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GROWTH RATE TESTS FOR MATERNAL DESCENDENTS OF PEDUNCULATE OAK (*QUERCUS ROBUR* L)

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Summary: The growth rate of *Quercus robur* L. saplings obtained from the germinated acorns sowed in the autumn and spring was investigated. The growth rate of descendents obtained from the spring sowed acorns was revealed to be much higher than those obtained from the autumn sowing. The differences of their growth rate were significant and therefore those differences have a certain practical value. It was also demonstrated the importance of collecting the acorns formed in conditions that assure cross-pollination of trees (from polymorphic population). Saplings obtained from this population grew much faster than those obtained after self-pollination (in consanguine population). This phenomenon could be a consequence of partial splitting of heterozygote and accumulation of homozygote in posterity after self-pollination, factor that influence the growth of obtained genotypes. In consanguine population was observed the high level of genotypes variation, accompanied with a low level of some part of saplings viability and vigor. Slow growing of oak saplings determines the difficulties of their maintenance, especially during the first years of life. Thus, cross-pollination and spring sowing of the obtained acorns are the two factors that are important to take into account when we want to r obtain viable and vigor descendents of pedunculate oak.

Key words: pedunculate oak, maternal descendents, polymorphic population, consanguine population, growth rate.

Introduction

One of the major specific events in biological science of XX century was the theoretical formulation of the concept of population. Now the population is considered as basic unit of existence, duplication and adaptation of the related genotypes, containing a group of similar individuals, with the common origin; which occupy a uniform area, have a specific combination of hereditary attributes and determined genotypic structure; assure appearance of multiple copies, constantly panmictic [12]. The population is elementary and the lowest form of specie collective existence [13]. It is laboratory the natural selection takes place [11], with the set of coadaptation genes inside it [4]. At the beginning the behavior and properties of natural populations were studied [8] that allowed the studying and comparison of processes that occur at the level of different populations. Admitting the fact that the population is a ecologic-genetic structure, biologists and mathematics used various mathematical methods for description of its behavior of attributes of descendents in conformity with the principles of Gr. Mendel.

The specific scientific interest represents the populations of pedunculate oak (*Quercus robur* L.) in order to determine the amplitude of geographical and biotopical variability of populations; revealing the character of sapling growth in dependence of origin; inheritance of phenological attributes, taxonomic purposes et al. The contemporary researches [9] have shown, that inside the specie of pedunculate oak there are only two categories of group variability: populations and groups of populations. Specific biological features of this species and ecological mosaic area of its distribution influence the

* The Nature Reserve „Plaiul Fagului", Moldova

differentiation of populations at different territories [1]. Special value in this process has the effective distance of distribution of pollen and acorn. The distribution of pollen from the individual oak tree achieves about 70-100 meters [10]. Insignificant distribution of acorn is the consequence of his size. Mature acorn fall directly under a crone of a parent tree or are rolled on a small distance. Discrepancy of the period of pollination of trees within the limits of a large forest, absence of air circulation necessary for caring up of pollen on the large distances create obstacles for panmicthy and result in isolation of populations of an oak on small distances.

The present work represents the results of researches the descendents from two populations of pedunculate oak (*Quercus robur* L) incorporated in Scientific Reservation "Plaiul Fagului" influenced by the polymorphic or consanguine origin of acorn.

Material and methods

In half sib seed plantation are tested saplings a pedunculate oak occurred from acorns of 64 trees that represent sample of a natural population, and sapling, brought up from acorns collected from 6 trees, which are growing isolate on the margin of the forest.

Collecting of acorns was carried out from each tree separately. The half sib plantation has been created by seeding the acorns in the autumn 2001 and spring of 2002 on square sites, with the lateral party length of 7 meters. Acorns were seeded in rows at the depth of 6-7 cm and distances between saplings 1x1 in meters. The experiments were plotted in 4 variants with 5 repetitions each. Variants are differentiated one from another by the sites of acorn collection. The circuit of a skilled site is shown in [2]. The experimental population was modeled from the 64 different genotypes on one site that has received the name a *polymorphic population*. The other experiment has been incorporated on the basis of acorns collected from isolated trees, named the *consanguine population*.

