THE NUMBER OF TERMINAL BUDS OF CENTRAL SHOOT AS DIAGNOSTIC GROWTH INDEX OF HALF SIBS OF SCOTCH PINE

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Annotation. The number of buds on central shoot of half sibs posterities of Scotch Pine in age 1–6 years is research. Inheritance the number of terminal buds of progeny test is established. Correlation relationship analysis of number of terminal buds with growth of half sibs posterities is done.

Keywords: progeny test, terminal buds.

INTRODUCTION

Boughs length and thickness, the angle of fastening of branches to the trunk and the number of shoots in one whorl are important features of the Scotch pine crown.

According to the literature [5] trees with a broad crown have less branches in one whorl. Data about productivity of narrow- and wide crown pines are contradictory [3].

The diameter and volume of the trunk of the wide crowns Scotch pine in the southern and western regions much larger than narrow crowns. In northern regions narrow crowns pine trees grow better.

The formation of a dense crown with numerous branches and a large number of needles is spent a lot plastic material, and it slows the growth dense needles pine trees in height and diameter [1].

According to [5] pine seedlings with the number of apical buds more than five in the progeny test were more growing. Swedish and Finnish arboriculturists prefer narrow crown pines, because the same area can grow larger amount of wood.

Questions about early genetic evaluation for Scotch pine by the number of apical buds are topical.

MATHERIAL AND METHODS

The number of terminal buds on the main shoots 1-6-year progeny tests of Scotch pine in the sq. 110 b. 3 Sokyrychy forest state enterprise "Kivertsy forestry", area of 1,3 ha* was installed.

Type of forest conditions – fresh moist suboakery (C_{2-3}). In grass cover Pulmonaria obscura, Oxalis acetosella L., Galium odoratum L., Veratrum lobellianum, Humulus lupulus are growing.

Progeny tests were created without soil preparation. All seedlings were planted in 1976 with the placement of 3,0 x 0,75 m. The halfsibs of 18 plustrees of Volodymyr-Volynsk (group VV), Kivertsy (Kiv), Kamyn-Kashyrsk (KK), Cuman (C) state forestry of Volun region and Radehyv (L) – Lvyv region in cultures are represent.

Control seedlings were grown from seed production gathering of Volodymyr-Volynsk, Kivertsy and Cuman state forestries. Height of one-year seedlings was between 10–14 cm. In this paper we used mathematical and statistical methods [6].

In order to establish influence of environmental conditions on the number of terminal buds we determined the inheritance coefficient (H^2) in the broadest sense by using analysis of variance [4].

Correlation analysis was conducted by using correlation coefficients (R), Spearman rank correlation (RS), Gamma (RG) and Kandel-Tay (RK-T).

RESULTS AND DISCUSSION

The study of the number of terminal buds on 1-year halfsibs posterities was founded that their mean is 4,6 ± 0,2 at minimum 2 and maximum 13 pieces.

The coefficient of variation V is 34,9%, which demonstrates the high variability of this feature. As we can see from table 1, halfsibs VV-1, Kiv-1 and Kiv-8 have significantly greater number of buds in compare with control, and the halfsibs VV-6 – significantly lower ($t_f > t_{st}$).

The rest halfsibs by the number of buds don't differ from the control variant.

* Note. Measurement of 1-6-year-old cultures was carried by V. Voytyuk, 27-year-olds – own research

Table 1

Variational and statistical indicators of the number of buds 1-year halfsibs

Variant	M ± m	s	V, %	P, %	t
VV-1	4,92 ± 0,22	1,72	34,97	4,37	1,99*
VV-3	4,26 ± 0,16	1,33	31,12	3,86	-0,69
VV-6	3,82 ± 0,22	1,63	42,80	5,77	-2,26*
VV-7	4,43 ± 0,31	1,68	37,78	6,90	0,07
Kiv-1	5,00 ± 0,19	1,53	30,62	3,80	2,50*
Kiv-2	4,78 ± 0,20	1,50	31,35	4,23	1,51
Kiv-3	4,38 ± 0,20	1,57	35,85	4,48	-0,15
Kiv-4	5,00 ± 0,36	1,96	39,28	7,29	1,51
Kiv-6	4,76 ± 0,18	1,41	29,52	3,84	1,53
Kiv-7	4,36 ± 0,14	1,11	25,49	3,32	-0,27
Kiv-8	5,20 ± 0,29	2,24	43,09	5,61	2,45*
КК-1	4,59 ± 0,22	1,71	37,27	4,70	0,69
L-2	4,66 ± 0,23	1,71	36,66	4,90	0,93
L-3	4,16 ± 0,21	1,57	37,77	5,09	-0,97
L-4	4,48 ± 0,20	1,43	32,02	4,44	0,29
L-5	4,68 ± 0,24	1,98	42,25	5,20	0,97
C-4	4,63 ± 0,18	1,35	29,19	3,80	0,96
C-8	4,18 ± 0,21	1,31	31,36	5,09	-0,88
Control	4,41 ± 0,14	1,41	31,92	3,19	-

