hot (middle of June). It is one of the adaptive characteristics of tree plants to dry steppe conditions in the Volgograd region. Plants escape hot weather in phase of biological dormancy (Table 1).

Plants that have the shortest growth period are the most beneficial. Among them are boreal species (*Quercus, Acer, Tilia, Fraxinus*). They are characterized by short but more intense monocyclic sprout growth. During a four to six-week period, they form sprouts of significant length, and culmination

Table 1. Growth period and average sprout length of tree species from Volgograd region (Nizhnevolzhskaya station tree species selection)

Species	Growth period according to term dates		Average growth length in days	Annual increment volume (m)
	Beginning	Finish		
Quercus robur	16.IV-30.IV	24.VI-11.VII	27	0.34 ± 0.014
Acer platanoides	17.IV-30.IV	13.V-15.VI	36	0.22 ± 0.010
Acer negundo	22.IV-10.V	12.V-13.VI	35	0.38 ± 0.020
Tilia platyphyllos	16.IV-3.V	30.IV-20.V	37	0.14 ± 0.007
Tilia cordata	20.IV-7.V	13.V-15.VI	28	0.25 ± 0.010
Fraxinus pennsylvanica	18.IV-10.V	22.V-31.V	25	0.21 ± 0.009

Table 2. Growth of Quercus robur in steppe region conditions

Indices	Soil types		
	Common and southern black soils (Rostov region)	**Dark chestnut soils (Volgograd region)**	**Chestnut soils (Volgograd region)**
Height (m) at the age of			
10 years	4.1-5.7	3.0-4.6	3.5-4.6
20	9.8-10.6	4.3-9.3	6.5-8.5
30	12.0-13.1	8.0-9.5	7.5-10.5
50	13.5-17.6	8.8-12.6	-
Diameter (cm) at the age of			
10 years	3.9-5.0	3.5-4.5	3.5-55
20	9.3-14.6	6.9-12.0	8.6-12.3
30	12.6-14.2	9.0-12.0	10.0-12.9
50	14.5-17.4	13.0-26.6	-
Age of the highest increment (years)	10-20	5-15	3-14
Volume of the highest increment (cm)	50-100	60-100	80-100
Volume of largest diameter increment (cm)	0.6-1.3	0.6-1.0	0.7-2.0
Age of decreasing diameter increment	25	20	20
Cambium productivity cm^3/m^2 in the highest increment period	4800	4400	4500-6900
Cambium productivity over 20 years	2000	2000	1000
Ratio of height to diameter (h:d)	1:1	1:2	-

of increment takes place at the beginning of the growth period, just after the leaves come out (the first half of May) when average air temperature is not higher than 15°C. Species of this group stop their increment before the weather becomes hot. In addition, tree species in drought conditions are characterized by monocyclic and shortened sprout growth period.

Table 2 shows the different growth rates of *Quercus robur* in different soil regions. *Q. robur* grows not less intensely on arid steppe soils during the first ten years than on black soils (Table 2).

According to average models that consider soil/climatic regional data, *Quercus robur* growth curves of tree species show that growth processes in steppe environments are intensive until the age of 20 years. Low precipitation, high transpiration, and intense winds limit growth. By 30 years of age, *Quercus robur* in Volgograd and Rostov regions and in the southeast of Russia is greatly lags behind *Quercus robur* in cultures of Ukraine or the Stone Steppe Voronezh region (Kruzhilin, 2008; Semenyutina, 2013;).

In dry oakery conditions in common and southern black soils, pure oak stands form by the age of 50 years when the undergrowth is made up of *Cotinus coggygriga* and *Acer platanoides* (Table 3). A large store (210 m^3/ha) is formed with participation of *Fraxinus lanceolata* (22%). Different culture densities influence the growth of *Quercus robur*. Height difference of *Quercus robur* is 3.9 m, and the diameter difference is 2.9 cm.

Optimal composition and density of oak cultures in different age periods for 5 culture variants are proved in Table 3. In a variant with the scheme -Q-Ap-Q-Ap ($Д_2$, placement scheme 3x1m), the optimal number of *Quercus robur* pieces in the stand composition (y) is defined by the formula y=4.2+0.05X, where X is the age in years. The formula error is ($\pm S_y$) = ±0.080. The age correlation ratio to piece number of *Quercus robur* in composition is ($r \pm m_r^2$) = 0.945±0.0358.

