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Distribution of Lithuanian Scots pine trees according to breeding categories and their seed production in seed stands

Abstract: In addition to other traits, value of stands for breeding can be evaluated according to the number of plus trees and productive trees. According to this property, stands with the highest value for breeding are located in eastern Lithuania. Trees start to differentiate into breeding categories at the juvenile stage: in Scots pine stands on *Pinetum myrtillosum* sites, at the age of 6 to 8 years and in Scots pine stands on *Pinetum vacciniosum* sites, at age of 10 to 12 years. According to radial increment, the trees start to differentiate into selection categories of productive, medium and minus trees, which often remain in these categories until mature age. The following four types of radial increment of trees were distinguished: (1) fast growth at the juvenile stage, followed by a gradual decrease, (2) fast growth at the juvenile stage, followed by a stable growth from age 20 to 30 years, (3) slow growth at the juvenile stage, followed gradual increase, (4) unstable growth all the time. In Lithuania, abundant seed yield used to occur in three to four year intervals. Populations with abundant flowering may produce approximately 10 kg of seeds (filled and empty) per ha, while the populations with weak flowering – 1 to 2 kg per ha. In mature Scots pine stands of stocking level ca 0.7, 6 to 8% of the seeds are produced by plus trees, 24% by productive trees, 55 to 60% by trees of medium productivity and 10% by minus trees. Being suppressed, minus trees produce 2% of the seeds only.

Additional key words: Scots pine, breeding categories, radial increment, seed bearing

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Introduction

Seed collection stand is an important mean for gene conservation *in situ*. 30% of seeds are planed to be collected in seed collection stands for regeneration of forests in Lithuania. Benefit of seed collection stands is not only to obtain seeds of appropriate quality but also to conserve the stands of good quality on sustainable basis by applying selective thinning and by supporting the natural regeneration. In addition to establishment of forest, seeds from seed collection stands may also be used for dynamic conservation of genetic resources in multi-population plantations.

Considering this complex value of seed collection stands, assessments on development of these stands over ontogeny is of high importance for successful development of the future generations (Gabrilavičius 1995). The following questions became of the first priority: (1) trees of which breeding category are making up the seed collection stands, (2) how the trees differentiated into breeding categories during the ontogeny and (3) which are the patterns of their growth.

Assessment of the flowering regularities and the possibilities to collect the seeds as well as annual forecast of seed yield also are among the most important factors.

Material and methods

Seed collection stands of good quality were assessed in three populations in Lithuania: western

(Darbenai), southern (Kapčiamiestis), and eastern (Labanoras). In these stands, trees were evaluated to be ascribed into breeding categories (plus trees, productive trees, medium productivity trees and minus trees) according to the scale by Ramanauskas and Gradeckas (1996).

Radial increment of the trees was determined according to increment cores sampled from the trees of different breeding categories. Width of each annual ring in an increment core was measured.

Tree bearing (seed yield) was assessed according to the scale by Korcagin (1960) and the parameters describing the seed harvest were calculated according to Nekrasova (1955).

Results and discussion

Value of stands may be estimated according to the number of plus trees, productive trees, medium productivity trees and minus trees, which usually are estimated in premature and mature stands. As the main function of the seed collection stands is to produce seeds, it is important that these stands are composed predominantly of the trees of good quality which are able to produce sufficient amount of seeds. Large minus trees (with thick branches, wide and long crown, inappropriate self pruning) are most undesirable trees in such stands. Trees of this category are usually flowering well and may have a substantial influence on the quality of the future generations, whereas, minus trees which are suppressed produce little seeds and, therefore, their influence to quality of the seed harvest is much less. Number of trees of different breeding categories in the studied stands is given in Table 1.

Analysis of the increment cores showed that trees start to differentiate into breeding categories at the juvenile stage (already in the first decade). In the pine stand on *myrtillosum* site differentiation of trees into productive, medium and minus trees occurs at age 6 to 8 years and in the pine stand on *vacciniosum* site- at age 10–13 years. Radial increment of these trees is gradually decreasing with age. According to an index of traits, primarily according to the structure of crown, plus trees and large minus trees start to differentiate within the category of productive trees. Minus trees with slow growth are dying out starting from the beginning of the differentiation up to rotation age. Usefulness of these trees for breeding is low, as they are of weak reproductive capacity and not taking part in the composition of the new generations. In naturally regenerated stands, number of trees is decreasing from 10–30 thousands per ha at the juvenile stage to 300–600 trees per ha at the mature stage. This development of stands and the process of natural selection are particularly important because selection does not act at random. It is populations but not individuals which are evolving. In the stands of Labanoras population, there were more plus trees and productive trees than in the other two stands studied. This stand also contains the lowest number of minus trees. The highest number of productive and medium trees as regards radial increment was found in Kapčiamiestis population. In this population, there was the greatest difference between productive and minus trees. The process of differentiation into selection categories in Kapčiamiestis population is faster and more intensive and is finished earlier than in the other populations. The breeding categories of trees under development usually remain until mature age. A tendency was noted, that the number of minus trees in populations is decreasing with increasing age. However, this tendency is weak, as category of minus trees is gradually replenished by trees of the other category, primary from the category of medium trees.

