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S. Rabko, Head of the Department, PhD;
L. Paplauskaya, Assistant Professor, PhD; P. Tupik, Assistant Professor, PhD
(Belarusian State Technological University, Minsk, Belarus);
I. Kimeichuk, Assistant Lecturer
(Bila Tserkva National Agrarian University, Bila Tserkva, Ukraine)

STRUCTURE AND GROWTH OF CLIMATIC TYPES OF NORWAY SPRUCE IN THE CONDITIONS OF BELARUS

To identify climate types suitable for use in a certain forest vegetation zone, promising in terms of productivity, resistant to climate changes, atmospheric pollution and damage by pests and diseases, geographical crops are created with seeds or seedlings grown from seeds of different geographical origins. For example, since 1989, a long period of warming has been observed in Belarus with an increase in the climatic norm of the average annual temperature by 1.1°C.

Due to the increase in average annual temperature and low moisture availability during the growing season, forest plantations in the southern and southeastern regions of Belarus experience a lack of soil moisture, which leads to their weakening. European spruce is the most vulnerable wood in terms of climate change.

In this regard, the study of the growth of European spruce in different climates in the conditions of Belarus is relevant from the point of view of seed movement and its use in forestry production. Research conducted in the European North of Russia showed that the climate types of more northern regions show higher growth rates when grown in a warmer climate compared to more southern ones, although they lag behind the southern ones in terms of parameters.

It is also known about the successful growth of western climates during the movement of seeds even outside its range. A positive correlation was established between the height of crops and the climate index (R=0.50) and between the height and the hydrothermal coefficient (R=0.70±0.12).

The study of European spruce growth on the territory of Belarus was carried out in 60-year-old geographical cultures, where six climates are represented: Minsk, Vitebsk, Novgorod, Vologda, Ivano-Frankovsk and Grodno. The cultures are located in the Negoreloye educational and experimental forest farm, which belongs to the Neman-Predpolesie geobotanical district.

The nature and rate of accumulation of wood stock per unit of time from a certain area is determined by the growth of the spruce in height and diameter. The intensity of physiological processes in geographical spruce cultures under the influence of new conditions of the external natural envi-

ronment mainly affects their growth, which depends on the height and diameter of the plants.

In terms of growth, all studied geographical variants have close values, their average height of plantations ranges from 22.5 m in the Minsk climate to 23.5 m in the Grodno climate. At the same time, the southern (Ivano-Frankivsk) and western (Grodno) climate types have some advantage in height growth. Lower altitude indicators in the Minsk and Vologda climates (Table 1).

Table 1 – Average height of geographical cultures of European spruce

The name of the climate type	Average height ($M\pm m$), m	Mean square deviation (σ), m	Coefficient of variation (v), %	Average accuracy (ρ), %
Minsk	22.5±0.4	3.8	16.9	1.8
Vitebsk	23.0±0.4	3.4	14.8	1.7
Grodno	23.5±0.6	5.6	23.8	2.6
Novgorod	22.8±0.5	3.7	16.2	2.2
Vologda	22.6±0.5	5.4	23.9	2.5
I.-Frankovsk	23.4±0.6	5.8	24.8	2.6

The growth of geographical crops in diameter indicates the more intensive growth of southern and western climates. There is a significant difference between the average diameter of the Grodno and Ivano-Frankovsk climates on the one hand and the Vologda and Minsk climates on the other (Table 2).

