Root Abundance of Pine, Spruce, Birch and Black Alder in the Peat Soils

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Irrespective of drainage intensity in marshy pine, spruce and birch forests 80-97% of all roots are concentrated in the upper 20 cm layer of the soil. In drained peat soils the quantity of roots increases 3-5 times, and they penetrate 20-40 (60) cm deeper. Spruces as as well as pines rooted (strikes roots) up to 100-120, and birches only up to 80-100 cm depth. In the upper layer of the soil the most part of roots concentrated in drained spruce forests, and the least part in undrained pine forests. In the spruce forests aged 70-90 years in 1 m^2 area and 20 cm thick layer of the soil the roots of trees weigh 4,604-7,255 g, their length is 239-263 m, and in pine forests 800-1,000 g and 73-136 m, respectively.

Key words: peat soils, drainage, spruce, birch, black alder, root abundance.

Introduction

Investigation of the quantity and structure of root systems and their spreading in the soil horizons is connected with the solution of practical and theoretical problems. They include determination of drainage standards, choosing of tree species for creating stands resistant against windfall, which are characteristic of the conditions of reforestation under the cover of stand, determination of hardness of peat soil surface for the thoroughfare of mechanisms, determination of biological exchange of materials in the forest phytocenoses, determination of interrelations of root systems of different species and many others. All these questions are very complicated and hither to investigated in sufficiently. L.Heikurainen, (1961); G.Hochtanner and O. Sutschek (1964) present the data on root systems of forest stands in the drained mires of Finland and Germany. L.K.Koščeev (1962) studied root systems of pine in Sphagnum peatmoss type of forest in relation with natural renovation of it. L.N. Zgurovskaja (1963) gave physical characteristic of the roots of pine, birch and spruce, growing in the peat soils. E.Paavilainen (1968) investigated interrelationship between the root systems of birch, spruce and pine and ground water level, P.Savill (1976) studied the effect of drainage of gleyic soils at the depth of root penetration of spruce and their stability against windfall. The data on rooting density of pine, birch and spruce, different diameter root factions are presented by S.E. Vompersky (1968).

Our task was to investigate rooting density of pine, spruce, birch and black alder in peat soils in the Lithuanian conditions by concentrating special attention on changing of root structure under the influence of drainage.

Materials and methods

Rooting density of different tree species was investigated both in undrained and drained high, low-lying and transitional mires with the peat layer thicker than 50 cm. Short characteristic of studied plots, where we investigated the distribution of roots upon the profile of peat soil is presented in Table 1. For the determination of trees root mass we used the method which had been proposed by N.P.Remezov (Ремезов, Быкова, Смирнова, 1959) with some additions by A.A. Molčanov (Молчанов, Смирнов 1967). The main point of this method is the following: around the medium model tree we separate square plot equal to the medium area of nutrition of one tree, which is found by division of investigated plot area of the number of trees. If such a plot for the determination of roots quantity is markedly larger than 3 m^3, what is usualy in mature stands, we give ½ - ¼ part of the feeding plot and dig two 0,5 m width open trenches from the stump to the boundary of nutrition area. Their depth depends upon the depth of tree root extention. Roots, separately from each 20 cm thickness layer of the soil are selected by handlle, first they are sorted out into skeleton roots and relatively thin (approx-

Table 1. Characteristics of study plots and stands.

Forestry	No. of study plot	Plot area	Forest type	Stand structure	Mean height, m
Kazlų Rūda	1	0,15	*Pinetum ledosum*	10P	4,3
Šilutė	2	0,20	"	10P	5,5
Dubrava	3	0,30	"	10P	10,8
"	4	0,20	*Pinetum ledosum* (drained)	10P+E; B	8,3
Šilutė	5	0,25	"	9P1E+B	12,7
Dubrava	6	0,30	"	10P+B	14,4
"	7	0,30	*Pinetum caricosphagnosum*	7P3B+E	19,9
"	8	0,20	"	10P+E; B	11,7
"	9	0,40	*Piceetum caricocalamagrostidosum* (drained)	8E2P	28,3
Šilutė	10	0,20	"	8E2P+B	19,1
Kaunas	11	0,30	*Betuletum caricocalamagrostidosum* (drained)	8B2P+E	22,1
Dubrava	12	0,30	*Alnetum caricosum* (drained)	8J1E1B	19,8
"	13	0,20	*Alnetum caricosum*	7J3B+E	17,0
"	14	0,40	*Alnetum urticosum*	10J+E	25,0
Šakiai	15	0,20	*Pubescentis-Betuletum caricosum*	10B+E	14,4
"	16	0,20	*Pubescentis-Betuletum caricosum* (drained)	9B1J+E	14,7
Šilutė	17	0,40	*Piceetum carico-calamagrostidosum* (drained)	10E	21,7