Note: $t_{0,5}$=1,98, * – significant difference

All studied tree by the number of buds on the main shoots were divided into three groups: small (five pieces), with average number (5–10 pcs.) and plenty of buds (more than 10 pcs.). It is founded that 46% of all halfsibs have 4-5 buds. In 28% of trees number of terminal buds in central shoot is minimal and amounts 2-3, 22% of trees has 6-7 terminal buds in central shoot (table 2). Posterities Kiv-4, Kiv-8, КК-1, L-5 have 0,6% of trees with number of buds more than 10.

Table 2

The distribution of 1-year halfsibs and control (%) by the number of buds

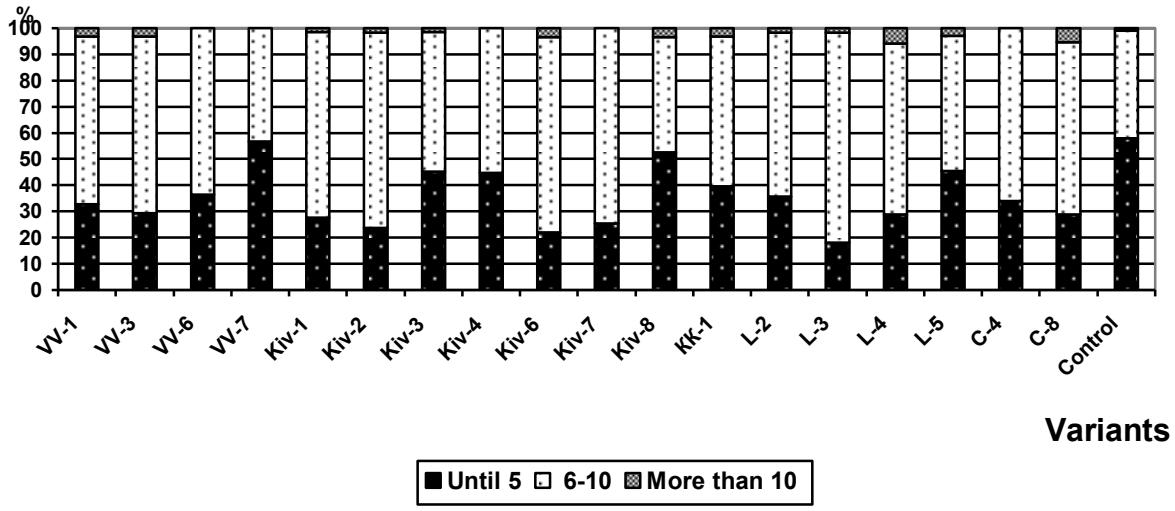
Variant	The number of buds					
	2-3	4-5	6-7	8-9	10-11	12-13

VV-1	25,0	35,9	35,9	3,1	-	-
VV-3	30,8	53,8	15,4	0,0	-	-
VV-6	52,7	30,9	12,7	3,6	-	-
VV-7	36,7	36,7	20,0	6,7	-	-
Kiv-1	12,3	55,4	26,2	6,2	-	-
Kiv-2	18,2	54,5	21,8	5,5	-	-
Kiv-3	29,7	50,0	17,2	3,1	-	-
Kiv-4	24,1	37,9	27,6	6,9	3,4	-
Kiv-6	16,9	59,3	20,3	3,4	-	-
Kiv-7	22,0	61,0	16,9	0,0	-	
Kiv-8	28,8	28,8	32,2	6,8	1,7	1,7
KK-1	30,2	42,9	23,8	1,6	1,6	-
L-2	25,0	46,4	21,4	7,1	-	-
L-3	38,2	43,6	18,2	0,0	-	-
L-4	26,9	51,9	19,2	1,9	-	-
L-5	30,3	42,4	18,2	6,1	3,0	-
C-4	25,4	47,5	25,4	1,7	-	-
C-8	31,6	50,0	18,4	-	-	-
Mean	28,0	46,1	21,7	3,5	0,5	0,1
Control	30,0	51,0	18,0	1,0	-	-

It was founded that the number of buds on central shoot of 2-years halfsibs posterities is 6,3 ± 0,3 with a minimum of 4-5 and a maximum 17 pieces. The variability for this feature is high (V = 30,2%). The mean number of buds on central shoot in control variant is 5,4 with limits 4-5 and 10-11pieces. 90% progenies is significantly differenced from control variant.

