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Assessment of long-term tending in mixed stands of spruce, fir and beech on research plot Korytnica

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ABSTRACT: The paper deals with problems of thinnings in a mixed stand (spruce-fir-beech) situated in the sixth altitudinal forest zone. Three of the five investigated plots were tended by free crown thinning for a long time, and two were left without any planned silvicultural treatments as control. Dynamic changes in tree species composition, stand structure, qualitative and quantitative production were evaluated for a period of 30 years. The changes were compared with respect to differences between the plot with long-term silvicultural treatments and the control plots (without treatments).

Keywords: mountain forests; thinnings; mixed stands; spruce – fir – beech

Mixed spruce, fir and beech stands are an important forest type of mixed forest complex in higher locations in the Alps and Carpathian Mountains. In Slovakia, the mentioned stands take up the area of one-fourth of the total forest area, i.e. more than 461,000 hectares mainly from the 4th to 6th altitudinal forest zone (HLADÍK 1996). Although a greater attention was paid to mountain forests in the last decades, their health condition (damage), natural and artificial regeneration and/or restoration were investigated (VACEK et al. 2000; JURÁSEK 2001; KORPEĽ 1996; VACEK 2001; BALCAR 2001; GUBKA 2001). A few papers also dealt with problems related to the silviculture of mountain forests (OTT et al. 1995; SLODIČÁK 2001) whilst the majority of papers emphasized their tending. Most papers were focused on pure spruce stands but considerably less findings were published about the management of mixed spruce, fir and beech stands and/or long-term effects of tending on their structure, production and stability (ASSMANN 1961; MOLOTKOV 1966; HOCKENJOS 1968; LEIBUNDGUT et al. 1971; ŠTEFANČÍK L. 1977a, 1990; PAUMER 1978; HLADÍK 1992; ŠTEFANČÍK I. 1999; ŠTEFANČÍK I., ŠTEFANČÍK L. 1998, 2001).

In Slovakia, research on the tending of mixed spruce, fir and beech stands started at the end of the sixties of the last century. For this reason four permanent research plots (17 partial plots) were established in the 5th and 6th altitudinal forest zone, situated in natural areas of mixed spruce, fir and beech forests in Slovakia in the Veľká Fatra Mountains and the Low Tatra Mountains. The first research results of the mentioned problems were published in 1977 (ŠTEFANČÍK L. 1977a). Permanent research plot (PRP) Korytnica was established as the first object of our research and the experimental material of this paper was collected in this PRP. This paper is a follow-up of the first two biometric measurements carried out in this plot, and published in the past (ŠTEFANČÍK L. 1977a,b).

The aim of this study was to find and assess the changes in tree species composition, stand structure, and in qualitative and quantitative production of mixed spruce, fir and beech stand on Korytnica PRP in a 30-year period of its tending.

MATERIAL AND METHODS

The mixed spruce, fir and beech stand at the growth stage of pole-stage stand up to thin high forest on permanent research plot (PRP) Korytnica was chosen as an object of our research. This PRP is located inside the zone of Forest District Liptovská Osada, Branch Forest Enterprise Liptovský Hrádok, and it was established in 1967 for research on the silviculture-production relations in mixed spruce, fir and beech stands. The series PRP Korytnica consists of five partial plots (PP) – three with an area of 0.08, 0.10 and 0.12 ha (designated as H), where free crown thinning is applied (ŠTEFANČÍK L. 1984). The other two plots are without any treatment – control plots (designated as O) with an area of 0.08 and 0.10 ha. The plots are isolated from each other and from another stand by 10 m wide tree belt. Before the research plots were established in the investigated stand, thinnings were carried out only rarely, in case they were realized their intensity was very low, focused on removal of thin and/or dying out individuals. A more detailed characteristic of research plots is presented in Table 1.

Table 1. Basic characteristics of permanent research plot (PRP) Korytnica I, II, III

Characteristic	TVP Korytnica I, II, III
Establishment of PRP (year)	1967
Age of stand (years)	spruce 58, fir 50, beech 50
Geomorphologic unit	Low Tatra Mts. (west part)
Exposition	NE
Altitude (m)	930–970
Inclination (degree)	30–35
Parent rock	Triassic Schist
Soil unit	Cambisol/Umbric Leptosol
Altitudinal forest zone	6th spruce-beech-fir
Ecological rank	B/C
Management complex	65
Management complex of forest types	611 fertile beech-fir sprucewoods
Forest type group	*Fageto-Aceretum (FAc)* v. st.
Forest type	6402 fern-beech maplewoods v. st.
Average annual temperature (°C)	4.2
Average annual precipitation sum (mm/year)	1,200

