ISSN 0536 - 1036. News of Higher Educational Institutions.
Forestry Magazine, 2010. No. 4

UDC 630*165.5:630*232.31
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SPRUCE FORMS AND THEIR SEED RELEVANCE

This paper presents the results of a study of spruce branching types on the territory of Shenkursky District of the Arkhangelsk Region. It investigates the biometric characteristics of cones, germinating capacity and germinative energy of the seeds of European, Siberian and hybrid spruce species with different branching types.

Keywords: spruce, species, branching type, cones, seeds, germination, germinative energy, seed dormancy.

The primary morphological marker of a tree crown is the branching type. The branching types of spruce in the Arkhangelsk Region were studied by P.I. Voychal [1], V.Ya. Popov [8] and D.S. Moseyev [6]. P.I. Voychal investigated the mechanical properties of wood of intraspecific spruce forms and concluded that the saw-tooth and brushlike forms of the wood are characterised by the highest strength. V.Ya. Popov and D.S. Moseyev identified the ratio of different spruce branching forms in different types of forest. At the same time, Voychal and Moseyev did not take into account the species of spruce. According to Moseyev, the types of spruce branching differ in different types of forest in the Arkhangelsk Region. Spruces with purely pectiniform, indefinitely pectiniform, brushlike and flat branching occur widely [6]. The quality of the seeds of European, Siberian and hybrid spruce species with different branching types has not been investigated.

We conducted our investigations in the Shenkursky District of the Arkhangelsk Region, on five growth plots set up in the forest of one specific type: grass and blueberry spruce forest (130–140 years old), yield class V as per GOST 16483.6–80 [2] and OST 56-69–83 [7]. The area of interest is located in the introgressive spruce hybridisation area characterised by occurrence of hybrid forms with certain features of European spruce and Siberian spruce [10].

The study of the formal diversity of spruce involved identifying, at each growth plot, the branching type of 100 trees in the middle of the crowns that are the most representative of the corresponding form based on the documented features [9, 12]. The study revealed variability of the

spruce cones and seeds. For the purpose of biometric processing of the study material, 30 cones from each of the crowns of each branching type were collected on each growth plot during the autumn timber harvest. These cones were weighed on the AND HL-100 scale, and their length and width in closed state were measured with a TOYA digital caliper immediately after picking. The types and hybrid forms of spruce were identified on the basis of the length to width ratio of the seed scales [4]. The 1998 documents were then used as reference materials for identifying the quality of the seeds of different types and interspecific forms of spruce by germination, without prior treatment ,in accordance with GOST 13056.6–97 [3].

Our records indicate that two spruce species grow in the Shenkursky District: European spruce (40%) and Siberian spruce (30%), as well as their hybrid forms (30%). Four spruce crown branching types occur in the area of interest: pectiniform (10.4%), compact (8.3%), flat (54.1%) and brushlike (27.2%). For the European spruce, the percentage ratio of these branching types is as follows: pectiniform, compact and flat – 12.5% each, and brushlike – 62.5%; for the Siberian spruce: brushlike – 33.3%, compact – 50.0%, and flat – 16.7%. Hybrid spruces have the pectiniform (33.3%), compact (16.7%) and flat (50.0%) forms. The Siberian and hybrid spruce species do not have the brushlike branching type.

The results of the investigation into the morphological characteristics of the cones and seeds of spruce with different crown branching types are provided in Table 1.

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Table 1

Biometric characteristics of cones and seeds of spruce from different branching types

Branching type	Cones						Weight of 1000 seeds, g
	Length, cm	Width, cm	Weight, g	Number of seeds per cone	Weight of seeds per cone, g	Number of seed scales per cone	
European spruce							
Pectiniform	7.1±0.2	2.20±0.03	10.6±0.6	35.9±8.3	0.06±0.01	91.3±3.9	2.1
Compact	8.2±0.2	2.30±0.03	14.6±0.6	9.3±1.2	0.02±0.00	92.9±4.4	2.4
Flat	7.8±0.2	2.30±0.03	14.0±0.6	16.6±1.5	0.06±0.01	90.3±3.3	3.5
Brushlike	7.9±0.1	2.30±0.02	13.6±0.4	11.5±1.5	0.03±0.00	82.1±2.6	2.7
Siberian spruce							
Pectiniform	7.7±0.1	2.40±0.02	15.0±0.5	16.5±2.9	0.05±0.01	95.5±2.3	3.0
Compact	6.7±0.1	2.20±0.02	9.9±0.4	8.5±2.4	0.01±0.00	81.9±3.5	2.0
Flat	7.1±0.2	2.40±0.04	12.7±0.7	7.4±1.4	0.02±0.01	86.0±3.6	3.0
Hybrid spruce							
Pectiniform	7.1±0.1	2.20±0.02	12.1±0.3	10.1±1.6	0.02±0.00	65.5±2.5	1.9
Compact	6.6±0.1	2Д0±0.03	8.5±0.4	9.5±1.6	0.02±0.00	68.1±1.7	1.4
Flat	6.6±0.1	2.10±0.03	9.9±0.3	11.1±2.3	0.03±0.01	86.5±3.6	2.3

The number of seeds and the weight of 1000 seeds vary depending on the branching type. There are no significant differences in the length and width of the cones ($t = 0…0.72$).