It should be noted that the number of buds on central shoots in 2-years posterities has correlation with the diameter of dead branches in the 27-age (R_S =0,47, p=0,04).

In 41% of trees all posterities the number of bud is 6-7, 30% of trees have got 4-5 buds on central shoots and 19% of trees– 8-9 pieces. (fig.1). There are variants among halfsibs, which have got 1% of trees with number of terminal buds more than 12. It is variants VV-3, Kiv-2, Kiv-3, Kiv-8, KK-1, L-2, L-3, C-8.



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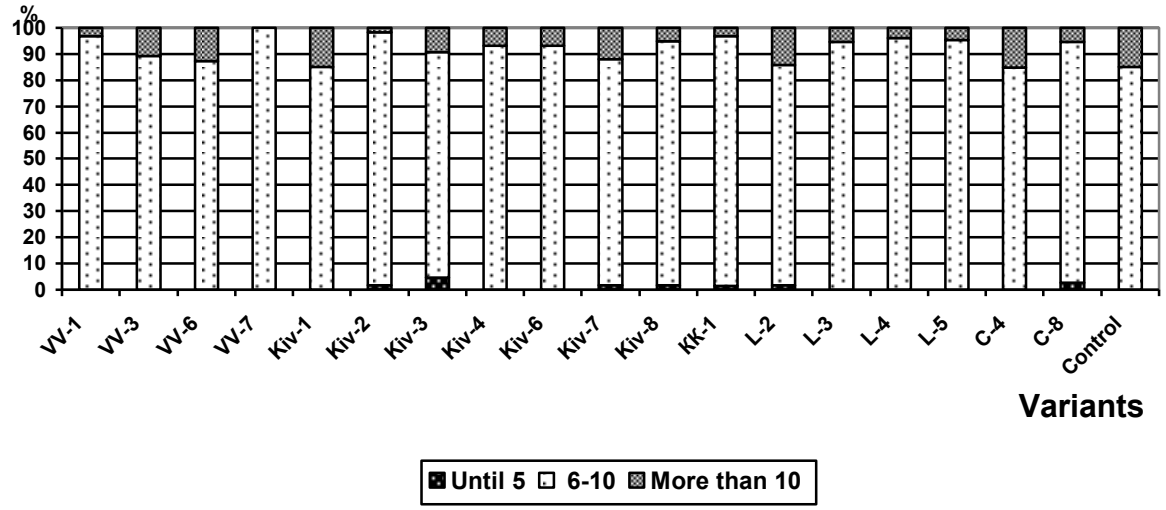

B

Fig. 1. Dynamics of the distribution (%) by the number of terminal buds in the context of progenies: A – in 2 years old , B – in 6 years old

The study of the number of buds on the central shoots of 3-5-year-olds halfsibs showed that their mean number is 6,6; 7,7; 7,9 with limits 2-3 and 20 pieces. The variability for this feature is high with tendency to lowering, accordingly V=32%, 27,8%, 26,8%. Most of all progenies have got a substantial difference from the control variants VV-1, VV-3, VV-7.

The study of the number of buds on the central shoots of 6-year-olds halfsibs showed that their mean number is 8,5±0,2 with minimum 4-5 and maximum 19. The variability for this feature is middle (V=17,8%). The mean number of bud in control

variant is 8,9±0,2 with limits 6-7 – 14-15. Posterity VV-3 has got significantly upper different from control variant (t_f =2,08). Variants VV-1, VV-7, Kiv-2, Kiv-8 та L-5 have got significantly less buds than control variant (table 3).