Researches at the level of populations have been lead, and the influence of period of sowing on the speed of the sapling growth has been appreciated. Two statistic-mathematical methods have been applied for estimation of authentic distinctions between average values of investigated attributes. With the help of Student pair criterion the importance of distinctions between population average values was revealed by comparing all possible combinations between variants [14]. Also the dispersive analysis with equal numbers for each class has been lead [15]. The mathematical model of the dispersion analysis was provided by the equation:

$$x_{ij} = m + \mu_i + \beta_j + \varepsilon_{ij}$$

where:

m – general average;

μ_i – a component i populations (i = 1 … n);

β_j – a component j repetitions (j = 1 … r);

ε_{ij} – the mistake which deforms ij a site with $\varepsilon_{ij.}$

Making dispersions of investigated attributes can be calculated, using the information of the table:

The statistical parameters used for dispersive the analysis of experimental results

Source of variability	Number of degrees of freedom	The sum of squares	An average square	Values F
Populations	n-1	H-C_t = K	K/n-1 = N	N/P = N
Repetitions	r-1	I-C_t = L	L/r-1 = O	O/P = R
Mistake	(n-1)(r-1)	M	M/Nr-1 = P	
In total	Nr-1	G-C_t = J		

The results received by using of two methods are considerably different. The dispersion analysis (the first method) calculates integrated differences between all populations comparing with general average. By the second method a comparison between the average values of all pairs of populations is made, that increase the probability of significant differences. The dispersion analysis causes more strict level of an estimation of differences between variants.

Results and discussions

Supervision over the growth by 896 descendants of a pedunculate oak has been provided during the first 3 years of their life. The generalized statistical data regarding the rate of sapling growth in height and on diameter are introduced in (**Tab. 1**, **Tab. 2**)

Table 1

Average values and factor variability of parameters describing the height of oak sapling

Population	The period of sowing	Height after 1-st year		Height after 2-nd year		Height after 3-it year	
		$\overline{X}$, sm	C, %	$\overline{X}$, sm	C, %	$\overline{X}$, sm	C, %
Polymorphic	Autumn	19,7	33,5	43,7	29,8	112,2	22,2
	Spring	21,6	28,6	50,4	28,7	123,9	25,9
Consanguine	Autumn	17,0	35,8	44,3	30,8	101,8	32,8
	Spring	20,7	26,4	46,4	26,0	113,0	23,7

Data included in the table1 demonstrated that the largest growth of height during the first year was realized by sapling of polymorphic population seeded in the spring. The average height of plants in this variant was achieved 21,6 cm. The difference from the consanguine sapling of autumn sowing regarding this parameter was at high reliability (P = 99,9 %; $t_{calc.}$ = 7,775). The tendency of faster growth of saplings diameters in polymorphic populations was also revealed. Consanguine sapling from the autumn and spring sowing had a diameters on 75,0 and 87,5% less in comparison with sapling the polymorphic population created by autumn sowing (**Tab. 2**).

Appreciable influence on energy of sapling growth was observed after spring sowing. For example, in a polymorphic population sapling, incorporated by spring sowing, exceed on 9,6 % on height that are brought up from autumn sowing, and in consanguine populations sapling created by autumn sowing grew on 82,1 %.

Table 2

Average values and factor variability of parameters describing the diameter of oak sapling

Population	The period of sowing	Diameter after 1-st year		Diameter after 2-nd year		Diameter after 3-it year	
		$\overline{X}$, mm	C, %	$\overline{X}$, mm	C, %	$\overline{X}$, mm	C, %
Polymorphic	Autumn	4,8	25,4	8,9	23,0	17,9	33,4
	Spring	4,6	25,1	10,5	24,3	20,0	22,3
Consanguine	Autumn	3,6	26,4	8,7	25,5	17,4	28,1
	Spring	4,2	25,6	9,6	21,3	18,8	19,0

The mentioned yearly tendency of stronger growth in height and diameter of sapling obtained from spring sowed polymorphic population was kept after 2-nd year of a life. So, this population surpassed on 13,8 % in height and on 20,7 % in diameter the consanguine a population obtained after autumn sowing. The revealed higer average values of height and diameter at sapling of polymorphic population is confirmed by the values of correlations. The factor of correlation achieved values r = 0,72 (p <0,001) (**Tab. 5**). Irrespective of genotype structure sapling created by spring sowing had stronger energy of growth in comparison with sapling obtained after autumn sowing. For example, sapling of polymorphic population obtained after spring sowing have found out average height authentically higher (P = 99,9 %; $t_{calc.}$ = 5,134) in comparison of that has been revealed at descendent after autumn sowing. The similar differences were observed also in diameter.

The highly authentic distinctions between populations were observed also for 3 year old plants (**Tab. 3, Tab. 4**).