Models of artificial forest plantations of *Quercus robur* grown according to tree-shade and compound mixture types are reasoned. On the base of inventory indices of the presented variants, programs of stand formation for a10-50 year period are developed (Table 4).

Using combined research data of geographical, edaphic, phenological and morphological forms of *Quercus robur*, the best environmental form was found to be the one in which trees grow out of acorns of upland oakery in the Buturlinovsky forest farm (Shipov Forest, the forest stand in the Voronezh region). The most promising are the ones that come out in-between and have bark with deep longitudinal cracks(h = 19.7±0.30, d = 25.4±1.8, and marketable stems 3.8%).

Cultures of *Pinus pallasiana* and *Quercus robur* in square 33/2 were laid out in the spring of 1974 on 5.6 ha. The type of growth conditions is dry oakery (Do1). The ground is common black soil, with medium humus and clay. It is mostly dry. The site used for the cultures was previously drubbed up of a dying third generation ash-oak stand. Then it was used as agricultural land for two years. Soil was prepared according to a system of bare fallow. Cultures were made up in a mechanized way. Two-year old seedlings of *Pinus pallasiana, Quercus robur* and *Cornus sanguinea* were used for planting. Location of planting

Table 3. Silvicultural and inventory indices of *Quercus robur* in conditions on the Low Don River (Tree-shrub mixture type (Д1)

A (Years)	Plant mixture and placement (m)	Stand composition (%)	Tree Genus	Average H±m_h (m)	Average D±m_d (cm)	N pce/ha	M_{A3} m³/ha	Q Class
35	-Q*-Cs-Fl-Cs-	70Q	Quercus	13.3 ± 0.20	14.2 ± 0.27	906	95.9	I
	3×1	30Fl	Fraxinus	9.8 ± 0.10	10.2 ± 0.17	971	40.7	III
38	-Q-Cs-Fl-Cs	29Q	Quercus	14.1 ± 0.30	17.0 ± 0.47	561	89.1	I
	1.5×1	71Fl	Fraxinus	14.4 ± 0.20	16.0 ± 0.31	1555	219.5	I
38	-Q-Cs-Fl-Cs	54Q	Quercus	13.0 ± 0.10	15.5 ± 0.56	697	86.3	II
	1.5×1	46Fl	Fraxinus	12.1 ± 0.15	12.1 ± 0.24	1070	74.8	III
21	-Q-Q-Cs-Fl/At-Cs	61Q	Quercus	9.8 ± 0.10	9.7 ± 0.34	1592	62.7	I[a]
	2×0.75	39Fl	Fraxinus	12.4 ± 0.10	11.4 ± 0.18	753	46.4	I[b]
21	-Q-Q-Cs-Fl-Cs-2×0.75 (Quercus)	48Q	Quercus	10.5 ± 0.15	9.7 ± 0.18	1401	57.9	I[a]
	1.6 (Fraxinus)	52Fl	Fraxinus	12.7 ± 0.10	14.6 ± 0.30	673	71.3	I[b]
21	-Q-Q-Cs-Fl-Cs-2×0.75 (Quercus)	66Q	Quercus	10.6 ± 0.20	9.3 ± 0.15	1840	71.1	I[a]
	1.6 (Fraxinus)	34Fl	Fraxinus	11.3 ± 0.10	10.9 ± 0.20	699	38.9	I[b]
50	-Q-Q-Pp-Fl-Pp-1×1	100Q	Quercus	13.7 ± 0.27	14.5 ± 0.20	1335	150.0	III
50	-Q-Q-At-Fl-At-1×1	78Q	Quercus	16.6 ± 0.17	16.7 ± 0.10	931	164.0	II
		22Fl	Fraxinus	12.9 ± 0.21	12.3 ± 0.15	609	46.0	III
50	Q-Q-At-Fl-At-1×1	100Q	Quercus	17.6 ± 0.26	17.4 ± 0.21	838	169.0	II

Notes: Q: *Quercus robur,* Cs: *Cornus sanguinea,* Fl: *Fraxinus lanceolata,* At: *Acer tataricum,* Pp: *Pinus* pallasiana, A: age, Q: quality class

places was 1.8±0.75 m. The mixture scheme: Pp-Pp-Pp-Cs-Q-Cs. Data from Table 5 show that *Pinus pallasiana* can grow successfully together with *Quercus robur*.

