The Correlations between Planting Material Quality and Artificial Pine Plantations Parameters

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Abstract. The creation and cultivation of the conifers artificial plantations depends on the planting material quality. The relationship of the main characteristics of pine planting material (Pinus sylvestris L.) with taxation character of artificial plantations is viewed on the paper. Pine forest trial is located on a long-cut logging site. Standard seedlings and saplings can be divided into three groups based on this stem diameter at the root collar: small, medium and large. This will enable better projection of future fast-growing trees. Trees grown from large seedlings are characterized by the height values. Such growth rates are noted in the future. The dynamic balance is established in this tree stand quickly, from the very initial phases of formation. All trees grow at a very fast pace. The initial plant ratios in size at the time of planting continue to remain constant. By the end of the second class of age, the maximum number of dominants (47% of all surviving) was formed from large planting material. This indicates that the use of selected high-quality planting material in combination with quality soil cultivation will significantly accelerate the growth of trees in the plantation and to receive target-oriented timber assortment 15–20 years earlier.

1. Introduction
The main silvicultural requirements for the seedlings and saplings quality are fast growth and stability of planting material. Maslakov [1] considers the selection and cultivation of the elite are one of the most important ways to improve the productivity of plantings of the future, especially in farms of plantation type. These are plants "dominants" and "subdominants". In this case, the selection of the elite trees can be carried out in forest nurseries. The uniform placement of planting material on the silvicultural area with optimal density will increase their stability and competitiveness with grass and tree vegetation, as well as stimulate fast and uniform growth. It is necessary to establish the initial parameters of planting material for the creation of forest plantations in the clearings. This will ensure the formation of artificial stands of the required composition and quality and will reduce the felling rotation.

According to studies by Polish scientists, the size of annual seedlings affects the growth of pine plantations of 20-year-old. They also note the selection of the best seedlings and saplings increases the
growth of 16-year-old plantations by 5-10% [2, 3]. According to our observations [4-6], the influence of the seedlings and saplings parameters on the growth of plantations is visible for two classes of age. This question was studied by other scientists [7, 8].

2. Methods and Materials
Experimental forest cultures of Pinus sylvestris L. on logging site were studied. The study allows to establish a link between the quality of planting material and the parameters of the artificial plantation in the Arkhangelsk region. The creation technology is the manual planting of 2-year-old standard pine seedlings in surface, prepared by the PKL-70 plow. Planting density are 4000 pcs / ha.

Each plant before planting on the silvicultural area measured the height and root collar diameter. Each plant was assigned a number in the register and fixed on with pegs. Periodic observations were carried out separately for each plant. In practice, various classifications are used to distinguish different classes of trees in young plantations by growth rate. For example, Maslakov [1] identified five categories (growth classes) of trees: 1) dominants; 2) subdominants; 3) satellites; 4) lagging behind; 5) outsiders.

Rogozin and Razin [9] divided the tree models according to the stem diameter in the early years of growth into three groups: thin, medium and thick. The same division of seedlings into three groups (large, medium, small) is recommended by Mochalov [10]. In this case it is possible to use the indicators of the average height and average diameter for the party and the quadratic deviation from the average.

Other classifications are used, for example, proposed by Zhilkin by productivity classes. Also used classification by Craft, it is based on the position of the trees in the canopy, etc.

Standard seedlings and saplings divided into three groups based on this stem diameter at the root collar: small, medium and large. This will make it possible to determine from which planting material large, fast-growing individuals are formed, i.e. mostly trees of the future. Pine plants were randomly planted on the silvicultural area according to various technological schemes.

3. Results and Discussion
The distribution of large, medium and small pine plants as a percentage formed from different groups of planting material in different years of observation is shown in the Table 1. There are the dynamics of the attrition of plants for two age classes.

| Age of cultures, years | The number of plants at the appropriate age according to the gradations within the group (%) | Attrition of plants (%) |
|------------------------|-------------------------------------------------------------------------------------------------|------------------------|
|                        | small | medium | large |                                                |
| Small planting material (root collar diameter = 0.13…0.33 cm) | 74    | 26    | -     | 48                                                |
| 5                      | 35    | 59    | 6     |                                                   |
| 10                     | 23    | 71    | 6     |                                                   |
| 12                     | 35    | 53    | 12    |                                                   |
| 36                     | 24    | 54    | 22    |                                                   |
| Medium planting material (root collar diameter = 0.34…0.54 cm) | 22    | 53    | 25    | 46                                                |
| 5                      | 22    | 53    | 25    |                                                   |
| 10                     | 14    | 58    | 28    |                                                   |
| 12                     | 16    | 65    | 16    |                                                   |
| Large planting material (root collar diameter = 0.55…0.75 cm) | 9     | 64    | 27    | 28                                                |
| 5                      | 9     | 64    | 27    |                                                   |
| 10                     | 9     | 64    | 27    |                                                   |
The smallest amount is in the pine cultures of small plants at the age of 12, it is not dependent on the size of the planting material. From large pine trees at the time of planting, by this age only 4% of small individuals have grown, which is 6 times less (t = 13.47 with \(t_{05} = 2.0\)) than from small seedlings, and 3.5 times less (t = 7.09 with \(t_{05} = 2.0\)), than from the average planting material. During this period, it is necessary to implement the first silvicultural cares aimed at better organization of the future plantings and increasing its potential productivity. Optimal conditions for each plant stabilize the rank structure of the stand, which increases the productivity of both individual plants and the stand as a whole. By the end of the second class of age, the maximum number of dominants (47% of all surviving) was formed from large planting material. This indicates that the use of selected high-quality planting material in conjunction with quality soil cultivation will significantly accelerate the growth of trees in the plantation, earlier to get target assortments for 15-20 years.