Table 3

Matrix of t_{calc} values and reliability of differences between growths of 3 year sapling of different populations

Population	Population 1	2	3	4
1. Polymorphic population, autumn sowing	-	4,306***	3,684***	0,262
2. Polymorphic population, spring sowing	4,306***	-	7,186***	3,349***
3. Consanguine a population, autumn sowing	3,684***	7,186***	-	3,342***
4. Consanguine a population, spring sowing	0,262	3,349***	3,342***	-

Note: the reliability on 0,01 %.

The greatest average heights have been found for spring sowed polymorphic population where average height sapling has registered 123,9 cm, when for sapling of consanguine populations was only 113,0 cm. Ranging the populations according to the investigated parameters has revealed, that to population with higher average heights of sapling has accordingly the higher diameters. It means, that there are correlating growth of his parts, that in our case can be confirmed by revealing of significant correlations between the investigated parameters in polymorphic population (r = 0,55; p <0,001) (**Tab. 5**). From this follows, that in the period of individual development the data received about average diameter, can serve for estimation of sapling growth in height and on the contrary.

Table 4
The dispersion analysis of growth in height of oak sapling
in hereditary plantation

Source of variability	Number of degrees of freedom	The sum of squares	An average square	Values $F_{calc.}$	P
Height sapling after 1-st year of a life					
Populations	2	40,24	20,12	6,418	
Repetitions	3	2,02	0,673	0,215	
Mistake	6	18,81	3,135		
In total	11	61,07			
Height sapling after 2-nd year of a life					
Populations	2	104,8	52,4	14,348	<0,05
Repetitions	3	41,12	13,707	3,753	
Mistake	6	21,91	3,652		
In total	11	167,83			
Height sapling after 3-rd year of a life					
Populations	2	876,8	438,4	25,12	<0,05
Repetitions	3	141,87	47,29	2,71	
Mistake	6	104,71	17,452		
In total	11	1123,38			

The tendency of the better growth of sapling from polymorphic population in comparison with consanguine was observed within first years of life. This phenomenon can be explained by the energy of growth that depends on a method of crossing of adult trees. Oak, being a species with air pollination can demonstrate deviations from accidental crossing when small size of populations form and when trees are on a margin of a large forest [6]. In our case parent trees of a pedunculate oak are pollinated by casual image, however the number of trees, donors of pollen, is smaller than that occurs inside a large forest. Therefore closely related crossings between trees of an oak are possible also. Feature of crossing parent trees results to the descendent negative consequences consanguine. Splitting heterozygote in posterity, accumulation of harmful recessive genes that influence growth, lead to a slow down of consanguine saplings growth. Weak growth of consanguine sapling is in certain measure caused by this phenomenon. Therefore, for realization of economic activities in forest areas is important to collect acorns from population of oaks and to exclude the isolated trees. Sapling, brought up from acorns produced by isolated tree will have weaker growth in comparison with saplings, received from acorns collected in high productive forest stands.

Spring sowing has influenced favorably the speed of sapling growth in populations during 3-rd year of a life. For example, the height of sapling received by spring sowing of polymorphic population was at 10,4 % above than that of autumn sowed. Such situation was observed and for diameters: the diameter growth of autumn sowed saplings was on 89,5-92,6 % more slowly that of spring sowed (**Tab. 1-2**). The establishment of the better saplings growth after spring sowing has the certain practical value. It is known [7] that oak has specific biological feature to grow slowly during the first years of a life, however forming in this period powerful root system. Therefore for obtaining of viable forest stands it is necessary to protect saplings from tall weeds during the first 5-7 years after sowing. Obviously, that such care demands financial expenses. In this connection, transition to creation of wood cultures by carrying out of spring sowing will lower term of translation of cultures in the area covered with a wood and will reduce labor and monetary expenses for their cares.

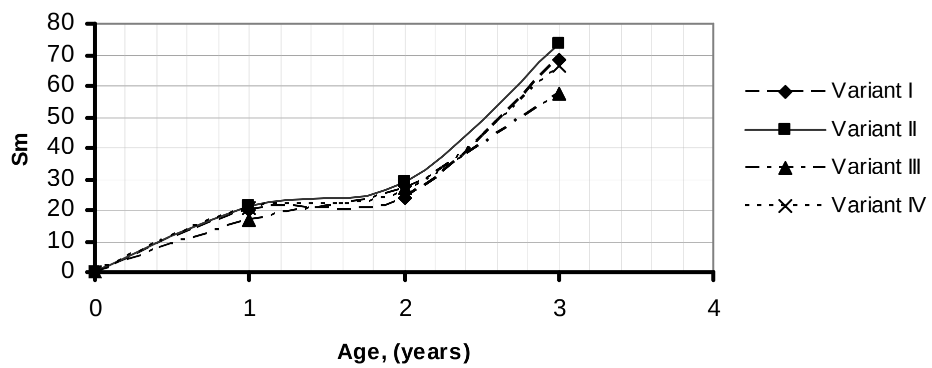
Table 5

Matrix of factors of correlation *r* between investigated parameters and their importance