Table 3

Variational and statistical indicators of the number of buds 6-year halfsibs

Variant	M ± m	s	V, %	P, %	t
VV-1	8,19 ± 0,18	1,47	17,93	2,24	-2,80*
VV-3	9,32 ± 0,16	1,29	13,82	1,71	2,08*
VV-6	8,82 ± 0,20	1,50	17,06	2,30	-0,16
VV-7	7,53 ± 0,24	1,33	17,68	3,23	-4,60*
Kiv-1	8,60 ± 0,21	1,68	19,59	2,43	-1,00
Kiv-2	8,27 ± 0,18	1,31	15,86	2,14	-2,50*
Kiv-3	8,66 ± 0,20	1,64	18,89	2,36	-0,80
Kiv-4	8,24 ± 0,34	1,81	21,91	4,07	-1,68
Kiv-6	8,69 ± 0,17	1,28	14,68	1,91	-0,73
Kiv-7	8,85 ± 0,22	1,71	19,33	2,52	-0,05
Kiv-8	8,12 ± 0,21	1,59	19,55	2,55	-2,87*
KK-1	8,60 ± 0,15	1,16	13,46	1,70	-1,21
L-2	8,79 ± 0,23	1,74	19,86	2,65	-0,27
L-3	8,40 ± 0,27	2,00	23,77	3,20	-1,48
L-4	8,46 ± 0,17	1,23	14,51	2,01	-1,73
L-5	8,12 ± 0,15	1,26	15,50	1,91	-3,38*
C-4	8,75 ± 0,25	1,92	21,92	2,85	-0,39
C-8	8,50 ± 0,21	1,29	15,17	2,46	-1,38
Control	8,86 ± 0,15	1,54	17,43	1,74	-

Among them distinguishes itself posterity L-3, 1,8% trees of this variant have more than 15 buds on central shoot (table 4).

Table 4

The distribution of 6-year halfsibs and control (%) by the number of buds

Variant	The number of buds						
	4-5	6-7	8-9	10-11	12-13	14-15	більше 15
VV-1	-	32,8	50,0	15,6	1,6	-	-
VV-3	-	6,2	56,9	30,8	4,6	1,5	-

VV-6	-	20,0	56,4	18,2	5,5	-	-
VV-7	-	50,0	46,7	3,3	-	-	-
Kiv-1	-	26,2	53,8	16,9	1,5	1,5	-
Kiv-2	1,8	25,5	56,4	16,4	-	-	-
Kiv-3	4,7	17,2	48,4	28,1	-	-	-
Kiv-4	-	31,0	62,1	3,4	-	3,4	-
Kiv-6	-	18,7	62,7	16,9	1,7	-	-
Kiv-7	1,7	15,3	57,6	18,6	5,1	1,7	-
Kiv-8	1,7	32,2	57,6	6,8	-	1,7	-
КК-1	1,6	17,5	60,3	20,6	-	-	-
L-2	1,8	17,9	48,2	25,0	5,4	1,8	-
L-3	-	30,9	58,2	5,5	3,6	-	1,8
L-4	-	21,2	61,5	17,3	-	-	-
L-5	-	30,3	60,6	9,1	-	-	-
C-4	-	23,7	54,2	11,9	6,8	3,4	-
C-8	2,6	18,4	60,5	18,4	-	-	-
Mean	0,9	24,2	56,2	15,7	2,1	0,8	0,1
Control	-	18,0	55,0	23,0	3,0	1,0	-

Thus, we can trace the following pattern: the percentage of halfsibs trees with number of buds to five pieces at the central shoots from age reduced practically to extinction, the percentage of halfsibs trees with number of buds more than ten pieces slightly increases; the percentage of trees with the number of buds 6-10 pc. in halfsibs to three years more than in the control, and subsequently is aligned (fig. 2).