The trees on all plots are numbered and measurement points at a breast height 1.3 m are marked out. The complex biometric measurements are carried out at 5-year intervals in accordance with standard methods that were developed for long-term research on silviculture-production problems of thinnings (ŠTEFANČÍK L. 1977a) on all plots. Within their framework, besides the quantitative parameters (breast height diameter, tree height, crown size at horizontal projection), the trees were also evaluated according to the silvicultural and commercial classification with orientation to the trees of selective quality that are the main bearers of quality. Since the establishment of PRP, seven biometric measurements have been carried out and simultaneously thinnings have always been performed. From a rationalisation point of view, the method of promising trees and later crop trees (ŠTEFANČÍK L. 1984), which is focused on individual tending of the trees of selective quality, was applied on the tended plot (H). Before the research started, a model of tree species composition and production target according to

Table 2. The model of assumed and actual number of crop trees in mixed spruce, fir and beech stand on the PRP Korytnica I, II, III

Plot	Tree species	Crop trees (assumption)		Crop trees (actuality)	
		(pcs./ha)	(%)	(pcs./ha)	(%)
I – H	spruce	94	55	100	44
	fir	8	5	13	6
	beech	68	40	100	44
	sycamore maple	–	–	13	6
	total	170	100	226	100
II – H	spruce	8	5	17	10
	fir	22	15	42	24
	beech	112	75	117	66
	sycamore maple	8	5	–	–
	total	150	100	176	100
III – H	spruce	40	25	50	28
	fir	8	5	10	5
	beech	112	70	120	67
	sycamore maple	–	–	–	–
	total	160	100	180	100

ŠTEFANČÍK L. (1977b) was developed that assumed the number and tree species composition of crop trees (Table 2). For information integrity we suggest that for all mixed spruce, fir and beech stands a general model of tree species composition and production target was developed by ŠTEFANČÍK L. (1990) that was already published within the framework of assessment of our 30-year results on Hrable PRP (ŠTEFANČÍK I., ŠTEFANČÍK L. 2001).

The experimental material was processed by common biometric and statistical methods according to presented standard methods for research on thinnings. In this paper we assessed the first measurement carried out at the time of PRP establishment in 1968 (at stand age of 50–58 years) and the last measurement in 1998 (at stand age of 80–88 years) in order to compare dynamic changes in investigated parameters on Korytnica PRP for the period of 30 years.

RESULTS AND DISCUSSION

Owing to the fact that we have collected a lot of results during the investigated period of 30 years, as well as due to the limited extent of this paper, only the most important data are presented. Some of them are presented in tables or in figures, the others are commented only verbally.

TREE SPECIES COMPOSITION

Percentage proportions of tree species according to the basal area (G) on Korytnica PRP are presented in Fig. 1. In the initial stage of our research the proportion of coniferous trees on the tended plots H was from 29% to 58% while on control plot O 50% and 33%, respectively. According to the tree species the highest proportion was found for beech (37–61%), followed by fir (13–30%), spruce (6–28%) and sycamore maple (3–11%). After 30 years, the proportion of coniferous trees on the tended plots ranged from 27% to 48% while on control plots 47% and 29%, respectively. Within the framework of individual tree species an increase in spruce (by 4–11%) and also beech (by 3–11%) proportion was registered on the tended plots. On the other hand, a decrease in fir proportion by 5–22% was found. On control plots there was an increase in spruce proportion by 5% and/or 4% and in the proportion of beech by 2% and 3%. The highest changes in the investigated period of 30 years were registered for fir (decrease by 8–9%) in favour of the other tree species (spruce, beech, sycamore maple). Comparison of the tree species composition with developmental goals according to HANČINSKÝ (1972) showed that all plots slightly differed from the required composition, especially by a higher share of beech to the detriment of spruce and on some plots also of fir and valuable broadleaved trees (sycamore maple, Scotch elm).

The above-mentioned development of tree species composition can be explained by the fact that growth conditions in this PRP (6th altitudinal forest zone, altitude 930–970 m a.s.l., etc.) are suitable for beech and are getting to optimal for spruce. As for a decrease in fir proportion, it was influenced by the fact that the mentioned stands were neglected from a silvicultural point of view at young and middle age, which resulted in crown reduc-