It is necessary to take into account that these species are antagonists, that is why coulisse or coulisse-row mixture types are recommended. Between *Pinus pallasiana* and *Quercus robur* it is desirable to introduce a shrub row. In this case, *Cornus sanguinea* decreases negative interaction between the trees. The general state of cultures is good, The forest environment is fully intact, and grass vegetation is absent. The plantation's state is highly ornamental.

Kulygin *et al.* (1998), Kruzhilin (2008), Matvienko (2002, 2003), and Matvienko and Mesropyan (2003) propose the best mixture schemes that consider forest growth conditions

Table 4. Program of stand formation for 10-50 years: Type of growth conditions – $Д_1$,species

Main inventory indices (y)		Age correlation ratio to index r (ŋ) ± Er(mŋ²)	Formula of age relation (x) to inventory indices(y)	Formula error (±Sy)
Number of Quercus pieces		0.9914±0.0057	y = 6.02 ± 0.04X	0.01
Density, pce/ha	Q	-0.992±0.053	$y = 1,862.19/e^{0,018X}$	4
	Ap	-0.9992±0.0005	$y = 976.33/e^{0,019X}$	0.2
Height, m	Q	0.9894±0.0071	$y = 0.93X^{0,731}$	0.951
	Ap	0.9791±0.0139	$y = 2,1042X^{0,461}$	0.101
Diameter, cm	Q	0.9924±0.0051	$y = 0.8439X^{0,781}$	0.092
	Ap	0.9783±0.0144	$y = 1,2479X^{0,627}$	0.278
Timber store, m³/ha	Q	0.9971±0.0019	y = -18.62 + 3.136X	0.257
	Ap	0.9031±0.0737	$y = – 18.16 + 2.61X-0.032X^2$	3.737

Notes: *Quercus robur* (Q), *Acer platanoides* (Ap), shrub – *Cornus sanguinea*, mixture scheme – Q-Q-Cs-Ap-Cs-, placement scheme – 2×1 m)

Table 5. Silvicultural and inventory indices of mixed cultures *Pinus pallasiana* and *Quercus robur* (age of 25 years)

Species	Height (m) (M мм)	Diameter (cm) (M мм)	Average increment In height (m/year)	Average increment In diameter (cm/ year)	Quality Class
Pinus pallasiana	11.1 0.2	12.6 0.3	0.44	0.50	I
Quercus robur	10.8 0.2	12.0 0.2	0.43	0.48	I

and form plantations for recreational and forest reclamation purposes (Table 6).

4. Conclusion

Quercus robur is one of the main tree species in steppe silviculture in Russia. It resists droughts and dry winds. It has longevity, and is prized as a valuable timber product. Therefore, understanding best growing practice is vital. In steppe area conditions, knowledge of silvicultural and inventory indices in different age periods allow growing of long-lived *Quercus robur* stands. Regularities of growth and stand formation are found. Variants such as resistance, longevity and productivity in conditions of steppe area of Russia are developed. Insufficient precipitation and higher temperatures in drought years shorten vegetative periods and increase difference of its continuity among species of different geographical origins. During years of favorable weather conditions, the difference is insignificant.

In dry oakery conditions, *Quercus robur* has a slower growth rate than both *Acer platanoides* and *Tilia cordata* during the first years of life. When planting width is 1.5 m, *A. platanoides* and *T. cordata* create crown shade. As a result, *Quercus robur* falls out of the stand. In oak-maple cultures, aged 11 to 20 years is the most critical for *Quercus robur*. By 25 years of age, the height of *Quercus robur* and *Acer platanoides* are equal at +13.5±0.10 for both species.

In dry and fresh oakeries of the Rostov region*, Quercus robur* can be successfully introduced into cultures using the coulisse mixture method. To clarify, in dry oakeries, 2 rows should be in coulisse, while in fresh, 2-3 rows is better.

In dense cultures with a trunk number of 1335 pieces/ha and undergrowth of *C. coggygriga*, *Quercus robur* grew according to the III quality class and formed less wood stock. Thus, by regulating stand density, it is possible to greatly increase the quality class of oak plantations.

Growth and productivity of *Quercus robur* is greatly influenced by acorn origin. The best results were obtained when acorns of the Buturlinovsky Forest Farm of the Voronezh region from the Shipov Wood were planted. A good companion for *Quercus robur* is *Acer platanoides*. *Acer platanoides* creates the second layer in an oak plantation by 35-50 years. It shades the soil and prevents turf formation, making lateral shading for trees. *Quercus robur* favors this faster growth in height.