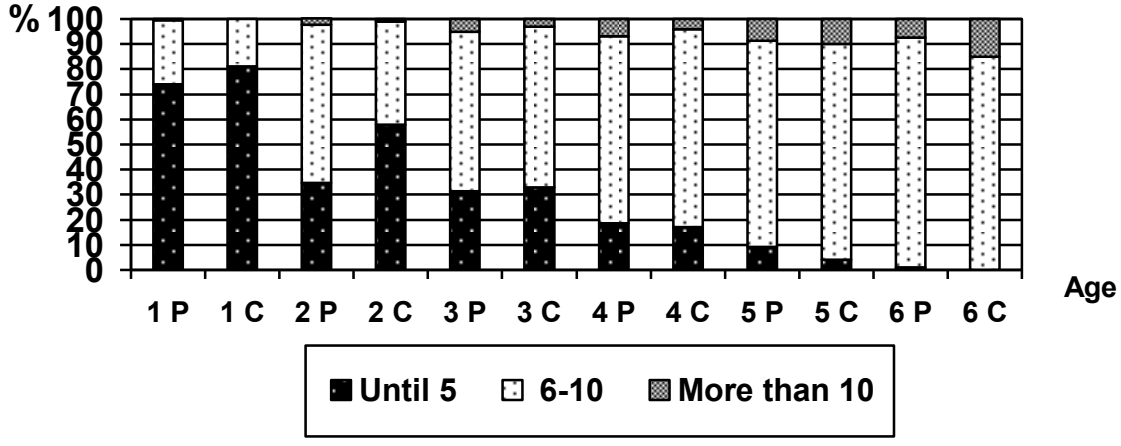

Fig. 2. Dynamics of the number of terminal buds on the central shoots for six years (numeric – posterity age, P – Posterities, C – control)

Calculations showed that the coefficient inheritance in the broad sense (H^2) is very low and for six years ranges between 0,02-0,06. Thus, environmental factors significantly influence the process of laying buds during the first six years of ontogenesis of halfsibs of Scotch pine.

Growth and qualitative indicators of 1-6-year-olds and 18-year-old progenies tests were used for correlation analysis.

Significant relationships between the number of buds and growth parameters and selection categories have not been identified. However, when we were using the growth and quality indicators of 27-year halfsibs [2], we found moderate correlations between:

mean number of buds on the central shoot in 4 and 5 years old halfsibs and numder of 27-years old minus trees (R=0,52 та R=0,46, p=0,01);

mean number of buds in six years and share of trees with curvature of the trunk (R_S =0,49, p=0,03, R_G =0,45, R_{K-T}=0,42);

share 2-years old seedling with 10-11 buds and height of 27-years old trees (R_S =0,67, p=0,001, R_G =0,54, R_{K-T}=0,53) and the percentage of plus trees (R_S =0,66, p=0,002, R_G =0,49, R_{K-T}=0,49);

share 2-years old seedling with 14-15 buds and number 27-years old minus trees (R_S =0,46, p=0,05), volume trunks of halfsibs (R_G =0,76, R_{K-T}=0,34, p=0,04) and the percentage of plus trees (R_G =0,77, R_{K-T}=0,35, p=0,04);

share 3-years old seedling with 2-3 buds and the percentage of minus trees 27-year old halfsibs (R_S =0,46, p=0,04, R_G =0,41, R_{K-T}=0,35);

share 3-years old seedling with buds more than 15 and height of 27-years old trees (R_S =0,47, p=0,03, R_G =0,88, R_{K-T}=0,40);

share 5-years old seedling with buds more than 15 and number of minus trees 27-year old halfsibs (R_S=0,54, p=0,02, R_G =0,46, R_{K-T}=0,41);

share 5-years old seedling with 10-11 buds and height of 27-years old trees (R_S =0,34, p=0,05, R_{K-T}=0,33).

From these data we can conclude that there is a moderate relationship between a large number of buds (more than ten) in central stoot 2-5- years old halfsibs and the

percentage of minus trees 27-year old halfsibs and between the percentage oftrees with the average number of buds (5-10) in age 3-5 years and height of 27-years old trees.

SUMMARY

During the first six years of ontogenesis halfsibs of Scotch pine the mean number of buds on the central shoots increasing from 4,5 to 8,9 pcs. The variability of this index decreases with age from high to average (V = 30 and 18% respectively).

In the first year of life 74% of all halfsibs trees has a small number of buds (five pieces) on the central shoots. Over the next five years the proportion of such trees is reduced and in the age of six years only a few variants have 1% of the trees with a small number of buds (Kiv-2, Kiv-3, Kiv-7, Kiv-8, KK-1, L-2 and C-8).

At the same time the proportion of trees with mean number of buds (6-10 pieces) significantly increasing and posterities that have the most trees (≈ 15%) with a large number buds (over 10 pieces) are distinguished. These variants are Kiv-1, L-2, C-4 and control.

In 2-years old by mean number of buds in central shoot practically all research posterities significantly different from control. In another age difference is significantly only in separate variants. More often than others halfsibs VV-1, VV-3, VV-7 have a substantial difference.

Environmental factors are influenced to the process of laying buds during the first six years of ontogenesis progenies test.

It was founded moderate correlations between large number of buds (more than 10) in central shoot in 2-5 years old halfsibs and percentage of minus trees 27-year old, also between percentage trees with average number of buds (5-10) in 3 and 5 years old and height of 27-years old trees.

If the more buds in age of two years is on shoots, the dead branches in the age of 27 have a smaller diameter (R_S =0,47, p=0,04).

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