Analyzing the number of lost plants, we can conclude that the largest attrition of plants is observed in individuals grown from small planting material. Differences in the mean values of this indicator are reliable at \(t_{05} = 2.0\): between small and medium planting material \(t = 10.33\), medium and large \(t = 7.02\), small and large \(t = 17.70\). The largest attrition of plants is observed in the first year after planting on the silvicultural area (on average, 92% of total). The biological characteristics of this species are more often affected in subsequent years. Pine cultures suffer from windfall and snowbreak, which is observed in young plantings after the crowns closure, in the planting formation phase.

Plants grown from large seedlings are characterized by the highest heights (Figure 1). This position, in relation to individuals formed from medium and fine planting material, is maintained and gradually increased. Differences in height in 10 years are 1.3 times between small and large groups (t = 5.18 with \(t_{05} = 2.0\)), between medium and large groups are 1.2 times (t = 3.59 with \(t_{05} = 2.0\)) in favor of the dominants; at the age of 20 are 1.2 times (t = 2.98 with \(t_{05} = 2.0\)) and 1.1 times (t = 2.08 with \(t_{05} = 2.0\)); at the age of 36 are 1.1 times (t = 4.30 with \(t_{05} = 2.0\)) and 1.08 times (t = 3.05 with \(t_{05} = 2.0\)), respectively. In cultural phytocenoses, dominants and outsiders stand out in 10 years.

![Figure 1. Growth course by height of pine plantations depending on the group of planting material.](image)

Growth in height of pine cultures, created by large planting material, is characterized by maximum values in all years of observation. Dominant trees securely hold their positions in the upper canopy. The differences between the mean values of groups at 36 years of age are significant (small and large \(t = 3.48\) with \(t_{05} = 2.0\); medium and large \(t = 2.56\) with \(t_{05} = 2.0\)).
The dynamic balance is established in this tree stand very quickly, from the beginning of the formation phase. All trees grow at fast pace (Figure 2), but the initial (at the time of planting on the silvicultural area) plant ratios in size continue to remain constant (Figure 1).

Figure 2 shows the dynamics of the annual amount of growth of pine plantations by year depending on the group of planting material.

There are both systematically higher growth rates compared with the average growth rate of the stand, and irregular fluctuations of the stochastic nature in the change in the growth of individual trees. By Maslakov [1] the individual capabilities of trees are limited. Their small part is able to accelerate its growth against the norm by 15-20%. Only roughly equal in size trees can compete in growth. But due to the random placement of the area and a large level of variability, the meeting of equals is a rare event. The status of dominates in the population is unconditional given the multiple increase in mass and the change in the absolute difference in size. They dominate the upper canopy, forcing satellites to reach up. Lagging behind means attrition of plants. Systematically lagging trees can be diseased, genetically deficient, etc.

Thus, when creating forest cultures at the stage of selecting planting material, it is more expedient to use medium and large seedlings and saplings, and small ones should be subject to rejection. Compliance with this condition will significantly accelerate the growth of trees in the planting, to get target assortments for 15–20 years earlier.

Table 2 shows the average values of planting material in height and root collar diameter during the years of observation; it is include attrition of plants.
| Years of observation | Biometrics | | | |
|----------------------|-----------|-----------------|-----------------|
|                      | quantity (pcs) | height (cm) $M \pm m$ | diameter (cm) $M \pm m$ |
| 1978, before planting | 232 | 15.6±0.21 | 0.4±0.01 |
| 1979                 | 145 | 16.2±0.26 | 0.5±0.01 |
| 1980                 | 142 | 16.2±0.27 | 0.5±0.01 |
| 1981                 | 138 | 16.1±0.26 | 0.4±0.01 |
| 1982                 | 137 | 16.1±0.26 | 0.4±0.01 |
| 1983                 | 134 | 16.2±0.26 | 0.4±0.01 |
| 1984                 | 131 |               |               |
| 1985                 | 131 | 16.3±0.26 | 0.5±0.01 |
| 1986                 | 131 |               |               |
| 1987                 | 131 |               |               |
| 1988                 | 130 |               |               |
| 1989                 | 130 | 16.3±0.26 | 0.5±0.01 |
| 2013                 | 126 | 16.2±0.26 | 0.5±0.01 |

Attrition occurs mainly small and medium plants during the adaptability and individual growth. The differences in mean values in height of the planting material before planting and at 10–12 years are reliable and are $t = 2.1$ with $t_{0.05} = 2.0$. This indicates the need to regulate phytocenotic factors through the first reception of cleaning cutting in pine cultures at this age.

It is impossible to conclude that only large trees grow from large planting material and only small trees from small planting material. Correlation analysis of the dependence of the main indicators planting material growth and forest cultures shows a weak link. This link does not depend on the method of soil cultivation; it tends to permanently decrease and by the end of the second age class does not exceed 0.275 in height, 0.246 in diameter, in terms of the intensity of the competition $D^2H = 0.247$.

4. Conclusion
When creating forest plantations at the stage of selection of planting material, it is better to use medium and large seedlings and seedlings, and small ones should be rejected. Compliance with this condition will significantly accelerate the growth of trees in the plantation, and get target assortments for 15–20 years earlier.

Early, fairly confident diagnosis of the coenotic status of trees, especially dominants and lagging ones, can be conducted in pine cultures at the age of 10-12 years. At this time, it is possible to conduct cares and selection cutting on this basis, with the aim of rationalizing the primary structures of the population.

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