imately diameter 1 cm and thinner) roots, washed off with the flowing water. The roots are left for 1-2 hours to dry. It must be noted, that relatively thin roots (diameter approximately 1 cm and thinner) are washed with water on the small-hole sieve (diameter of holes are 0,2-0,3 mm). Dried roots first of all are devided on to living and dry (dead), and later into factions according to their thickness. Sticked soil could not stay. The roots are divided into factions according to their thickness: ≤ 1 mm; 1,1-2; 2,1-3 and ≥ 3,1 mm, and are taken samples are taken separately according to root factions, in 2-3 repetitions for finding their absolutely dry weight. Total mass of tree roots is found calculating the quantity of roots, selected from all trees found in the trenche for the total area of nutrition of one tree.

Results

As seen in Table 2, on drained sites of high mires (study plots No. 4; 5; 6) roots of pine are spread rather abundantly up to the depth of 60 cm, by the way, some of them reach 100-110 cm. On undrained sites of high mires (study plots No. 2; 3), where medium depth of ground water level is 29-46 cm higher, vertical distribution of the root systems of pine in 43-120-year old stands is limited 35-40 cm, and in younger pine stands - 20 cm deep.

This confirms the conclusion made by many authors (Heikurainen, 1961; Paavilainen, 1968; Веретников, 1968; Вомперский, 1968; Fitzpatrick, 1994), that one of the main factors, which conditioned vertical spreading of roots in the soils, is the level of ground water.

However, on drained and undrained sites of the high mires on average 90-93% of all roots (Figure 1) are located in the upper (up to 20 cm) layer of the soil. Here up to 98% of the small (fine) (diameter up to 1 mm) roots are concentrated, which are most important for the vital activity of trees. Fine roots, with the diameters up to 1 mm, are distributed in soil horizons at the same depth as larger ones (Table 2). This does not entirely coincide

Table 2. Vertical distribution of roots in drained and undrained Scots pine forests on oligotrophic mires (dry matter kg/ha).