Results obtained from this research will allow forestry management to choose mixture types by considering forest growth conditions;. More productive plantations can be established after transition to forest lands by taking into account proved models. Applying best practices in forests and parks to create recreational and protective plantations will improve the stands, thereby increasing their productivity. Finally, healthy forests benefit local wildlife and human populations.

Table 6. Offered mixture and location schemes of trees and shrubs for recreational and protective plantations

Type of growth conditions	Mixture scheme	Espacement (m)	Codominant tree plants and shrubs
Do1, S1	P – P – P – P – P Cs-Cs-Cs-Cs-Cs	3.0×0.75	Acer campestre Acer tataricum
Do2, S2	P – P – P – P – P Cs-Cs-Cs-Cs-Cs	3.0×1.0	Acer platanoides Tilia cordata
Do1, Do2	P – P – P – P – P P – P – P – P – P P – P – P – P – P s – s – s – s – s Qr-Qr-Qr-Qr-Qr s – s – s – s – s	3.0×0.5(0.75)	Ribes aureum Lonicera tatarica Cornus sanguinea
S2, S3	P – P – P – P – P P – P – P – P – P P – P – P – P – P s – s – s – s – s Qb-Qb-Qb-Qb-Qb s – s – s – s – s	3.0×0.5(0.75)	Ribes aureum Lonicera tatarica Cornus sanguinea
Do1, Do2	P – P – P – P – P P – P – P – P – P P – P – P – P – P Cs-Cs-Cs-Cs-Cs Qr-Qr-Qr-Qr-Qr Cs-Cs-Cs-Cs-Cs	3,0×0,5(0,75)	Acer campestre Acer tataricum
S2, S3	P – P – P – P – P P – P – P – P – P P – P – P – P – P Cs-Cs-Cs-Cs-Cs Qb-Qb-Qb-Qb-Qb Cp-Cp-Cp-Cp-Cp	3.0×0.5(0.75)	Acer platanoides Tilia cordata
Do1, Do2	P – P – P – P –P P – P – P – P – P P – P – P – P – P s – s – s – s – s Qr-Qr-Qr-Qr-Qr Qr-Qr-Qr-Qr-Qr Qr-Qr-Qr-Qr-Qr s – s – s – s – s	3.0×0.5(0.75)	Ribes aureum Lonicera tatarica Cornus sanguinea
S2, S3	The same with Qb	3.0×0.5(0.75)	The same

Notes: P – *Pinus sylvestris* and *Pinus* pallasiana; Qr – *Quercus robur*; Qb – *Quercus borealis*; Cs –codominant species; s –shrub, Do – dry oakery, S – sudubrava

References

Ivonin, V.M. & Pen'kovsky, N.D. (2003). Forest reclamation (scientific research): study. North Caucasus Scientific Centre of Higher School FSAEI HPE SFU. Rostov-on-Don: 151.

Kruzhilin, S.N. (2008). Growth of English oak in forest cultures, created by different mixture types in conditions of the Low Don River: Author's thesis. Bryansk State Technology Engineering Academy. Novocherkassk: 182.

Kulik, K.N. & Semenyutina, A.V. (2008). Enrichment of forest reclamation complexes by stocking resources. Nizhnevolzhsky Agrouniversity Complex Review: Science and Higher Professional Education, **1**: 3-11.

Kulygin, A.A., Matvienko, E. Yu. & Taran, S.S. (1998). Perspective invasive plants for steppe forest stands of Rostov region. Land forest reclamation in the south of Russia. Digest of papers devoted to the 200th anniversary of the creation of the Forest Department in Russia. Novocherkassk State Land Reclamation Academy. Novocherkassk: 17-20.

Matvienko, E. Yu. (2002). Invasive plants in steppe stands in the southwest part of Rostov region: Author's thesis. Novocherkassk: 210.

Matvienko, E. Yu. (2003). Stocking experience of tree species in a study forest farm "Donskoe". Horticulture, seed breeding, stocking of tree species: Proceedings of the 6th International Scientific Conference. Krasnoyarsk: 53-54.

Matvienko, E. Yu. & Mesropyan, D.V. (2003). Growth of pure cultures of pine tree in dry oakery types of forest growth conditions of the Low Don River. Horticulture, seed breeding, stocking of tree species: Proceedings of the 6th International Scientific Conference. Krasnoyarsk: 55-57.