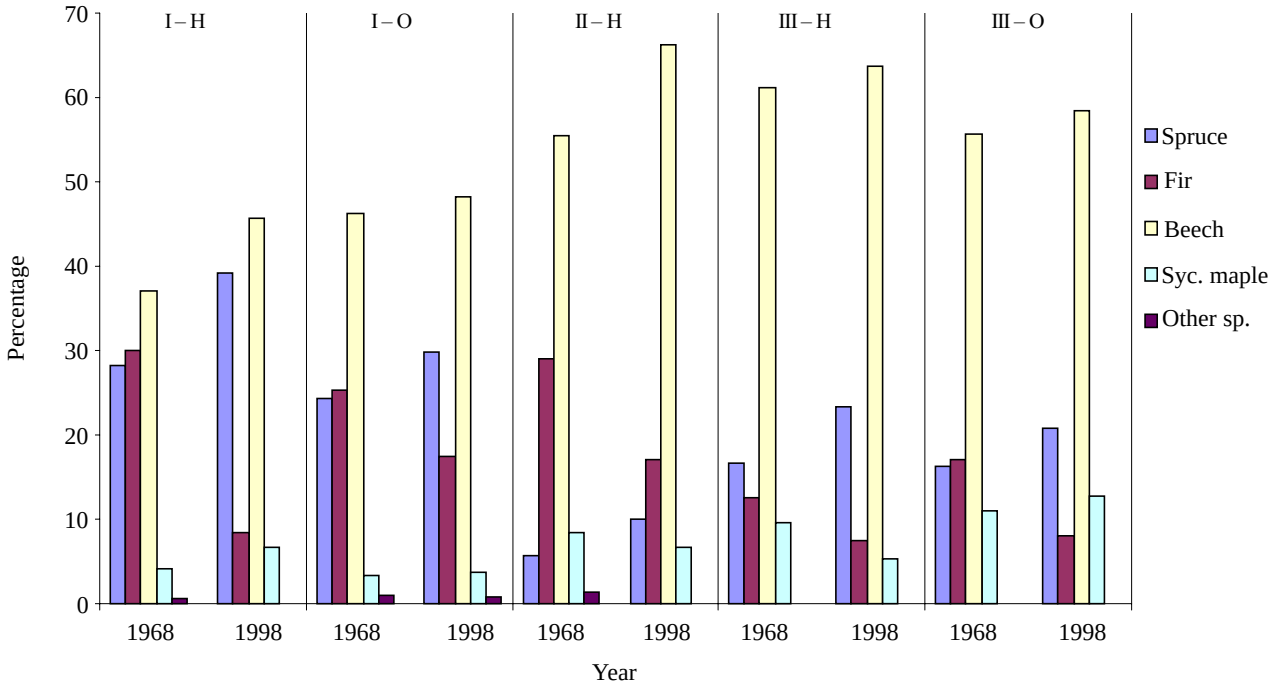

Fig. 1. Percentage proportions of tree species according to the basal area (*G*) on the PRP Korytnica I, II, III

tion and/or reduction of assimilatory organs (ŠTEFANČÍK L. 1977b). Well-known is also the fact that fir suffers very much due to tending treatments at later age, especially after previous silvicultural treatment was neglected, which brings about its increased mortality (KORPEĽ, VINŠ 1965). Changes found out in the tree species composition and in their decrease confirmed the known overall decline of fir in forest stands during the last decades (MÁLEK 1983) when its original proportion in the Slovak forests decreased from former 14.1% to 4.5% at present (HLADÍK 1996; VLADOVIČ et al. 1998).

Our results related to fir decline in mixed stands also correspond with those published by KANTOR and PAŘÍK (1998), who assessed changes in the tree species composition during a 35-year period of investigation in a 65-year mixed spruce, fir, pine, larch and beech stand that was not tended. The authors determined a considerable decrease in the fir proportion for 20 years from 28% to 17%. On the contrary, an increased proportion for beech and spruce by 5% and 9%, respectively, was found.

STAND STRUCTURE

Stand structure was described by relative frequency according to the growth (tree) classes. We calculated the proportion of trees at a crown level of the stand (1^{st} + 2^{nd} growth class) and suppressed level of the stand (3^{rd} to 5^{th} growth class), which is important from the silvicultural point of view. The results showed that in the initial stage the proportion of spruce at a crown level of the stand on all plots ranged from 21% to 56%, fir 13–30%, beech 19–50% and sycamore maple 4–52%. After the 30-year period the proportion of spruce at a crown level of the stand on tended plots ranged from 33% to 89%, fir 14–36%, beech 32–47% and sycamore maple 25–50%. On two control plots the proportion of spruce at a crown level of the stand was 46% and 75%, fir 50% and 60%, beech 32% and 48%, sycamore maple 40% and 45%.