No. of study plot	Depth, cm	Living roots		Thickness of roots, mm								Dead roots	
				< 1 mm		1-2 mm		2-3 mm		>3 mm			
		kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
Undrained Scots pine forests													
1	0-20	3410,1	96,7	108,0	97,6	111,0	96,8	115,5	96,7	3075,6	96,7	130	32,0
	20-40	116,1	3,3	2,6	2,4	3,6	3,2	3,9	3,3	106,0	3,3	30	18,0
		3526,2	100,0	110,6	100,0	114,6	100,0	119,4	100,0	3181,6	100,0	160	100,0
2	0-20	6511,9	92,6	105,7	100,0	117,9	100,0	125,0	100,0	616 ,3	92,1	280	87,0
	20-35	527,0	7,4	-	-	-	-	-	-	527,0	7,9	40	13,0
		7038,9	100,0	105,7	100,0	117,9	100,0	125,0	100,0	6690,3	100,0	320	100,0
3	0-20	10018,0	88,5	266,4	95,0	538,6	93,0	407,0	91,0	8806,0	88,0	1880	76,2
	20-40	1297,0	11,5	14,3	5,0	40,2	7,0	39,2	9,0	1203,3	12,0	586	23,8
		11315,0	100,0	280,7	100,0	578,8	100,0	446,2	100,0	10009,3	100,0	2466	100,0
Drained pine forests													
	0-20	15935,3	87,8	197,0	85,6	195,0	72,8	190,4	66,3	15352,9	88,5	-	
	20-40	1657,0	9,2	23,4	10,2	53,6	20,1	70,7	24,6	1509,3	8,7	-	
4	40-60	499,0	2,7	8,7	3,8	14,5	5,4	19,9	7,0	455,9	2,6	23	66,0
	60-80	58,6	0,3	0,8	0.4	4,8	1,7	6,1	2,1	46,9	0,2	-	-
	80-110	1,3	0,0	-	-	-	-	-	-	1,3	0,0	12	34,0
		18151,2	100,0	229,9	100,0	267,9	100,0	287,1	100,0	17366,3	100,0	35	100,0
5	0-20	19330,1	84,3	217,4	65,3	247,6	63,9	396,3	61,3	18468,8	85,7	-	
	20-40	3303,1	14,4	99,9	30,0	106,5	27,5	191,4	29,6	2905,3	13,5	14	52,0
	40-60	288,1	1,3	15,7	4,7	33,1	8,6	58,4	9,1	180,9	0,8	13	48,0
		22921,3	100,0	333,0	100,0	387,2	100,0	646,1	100,0	21555,0	100,0	27	100,0
6	0-20	31756,0	96,4	143,2	67,8	219,4	75,8	246,9	58,1	31146,5	97,2	-	
	20-40	1033,8	3,1	63,0	30,0	62,7	21,7	174,4	41,0	733,7	2,3	673	91,4
	40-60	170,8	0,5	4,7	2,2	8,7	2,5	4,0	0,9	153,4	0,5	63	8,6
		32960,6	100,0	210,9	100,0	290,8	100,0	425,3	100,0	32033,6	100,0	736	100,0

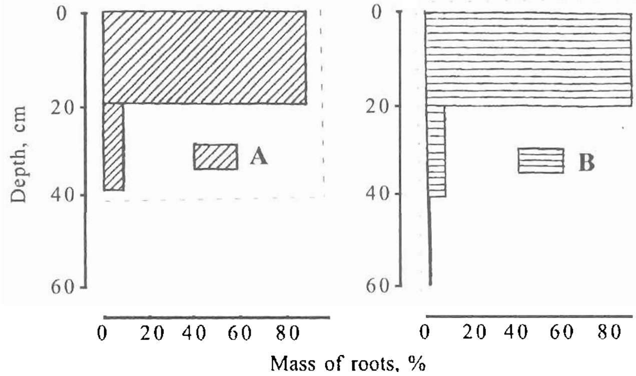

Figure 1. Vertical distribution of Scots pine root mass in drained (A) and undrained (B) oligotrophic mires (%).

with the data by S.Wompersky (1968), who shows, that in the 32-52-year-old, as well as in the young pine forests, fine roots did not penetrate deeper than 20 cm. This probably is related with different oxygen regime of soil water in the compared objects. When there is oxygen deficiency in the soil water, first fine roots die, which grow most intensively (Веретников, 1968). Moreover, fine roots (diameter up to 1 mm), make up only a small part of root mass; on the drained sites 0,8-1,6, and on undrained 1,6-3,2 %.

As shown in Table 2, total mass of the pine roots on undrained oligotrophic sites makes up 3,182-10,009 kg/ha, and in drained - 17,366-32,034 kg/ha, it is 3-5 times more, in comparison with undrained wet pine forests, even older lifetime. This is associated not only with increased productivity of stands in drained mires, but also with more intensive growth of tree roots in the drained soils. So, when the diameter of the tree stem is equal, root mass in drained pine forests always is larger, than in undrained (Капустинскайте, 1976).

The coefficient of rooting density (g/m^2) in the upper layer of the soil (up to 20 cm) in drained 40-70-year-old pine forests, growing on high mires, makes up 1,593-3,176, in the undrained ones - only 340-750 g/m^2 of the dry matter (Table 6). So, deeper and more densely located roots on the drained sites conditioned not only inclusion of the materials from deeper layers of the soil in the biological circulation, but also increased water permeability of them (Русецкас, 1998).