Makarenko (1969) reported that large trees retained the percentage of their rank (80%) during the study period. Medium trees were of least stability (40%) and minus trees in most cases remain as such (70%).

Trees differ in their growth rate even within the same stand. Variation among individuals in growth rate is influenced by a number of factors: inherited properties, crown structure, intensity of assimilation

Table 1. Distribution of trees according to breeding categories

Population	Percent							
	50–60 years old				80–90 years old			
	Plus trees	Productive	Medium	Minus trees	Plus trees	Productive	Medium	Minus trees
I. Pine stands on *Pinetum vacciniosum* sites								
Darbėnai	3	21	53	23	3	22	57	19
Kapčiamiestis	3	25	53	19	3	24	57	16
Labanoras	5	29	54	12	4	30	48	8
II. Pine stands on *Pinetum myrtillosum* site types								
Darbėnai	2	18	50	30	2	20	58	20
Kapčiamiestis	3	28	49	20	2	24	57	17
Labanoras	4	32	49	13	4	31	53	12

Table 2. Radial increment type of the trees of different breeding categories

Breeding category	% of trees for each type of the radial increment			
	Type 1	Type 2	Type 3	Type 4
Plus trees	–	40.0	–	60.0
Productive trees	27.7	24.7	2.0	43.6
Medium trees	36.0	27.0	2.0	35.0
Minus trees	58.9	24.2	1.1	15.8

processes, climatic conditions and other factors (Rohmeder and Schönbach 1959). In the natural populations studied the following four types of radial increment were determined: (1) fast growth at the juvenile stage, followed by gradual decrease in growth rate, (2) fast growth at the juvenile stage and from age 20–30 – more or less stable, (3) slow growth at juvenile stage followed by a gradual increase in growth rate at the later stages and (4) unstable growth all the time. Productive trees were mainly of the fourth type of radial increment (43.6%). Medium productivity trees were mainly of the first (36.0%) and the fourth (35.0%) type of radial increment, though, a high number trees exhibited growth of the second type (27.0%). Most of the minus trees exhibited the first type of radial increment (58.9%) (Table 2).

The peak of radial increment occurs at the age 10 to 20 years. In forest plantations this occurs earlier than in naturally regenerated forest (Mirosnikov and Atroscenko 1972).

Seed production by trees of different breeding categories

Studies on flowering abundance and variation in 14 populations over 5 year period showed that one population flowered each year over 5-year-period, six populations flowered during 3 years out of 5, four populations flowered during 2 years out of 5 and three populations flowered during 1 year out of 5. Scots pine is flowering more or less every year, but a relatively more abundant seed yield is produced each 3–4 year (Danusevičius 2000).

During the 5-year-long study period, 5% of the trees studied were not flowering at all, 41% was flowering every year and 54% was flowering with breaks. The pine trees with abundant flowering every year (1.3%) were identified. Populations (seed collection stands) with abundant flowering produce about 10 kg seeds from 1 ha per year, while the ones with a weak flowering – 1–2 kg seeds per ha and year (Ramanauskas 1978).

In mature seed collection stand of pine with a normal structure, percentage of seeds produced by trees of different breeding category is the following: plus trees produce 6–8%, productive trees – 24%, medium-productivity trees – 55–60% and minus trees about 10% of all seeds in the stand. Suppressed trees produce less than 2% of the total seed in the stand and have a little contribution to the future generations. However, seed yield of large minus trees is more important.

Conclusions

1. Quality of Scots pine stands (reflected by breeding category) is better on optimal site types for Scots pine. On fertile sites, there is relatively less plus trees and more minus trees.
2. Differentiation of individual trees into breeding categories starts at the juvenile stage: in Scots pine stands on *Pinetum myrtillosum* site type at 6 to 8 years old, and in Scots pin stands on *vacciniosum* site type at 10 to 13 years old.
3. The following four types of radial increment were determined: (1) fast growth at the juvenile stage, followed by a gradual decrease in growth rate, (2) fast growth at the juvenile stage and from age 20–30 more or less stable, (3) slow growth at juvenile stage followed by a gradual increase in growth rate at later stages and (4) unstable growth all the time.
4. As most of the trees retain their position in the stand, appropriate management may allow a faster improvement of breeding value of forest stands.
5. Abundant seed yield in Scots pine stands occurs each third or fourth year. Average annual production of seeds in the populations with abundant flowering is 10 kg of seed per ha and in the populations with weak flowering it is 1 to 2 kg of seed per ha.
6. In mature seed collection stands of pine with a normal structure, percentage of seeds produced by trees of different breeding categories is the following: plus trees produce 6–8%, productive trees 24%, medium-productivity trees 55–60% and minus trees about 10% of all seeds in the stand. Suppressed minus trees produce less than 2% of the total seed in the stand and have a little contribution to the future generations.

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