The premium biometric characteristics of cones are observed in the European spruce with compact and flat branching, Siberian spruce with pectiniform branching and hybrid spruce with pectiniform and flat branching of the crown (see Table 1). The European and Siberian spruce with pectiniform branching is characterised by the highest number of seeds per cone, and the European, Siberian and hybrid spruce with flat branching – by the highest weight of 1000 seeds (2.3 to 3.5 g).

Table 2

Percentage distribution of seeds by colour among spruce forms with different branching types

Branching type	Seed colour		
	Dark-brown	Brown	Light-brown
European spruce			
Pectiniform	33.4	21.0	45.6
Compact	60.6	9.0	30.4
Flat	65.9	17.5	16.6
Brushlike	70.3	19.5	10.2
Siberian spruce			
Pectiniform	33.3	36.7	30.0
Compact	49.1	40.6	10.3
Flat	32.5	35.4	32.1
Hybrid spruce			
Pectiniform	56.2	28.5	15.3
Compact	49.7	34.8	15.5
Flat	38.7	31.0	30.3

During germination, the seeds were classified by colour as dark-brown, brown and light-brown [5]. The distribution of spruce types based on the branching type and seed color is provided in Table 2. As we can see, dark-brown is the prevalent colour for the seeds of European spruce with compact (60.6%), flat (65.9%) and brushlike (70.3%) branching, as well as for Siberian spruce with compact branching (49.1%) and hybrid spruce with all types of branching (38.7% to 56.2%). The highest percentage of light-brown seeds is typical of the European spruce with pectiniform branching.

The values of commercial and absolute germinating capacity and germinative energy of the seeds of spruce with different branching types provided in Table 3 evidence a relatively high quality of the dark-brown seeds of the European, Siberian and hybrid forms of spruce with flat branching. The minimum values are typical of light-brown seeds, irrespective of the crown branching type.

Table 3

Seed quality depending on spruce branching type

Branching type	Germinative energy of seeds, %			Commercial germinating capacity, %			Absolute germinating capacity, %			Mean germination time, days		
	d-b	b	l-b	d-b	b	l-b	d-b	b	l-b	d-b	b	l-b
European spruce												
Pectiniform	2.7	–	–	2.7	–	–	2.7	–	–	8.5		–
Compact	6.0	3.6	–	6.0	3.6	–	6.1	3.7	–	8.5		–
Flat	13.0	1.3	–	13.5	2.6	–	13.7	2.7	–	7.7		–
Brushlike	3.0	–	1.0	3.0	–	2.0	3.0	–	2.1	8.2		11.0
Siberian spruce												
Pectiniform	4.7	1.5	0.3	4.7	1.5	0.7	4.7	1.6	0.7	7.4	7.0	10.0
Compact	2.3	–	–	2.7	–	–	2.9	–	–	7.3	–	–
Flat	9.9	1.0	–	9.9	1.0	–	10.1	1.1	–	6.9	7.0	–
Hybrid spruce												
Pectiniform	0.5	–	–	1.0	–	–	1.0	–	–	11.0	–	–
Compact	3.0	–	–	3.0	–	1.5	3.1	–	1.6	8.7	–	15.0
Flat	4.0	1.5	–	5.0	1.5	0.5	5.4	1.6	0.5	9.6	6.3	15.0

Note: d-b – dark-brown seeds; b – brown seeds; l-b – light-brown seeds. Dash means no seeds were found.

Table 4

Breakdown of spruce offspring by number of seed lobes in forms with different branching

Branching type	Percentage of plants with number of seed lobes							
	5	6	7	8	9	10	11	8–10
European spruce								
Pectiniform	–	–	60.0	20.0	–	20.0	–	40.0
Compact	–	20.0	60.0	20.0	–	–	–	20.0
Flat	–	38.1	61.9	–	–	–	–	–
Brushlike	–	–	16.7	50.0	16.7	16.6	–	83.3
Siberian spruce								
Pectiniform	–	23.5	47.1	23.5	5.9	–	–	29.4
Compact	14.3	28.6	57.1	–	–	–	–	–
Flat	–	11.1	33.4	22.2	22.2	11.1	–	55.5
Hybrid spruce								
Pectiniform	–	–	100.0	–	–	–	–	–
Compact	–	60.0	40.0	–	–	–	–	–
Flat	–	27.3	45.4	18.2	9.1	–	–	27.3

The offspring of spruce trees with different branching types include sprouts with 6–8 seed lobes (see Table 4). Specimens with 9–10 seed lobes are rare, with 5 seed lobes – very rare, and there are none with 11 seed lobes. The highest number of sprouts with 8–10 seed lobes is observed in specimens of European spruce with brushlike branching and Siberian spruce with flat branching. Sprouts with 8–10 seed lobes grow fast and are better suited than the others for establishing seed plantations and plots[11].

The rating of crown branching types based on the weight of 1000 seeds, their germinative energy and germinating capacity is as follows: flat branching type – 12 out of 12, pectiniform and compact – 7, and brushlike – 4.

The results of this investigation bring us to the conclusion that trees with flat crown branching should be preserved during improvement cuttings. Spruce with this branching type should be given priority during seed harvesting and establishment of seed plantations and plots.

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Received on 19.01.10