On the mesotrophic, even undrained mires, pine roots reach the depth up to 60 cm. However, approximately 97% of all roots and 91-95% of the fine roots are located in the soil layer up to 20 cm (Table 3). Root systems of the mature spruce forests, which have formed on the same but drained sites (study plots No. 9; 10) penetrate up to 80-120 centimeters deep. The coefficient of rooting density of the upper layer of the soil (up to 20 cm) makes up 4,010-7,255 g/m^2. Especially

Table 3. Vertical distribution of trees roots in mesotrophic mires (dry matter kg/ha).

No. of study plot	Depth, cm	Living roots		Thickness of roots, mm							
				< 1 mm		1-2 mm		2-3 mm		>3 mm	
		kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%
7	0-20	18079,9	97,1	91,0	95,6	70,7	92,2	46,2	82,6	17872,0	97,1
	20-40	453,0	2,4	3,6	3,8	4,8	6,2	8,5	15,2	436,1	2,4
	40-60	93,7	0,5	0,6	0,6	1,2	1,6	1,2	2,2	90,7	0,5
	Total spruce	6000,0									
Total: spruce and pine		24627,6	100	95,2	1	76,7	100	55,9	100	18398,8	100
8	0-20	16269,9	97,2	83,3	91,2	119,9	91,2	233,3	89,1	15833,4	97,4
	20-40	440,0	2,6	7,3	8,0	10,6	8,1	23,8	9,1	398,3	2,5
	40-60	24,0	0,2	0,7	0,8	0,9	0,7	4,7	1,8	17,7	0,1
Total		16733,9	100	91,3	1	131,4	10	261,8	100	16249,4	100
9	0-20	72549,4	91,8	409,0	65,9	475,2	65,7	494,6	54,5	71170,6	92,7
	20-40	3361,1	4,3	146,8	23,6	127,3	17,6	275,5	30,4	2811,5	3,7
	40-60	1606,3	2,0	18,9	3,0	46,6	6,4	61,5	6,8	1479,3	1,9
	60-80	930,9	1,2	29,3	4,7	55,6	7,7	30,8	3,4	815,2	1,1
	80-120	564,8	0,7	16,9	2,8	19,0	2,6	44,6	4,9	484,3	0,6
Total		79012,5	100	620,9	10	723,7	10	907,0	100	76760,9	100
10	0-20	40488,0	71,6	206,7	82,4	985,7	78,5	47,1	80,8	38808,5	71,3
	20-40	14034,0	24,8	28,7	11,4	190,2	15,1	81,0	13,4	13734,1	25,2
	40-60	1396,0	2,5	15,1	6,0	75,4	6,0	31,9	5,3	1273,6	2,3
	60-80	604,0	1,1	0,6	0,2	4,8	0,4	3,0	0,5	595,6	1,2
Total		56522,0	100	251,1	1	1256,1	10	603,0	100	54411,8	100
11	0-20	23651,0	60,0	391,5	59,8	579,4	71,8	513,3	58,4	22166,8	59,7
	20-40	12254,7	31,1	131,8	20,2	149,5	18,5	237,4	27,0	11736,0	31,6
	40-60	3366,0	8,5	106,3	16,2	69,1	8,6	118,3	13,5	3072,3	8,4
	60-80	163,8	0,4	24,8	3,8	7,7	1,0	8,8	1,0	122,5	0,3
	80-100	5,1	0,0	0,1	0,0	1,7	0,1	1,1	0,1	2,2	0,0
Total		39440,6	100	654,5	1	807,4	10	878,9	100	37099,8	100

powerful root systems (depth up to 120 cm) are developed in the spruce stand (study plot No. 9), where as a result of intensive drainage (study plot is located between two ditches, which are intersected under the right angle. Their depths are (1,2-1,4 m) at level of ground water over the warm period of year on average lowered to the depth 115 cm. Consequently, when the conditions of peat aeration are favourable, even on the deep peat soils, spruce is able to form a powerfool root system.