Table 2 – Average diameter of geographical cultures of European spruce

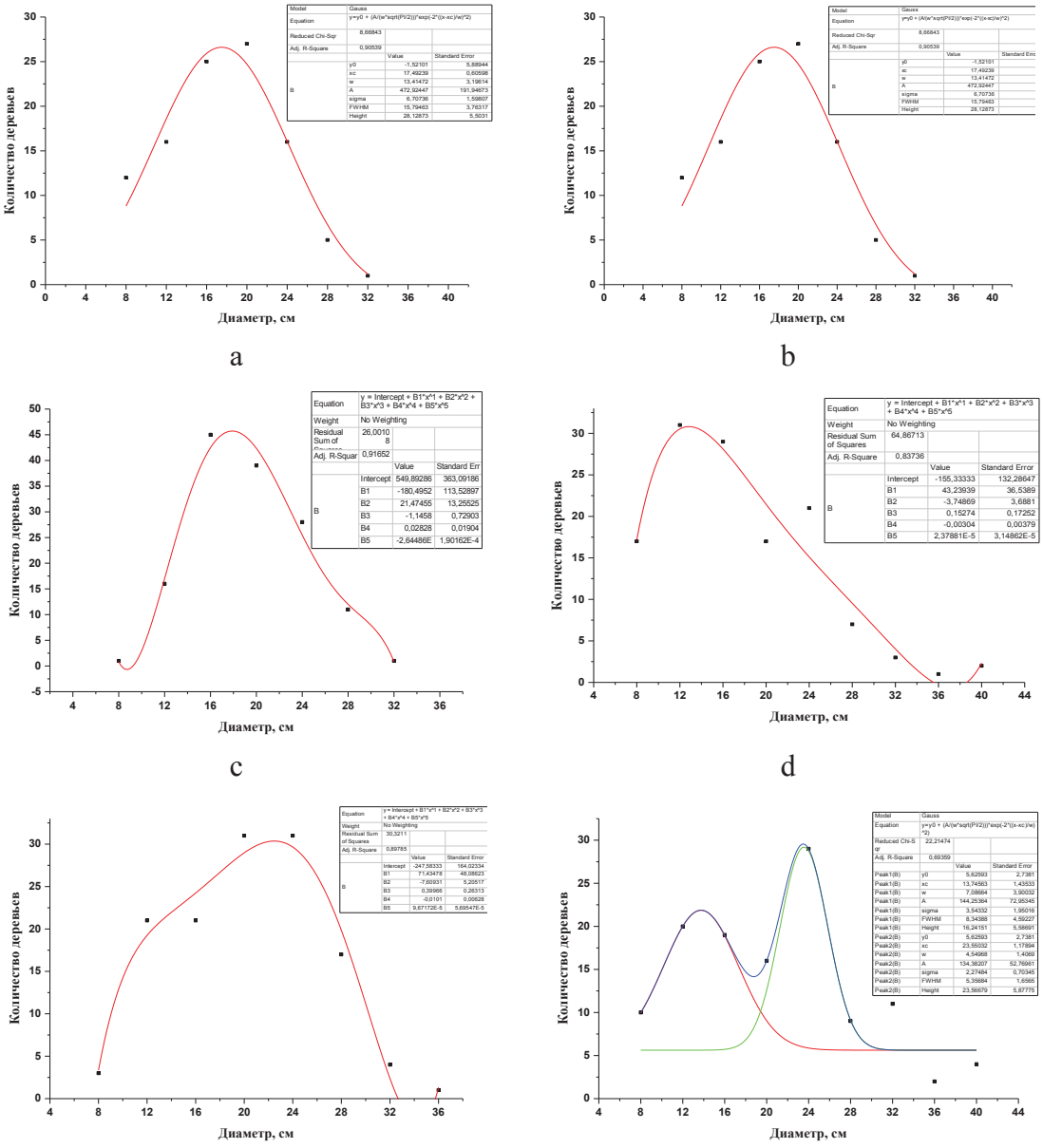
The name of the climate type	Average diameter ($M\pm m$), cm	Mean square deviation (σ), m	Coefficient of variation (v), %	Average accuracy (ρ), %
Minsk	18.2±0.56	5.63	32.2	3.2
Vitebsk	20.8±0.72	6.86	34.7	3.7
Grodno	22.0±0.73	8.02	38.9	3.6
Novgorod	19.9±0.41	4.88	25.2	2.1
Vologda	18.5±0.62	7.01	40.3	3.6
I.-Frankovsk	21.1±0.52	5.92	29.2	2.6

In most climates, there is a high level of variability (more than 30%), which indicates favorable conditions for most genotypes and in such conditions natural selection preserves a greater number of genotypes. The average level of variability is observed in the Novgorod (25.2%) and Ivano-Frankivsk (29.2%) climates, in these climates natural selection preserved the genotypes most resistant to these conditions.

The average values of tree diameters, as well as the distribution of European spruce trees in different climates by diameter (Fig.) indicate the uneven course of differentiation of trees of different origins.

A significant predominance of trees with smaller diameters is observed in cultures from seeds of northern origin. Thus, in the northernmost Vologda climate, 48% of trees are distributed no more than 8 to 16%. And here, for northern origins, the climate changes gradually and linear selection is observed.

That is, settlement is gradually shifting towards the preservation of slower-growing, but more stable genotypes. The average value of the population is also shifting in this direction.



a – Minsk; b – Vitebsk; c – Novgorod; d – Vologda;
e – Ivano-Frankovsk; f – Grodno

Figure – Distribution curves of trees by climate diameter

In local climates (Minsk and Vitebsk), the distribution of the number of trees by diameter is described by a normal distribution curve. At the same time, genotypes close to the average value are preserved, stabilizing natural selection is observed. From this we can come to the disappointing conclusion that the local climate types are in a state of equilibrium, although in terms of growth indicators they are inferior to the southern and western climate types. In the southern Ivano- Frankovsk climate, trees with a large diameter in relation to the average prevail, which make up 41%. Small trees account for 34.8%.

This climate is also characterized by linear natural selection, but unlike northern climates, the average shift is directed to the right, i.e. towards faster growing genotypes. A spruce plantation grown from seeds of Grodno origin is characterized by a significant spread of trees in diameter. The tree diameter distribution curve has two peaks. This indicates that natural selection preserves here trees that deviate from the mean value both in one and the other direction. This happens when the climatic conditions do not correspond to the successful growth of the population, and it breaks into two local corresponding given conditions.

There is a so-called natural selection that breaks them apart. In the southern Ivano-Frankovsk climate, trees with a large diameter in relation to the average prevail, which make up 41%. Small trees account for 34.8%. This climate is also characterized by linear natural selection, but unlike northern climates, the average shift is directed to the right, i.e. towards faster growing genotypes. On the basis of the conducted research, it is possible to draw a conclusion about the different climatic response of European spruce to the conditions of their cultivation in Belarus.

The manifestation of stabilizing selection in local climates indicates the stability of the population in the climatic conditions of their cultivation. Northern climate types, in which there is linear selection toward the retention of slow-growing genotypes, show greater adaptation to the types of forest vegetation conditions that have changed compared to their homeland.

The growth of southern and western climates suggests their genetic potential as fast-growing but less adapted to changing conditions.

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О.Н. Абдуллаев, ассист. (Ташкентский государственный аграрный университет,г. Ташкент, РеспубликаУзбекистан)

ПОКАЗАТЕЛИ РОСТА СЕЯНЦЕВ КЛЕНА

Динамика роста и прироста однолетних растений. В течение всего вегетационного периода через каждые 10 дней нами проводились измерения роста 10 сеянцев по высоте. В связи с небольшим количеством однолетних сеянцев у *A. campestre* изучение динамики ро-