Attribute	Attribute				
	2	3	4	5	6
1. Height after 1-st year of a life	0,62***	0,13	0,17	0,17	– 0,10
2. Diameter after 1-st year of a life	-	0,22	0,28*	0,27	0,12
3. Height after 2-nd year of a life	-	-	0,72***	0,68***	0,49***
4. Diameter after 2-nd year of a life	-	-	-	0,60***	0,61***
5. Height after 3-rd year of a life	-	-	-	-	0,55***
6. Diameter after 3-rd year of a life	-	-	-	-	-

The analysis of pedunculate oak saplings growth during first 2-th years has shown high similarity. Values of the current saplings gain variatied from 17,0 to 21,6 cm after 1-th year of a life and from 24,0 to 27,3 cm after 2-th year of life. From the relation of the sums of average values of the current gain of sapling in populations in 2-th year to corresponding parameter of 1-th year of a life have received an index which testifies, that the promoter of 2-th year of a life sapling growth was in 1,3 times more than the last year. During 3-it year of a life has considerably increased growth rate of sapling height in all researched populations. In comparison with 1-th year, in 3rd year the current gain sapling in height has sharply increased. From the schedule it is clear, that during 3-it year of a life the highest energy of sapling growth has been revealed in polymorphic populations of the created by autumn and spring sowing. From the above-stated follows, that during the first two years of a life the growth rate sapling in populations was insignificant, and parameters of the current gain had almost identical values. During 3-it year of a life growth sapling height has considerably increased.

Schedule. Dynamic of gain of oak sapling in different populations



Variant I – polymorphic population, autumn sowing;
Variant II – polymorphic population, spring sowing;
Variant III – consanguine a population, autumn sowing;
Variant IV – consanguine a population, spring sowing.

The analysis of a course of oak saplings growth in height during first 3rd years of a life has revealed, that in comparison with previous year the growth rate sapling has increased in 1,3 times, and after 3-it year of a life in comparison with 1-th year – 3,4 times. Insignificant growth of saplings during the first years of a life is consequence of specific features of this species to form developed root system. This biological feature of an oak to grow insignificantly in the first years of a life is not attractive for syvilcultorist that work in forestation. The constant attention which needs to be rendered sapling dings during 5-7 years (that is before translation of wood cultures) has as result frequent refuse by syvilcultorists to enter the oak into structure of wood cultures. Are worthy economically less valuable, but fast-growing exotic wood as, for example white acacia (*Robinia pseudoacacia*) in view of that the period and expenses for itscultivation are lower. The carried out scientific researches have revealed, that the white acacia in inappropriate ecological conditions grows quickly up to age of 10-12 years. After that growth in height starts to be reduced considerably and the kind gradually dries out. This process is shown in acacias plantations at the south of Republic Moldova [3]. The oak on the contrary, grows more slowly during the first 5-10 years period, during which the root system shows strong annual growth. In the subsequent, growth in height increases, can annually reach 1-1,5 meters in length, being active during 150-200 years [7]. These statements are rather convincing argument for cultivation the pedunculate oak in corresponding ecological conditions. This species has been named Professor M. Drăcea [5] „the *aristocrat* of woods and *diamond* wood". This specie in recent times occupied extensive territories in the south of Moldova. At the same time, the activity of actual sylvilcultors results in decreases of oak forest stands.

Conclusions

1. Variability in height and diameter in populations of pedunculate oak saplings decreases with the age. The high variability of one-two year saplings is a consequence of their high sensitivity to negative influence of harmful factors. With age the saplings become more viable and less dependent from fluctuation of local and time factors of environment. The lower viability of saplings received by autumn sowing has also caused increase in residual variability of their length and diameter.
2. Consanguinization promotes the decrease of sapling growth in height and diameter. From this follows for initiation of new oak plantation it is necessary to avoid collecting the acorns from isolated oak trees.
3. Saplings appeared after spring sowing is higher in the height and larger in diameter than those obtained from autumn sowing. It is necessary to recommend spring sowing of stratified acorns in forestry activity.
4. In the first two years of a life oak saplings demonstrated a\slow growth and its increase begin during the third year of saplings life.

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