On the sites of low mires black alder develops the deepest root system (Table 4). We failed to find the essential differences between root systems of these trees growing on the drained and undrained sites. Here root mass in the 20-60-year-old black alder stands fluctuated from 18 to 40 t/ha and consituted 18-23% of the total phytomass of the trees both in the undrained and drained study plots. Up to 90% of all roots are located in the upper (up to 40 cm) layer of the soil (Figure 2). Some roots in the mature stands reach 2-2.2, in the undergrowth 1.5-1.6 m depth, by the way, this does not depend upon drainage intensity. Roots, with diameters up to 1 mm, on average comprise 0,7-1,4% of the whole root mass. Nodules on the roots with microorganisms which are fixing nitrogen are separated only on the tufts and between them in the upper 20-30 centimeter-layer of the soil. In the 50 year-old -black alder stand they make up to 230 kg/ha (biomass + necromass) in the dry condition.

Table 4. Vertical distribution of tree roots in eutrophic mires (dry matter, kg/ha)

No. of study plot	Depth, cm	Living roots		Thickness of roots, mm							
				< 1 mm		1-2 mm		2-3 mm		>3 mm	
		kg/ha	%	kg/ha	%	kg/ha		kg/ha	%	kg/ha	%
1	2	3	4	5	6	7	8	9	10	11	12
	0-20	25113,2	68,2	175,8	69,3	75,3	49,3	100,5	55,1	24761,6	68,3
	20-40	6701,8	18,2	26,8	10,6	20,1	13,1	33,5	18,4	6621,4	18,3
	40-60	1914,8	5,2	21,1	8,3	13,4	8,7	7,6	4,2	1872,7	5,2
12	60-80	1399,3	3,8	12,6	5,0	9,8	6,4	9,8	5,4	1367,1	3,8
	80-100	1067,9	2,9	6,4	2,5	27,8	18,1	26,7	14,6	1007,0	2,8
	100-120	294,6	0,8	5,3	2,1	3,2	2,1	2,1	1,2	284,0	0,7
	120-195	331,4	0,9	5,6	2,2	3,6	2,3	2,0	1,1	320,2	0,9
Total		36823,0	100	253,6	100	153,2	100	182,2	100	36234,0	100
	0-20	24702,1	75,1	320,4	69,7	845,7	84,4	1137,0	81,5	22399,0	74,5
	20-40	4772,7	14,5	55,9	12,2	101,8	10,2	126,0	9,0	4489,0	14,9
13	40-60	2610,3	7,9	54,8	11,9	23,5	2,4	80,9	5,8	2451,1	8,2
	60-80	644,1	2,0	18,0	3,9	23,2	2,3	41,9	3,0	561,0	1,9
	80-100	135,6	0,4	6,8	1,5	5,4	0,5	5,3	0,4	118,1	0,4
	100-160	33,9	0,1	4,0	0,8	2,0	0,2	4,2	0,3	23,7	0,1
Total		32898,7	100	459,9	100	1001,6	100	1395,3	100	30041,9	100
	0-20	23736,2	52,2	189,3	38,8	42,1	10,8	192,6	34,7	23312,3	52,9
	20-40	5404,5	11,9	45,6	9,4	73,6	18,9	82,3	14,8	5203,0	11,8
	40-60	5515,9	12,1	146,7	30,1	21,0	5,4	42,7	7,7	5305,5	12,0
14	60-80	2625,2	5,8	12,1	2,5	50,4	12,9	56,1	10,1	2506,6	5,7
	80-100	1925,0	4,2	7,5	1,5	32,5	8,3	36,0	6,4	1849,0	4,2
	100-140	5447,2	12,0	74,5	15,3	83,8	21,5	104,8	18,9	5184,1	11,8
	140-200	857,5	1,8	11,7	2,4	86,7	22,2	41,2	7,4	717,9	1,6
Total		45511,5	100	487,4	100	390,1	100	555,7	100	44078,3	100
	0-20	13503,9	79,9	354,3	93,9	240,1	88,5	364,1	88,7	12545,4	79,2
15	20-40	3398,7	20,1	21,5	5,7	28,9	10,7	44,3	10,8	3304,0	20,8
	40-60	8,2	0,0	1,6	0,4	2,3	0,8	2,0	0,5	2,3	0,0
Total		16910,8	100	377,4	100	271,3	100	410,4	100	15851,7	100
	0-20	18936,6	85,3	416,6	89,9	189,4	70,3	359,8	77,2	17970,8	85,6
16	20-40	3108,0	14,0	21,8	4,7	37,3	13,8	65,3	14,0	2983,6	14,2
	40-60	88,8	0,4	19,6	4,3	28,9	10,7	31,9	6,9	8,4	0,0
	60-80	66,6	0,3	5,3	1,1	14,0	5,2	8,8	1,9	38,5	0,2
Total		22200,0	100	463,3	100	269,6	100	465,8	100	21001,3	100
	0-20	36040,4	89,4	501,0	82,9	354,9	77,8	480,5	72,4	34704,0	90,0
	20-40	1921,9	4,8	59,4	9,9	48,1	10,5	82,1	12,4	1732,3	4,4
	40-60	1745,9	4,3	34,2	5,7	33,4	7,4	70,5	10,7	1607,8	4,2
	60-80	466,6	1,2	6,9	1,1	17,4	3,8	24,4	3,7	417,9	1,1
	80-100	87,6	0,2	1,5	0,2	1,0	0,2	1,7	0,3	83,4	0,2
	100-120	28,9	0,1	1,3	0,2	1,3	0,3	1,5	0,2	24,8	0,1
Total		40291,3	100	604,3	100	456,1	100	660,7	100	38570,2	100