Matvienko, E. Yu. (2010). Stocking experience of pine genus (*Pinus*) in black soil zone of the Low Don River. Problems and development perspectives of forest reclamation and forestry in the Southern Federal District: Proceedings of the International Scientific Practical Conference devoted to the 90th Anniversary of Forest Education in the River Don location. Novocherkassk: 278-282.

Semenyutina, A.V. (2002). Assortment of trees and shrubs for reclamation of agricultural and urban landscapes of arid zone: Scientific Methodological Recommendations. Moscow-Volgograd: Rosselkhozakademia: 59.

Semenyutina, A.V. (2013). Dendroflora of forest reclamation complexes. Volgograd: VNIALMI: 266.

Semenyutina, A.V. (2014). Landscaping of rural areas: Study guide. Volgograd: 144.

Semenyutina, A.V., Khuzhakhmetova, A. Sh., Podkovyrov, I. Yu. & Svintsov, I.P. (2015). Scientific foundations of stocking by method of genus complexes to choose tree species for landscaping technologies. Fundamental Researches, **2(21)**: 4687-4692.

Semenyutina, A.V. & Kostyukov, S.M. (2013). Bioecological justification assortment of shrubs for landscaping urban landscapes. Accent Graphics Communications. Montreal, Canada: 164.

Semenyutina, A.V., Podkovyrov, I.Y., Semenyutina, V.A. & Podkovyrova, G.V. (2016c). Mathematical justification of the selection of woody plants biodiversity in the reconstruction of objects of gardening. International Journal of Pure and Applied Mathematics, **110 (2)**: 361-368

Semenyutina, A.V., Svintsov, I.P. & Kostyukov, S.M. (2016). Gene resources of shrubs for amenity planting: Monograph. Moscow. Science. Idea: 238.

Semenyutina, A.V., Taran, S.S., Kruzhilin, S.N. & Petrov, V.I. (2016b). Ontogenesis, ecological role and shrub perspective for protective forest stands of different purposes. Social and Ecological Technologies, **2**: 74-83.

Taran, S.S. (2007). Arboriculture: study. Ministry of Agriculture of RF; FSEI HPE Novocherkassk State Land Reclamation Academy. Novocherkassk: 119.

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خصائص النمو وديناميكيات العمر في تكون السنديان القوي Quercus Robur l في السهول

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الملخص

شجرة السنديان القوي Quercus robur (البلوط الإنجليزي) هي واحدة من النباتات الشجرية الرئيسية في زراعة الغابات السهلية في روسيا. سيؤدي تطبيق نتائج البحث في هندسة الغابات والحدائق لتشكيل المزارع الترفيهية والوقائية إلى تحسين حالة المزارع وزيادة إنتاجيتها بالإضافة إلى السمات الجمالية والأهمية البيئية على وجه العموم.
مُهمة البحث هي دراسة نمو وديناميكيات العمر لنمو السنديان القوي Quercus robur في المناطق السهلية.
أُجريت الأبحاث في منطقة السهول في جنوب روسيا (مناطق فولجوجراد وروستوف). يؤدي التساقط غير الكافِ للأمطار وارتفاع درجات الحرارة في السنوات القاحلة إلى انخفاض الفترة الخضرية وزيادة الاختلاف في استمراريتها بين الأنواع ذات المنشأ الجغرافي المختلف. تم العثور على انتظامات النمو، وتم تطوير متغيرات تتميز بالمقاومة وطول العمر والإنتاجية في مناطق السهول في روسيا. ومن المعروف أنه في ظروف البلوط الجاف فإن السنديان القوي Quercus robur يلي القيقب الدلبي Acat platanoides والزيزفون Tilia cordata في النمو. وبالتالي، عند تنظيم الكثافة فمن الممكن زيادة درجة الجودة في مزارع البلوط إلى حد كبير. تم الحصول على أفضل النتائج عندما تم استخدام جوز البلوط من مزرعة غابات Buturlinovsky في منطقة فورونيتش Voronezh (خشب Shipov). الرفيق الجيد للسنديان القوي Quercus robur هو القيقب الدلبي Acat platanoides. يشكل القيقب الدلبي platanoides Acer الطبقة الثانية في زراعة البلوط من عمر50-35 سنة. فهو يظلل التربة ويمنع تكون العشب مما يعمل على التظليل الأفقي للأشجار. يفضل زراعة السنديان القوي Quercus robur في المرتفعات للحصول على النمو السريع.