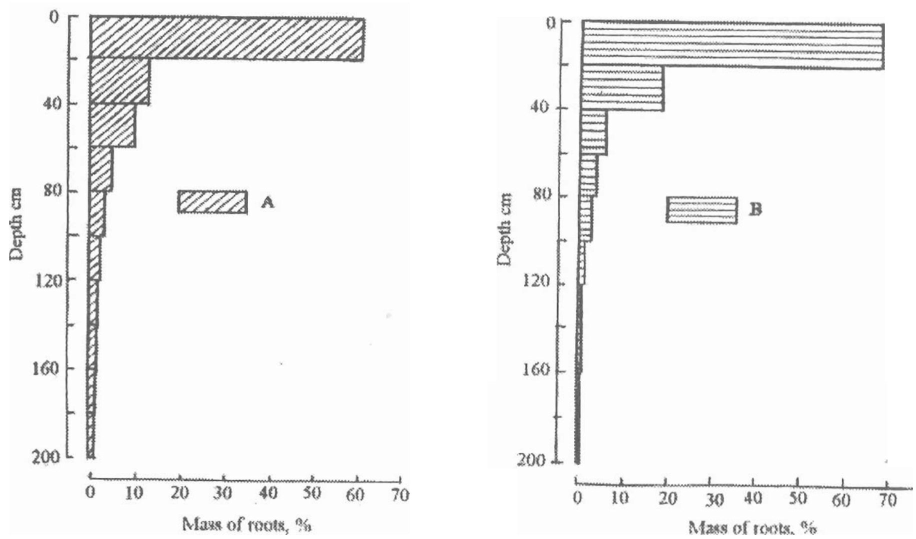

Figure 2. Vertical distribution of root mass of black alder in drained (A) and undrained (B) eutrophic mires (%).

In the undrained birch stands (study plot No. 15) vertical spreading of tree root systems is limited at 50-60, and in drained (study plots No. 11, 16) at 70-80 (100) centimeters depth. Root systems of spruce (fine roots in this number) on the long ago drained sites in deep lowlands (study plot No. 17), and in transitional mires (study plot No. 9) reach 1.2 m depth. However up to 89-92% of all spruce roots are concentrated in the upper 20 - centimeter-layer of the soil (Tables 3 and 4).

The length of determined diameter roots in the unit of mass depends upon species and soil conditions. The length (Lg) of one gramme fine roots (up to 1 mm) of pine on the drained sites makes up 3.7-4.4 m, birch 4.1±0.5, and black alder only 2.6 m (Table 5). Magnitude Lg in undrained pine stands is 1.37-1.62 times less in comparison with that in drained, and makes up 2.7±0.2 m.

Table 5. The mean values of root length coefficients (m/g dry matter) of different tree species in the peatland forest types

Tree species	No. of study plot	Diameter of roots, mm			
		<1	1-2	2-3	≥4
Pine	5; 6	3,7±0,3	1,3±0,2	0,6±0,1	0,005±0,001
Pine	2; 3	2,7±0,2	1,1±0,1	0,3±0,02	0,04±0,004
Pine	4	4,4±0,4	0,5±0,2	0,7±0,03	0,03±0,01
Spruce	9	2,8±0,4	1,0±0,2	0,6±0,2	0,01±0,003
Black Alder	12; 13;14	2,6±0,5	1,4±0,3	0,7±0,2	0,007±0,002
Birch	11; 16	4,1±0,5	0,9±0,1	0,4±0,02	0,003±0,001

The most significant rooting density in the upper layer of the soil according to mass and length is observed in spruce stands (Table 6), where roots of different diameter, located in the 20-centimeter-layer of the soil, make up 239-263 m.

Table 6. The mean values of rooting density coefficients (g/m² dry matter) and roots lengths m, in the soil layer at 20 cm depth.

No. of study plot	In mass		In length	
	all roots	diameter <1 mm	Total length of roots, m	
			all	diameter <1 mm
1	340	11	59	37
3	1002	27	136	57
4	1593	20	177	88
6	3176	21	206	62
7	1808	9	120	35
8	1627	8	68	26
9	7255	41	263	115
11	2365	39	239	160
12	2511	18	82	47
14	2374	19	84	49
15	1350	35	184	144
16	1894	42	208	172
17	3604	50	239	140

Conclusions

1.On the undrained and drained sites 71-97% of all roots of pines, spruces and birches stands are located in the upper 0-20-centimeter-layer of the soil. On the drained sites rooting density increased 3-5 times, and rooting depth - 20-40(60) cm.

2.On the long ago drained sites roots of spruce and pine penetrate at 110-120 centimeters depth. Birch in this respect is inferior to coniferous species. Maximal depth of birch root penetration in the peat soils is 90-100 cm.

3.In the black alder stands, irrespective of drainage, in the upper 20-centimeter-layer 52-76% of all roots are located. In the mature stands roots penetrate up to the depth 2.2 m.

4.The largest rooting density in the upper layer of the soil is observed in the drained spruce stands, the smallest - in the undrained pine stands. In the 20-centimeter-layer of the soil under the 70-90 year-old spruce stands mass of different diameter roots makes up 3,604-7,255 g per 1 m^2, length 239-263 m, and in the pine stands - 800-1,000 g and 73-136 m, respectively.

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РАСПРОСТРАНЕНИЕ КОРНЕЙ СОСНЫ ЕЛИ, БЕРЕЗЫ И ЧЕРНОЙ ОЛЬХИ В БОЛОТНЫХ ПОЧВАХ

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Резюме

Независимо от интенсивности осушения в болотных сосняках, ельниках и березняках, 80-97% всех корней сосредоточено в поверхностном 0-20 сантиметровом слое почвы. При этом в осушенных болотных почвах количество корней увеличивается 3-5 раз, а их углубление на 20-40(60) см. Корни ели, как и сосны проникают до 100-120, а березы только до 80-100 см глубины. Корни черноольшаников независимо от осушения распространены до 1,8-2,2 м глубины. Наибольшая насыщенность поверхностного слоя почвы корнями наблюдаются в осушенных ельниках, а наименьшая в неосушенных сосняках. В 20-сантиметровом слое почвы под 70-90 летним ельникам масса корней различного диаметра на 1 м^2 составляет 4604-7255 г, их длина 239-263 м, а в сосняках соответственно 800-1000 г и 73-136 м.

Ключевые слова: болотные почвы, осушение, ель, береза, черная ольха, распространение корней.