Although the stand structure (classification according to the growth classes) depends on site, tree species, age and tending measures (ŠEBÍK, POLÁK 1990), these results suggest a slight increase in the proportion of the crown level of the stand within the framework of stand structure for all tree species during the period of 30 years. Similar development was also found on other PRP that were investigated in mixed spruce, fir and beech stands (ŠTEFANČÍK I., ŠTEFANČÍK L. 1998). It was confirmed that the intensity of shifts within the framework of the relative height position of trees decreases in relation to age, it means that a lower number of trees shifts into lower growth classes (ŠTEFANČÍK L. 1974; ŠEBÍK, POLÁK 1990).

DEVELOPMENT OF QUALITATIVE PRODUCTION BY THE METHOD OF CROP TREES

Table 3 presents the development of crop trees, the main bearers of stand quality and quantity. It can be seen that the number of promising trees (future crop trees) ranged from 210 individuals per hectare to 363 individuals per hectare, with the share of growing stock 32–48%. After the 30-year period the number of crop trees decreased, so their number ranged from 176 individuals per hectare to 226 individuals per hectare on tended plots, while 162 individuals per hectare and 140 individuals per hectare on control plots. The proportion of crop trees in growing stock was from 53% to 74% on tended plots while only 40% and 42% on control plots. As for the tree species composition of crop trees, the proportion of beech was 50% and the remaining 50% included spruce and fir, rarely sycamore maple.

Very interesting results were found by a comparison of the actual number of crop trees with that of the expected ones (Table 2). It is clear that the number of crop trees determined before the research started was slightly higher in comparison with the model after the 30-year period of tending. The differences were minimal also according to the percentage share of tree species. It can be assumed

Table 3. Development of crop trees

Plot	Age (years)	Number of trees (per 1 ha)	Basal area (m^2/ha)	Basal area (% from main stand)	Volume of timber to the top of 7 cm o.b. (m^3/ha)	Volume of timber to the top of 7 cm o.b. (% from main stand)
I – H	50–58	363	11.54	39.2	111.79	48.3
	80–88	226	19.81	66.3	261.11	71.5
I – O	50–58	263	11.06	28.4	113.51	38.8
	80–88	162	16.25	37.2	231.45	40.1
II – H	50–58	242	9.57	29.9	94.55	42.3
	80–88	176	14.06	46.5	193.55	53.3
III – H	50–58	210	9.61	34.1	94.69	40.9
	80–88	180	20.00	68.8	285.16	73.9
III – O	50–58	210	10.33	27.0	103.03	31.8
	80–88	140	17.77	39.2	262.54	41.9

Explanatory notes: H – plots with the free crown thinning, O – plots without treatment (control)

that within the rotation the number of crop trees will be in accordance with the model. It is to note that the model developed for Korytnica PRP contains a lower number of trees in comparison with the general model developed for spruce, fir and beech stands (ŠTEFANČÍK I., ŠTEFANČÍK L. 2001), which was a consequence of the lack of silvicultural treatment on PRP during the period before our research started. In the case of both early and systematic tending a higher number of crop trees could be achieved in accordance with the mentioned model. The same development was found on Korytnica PRP as in the mixed spruce, fir and beech stand on Hrable PRP with similar natural conditions (ŠTEFANČÍK I., ŠTEFANČÍK L. 2001), so that on some plots and/or for some tree species the assumed diameter of crop trees was already achieved at the age 80–90 years.

It can be concluded that contrary to delayed tending (at the age of 50 years) the results were always more favourable in comparison with the plot without treatment. Of course, neither quantitative nor qualitative losses could be compensated because of neglected tending. This fact was confirmed by our results from other mixed spruce, fir and beech PRP (Motyčky, Hrable) (ŠTEFANČÍK L. 1990; ŠTEFANČÍK I., ŠTEFANČÍK L. 2001).

DEVELOPMENT OF QUANTITATIVE PRODUCTION

Tables 4 and 5 show the basal area of the whole stand and main stand at the first biometric measurement in 1968 as well as at the last one carried out in 1998. On tended plots H totally for all tree species 13.5–19.7% of *N* (num-

Table 4. Development of the basal area and its decrease on the plots in 1968

Plot	Age (years)	Tree species	Total stand	Decrease (secondary stand)					Main stand
				thinning of living trees	dead trees	other* decrease	treatment intensity		
			(m^2/ha)	(%)	(%)	(%)	(m^2/ha)	(%) total	(m^2/ha)
I – H	58	spruce	9.62	13.5	–	–	1.30	13.5	8.33
	50	fir	10.20	10.1	–	–	1.03	10.1	9.17
	50	beech	12.56	15.8	–	–	1.99	15.8	10.57
	50	s. maple	1.38	15.2	–	–	0.21	15.2	1.16
		other	0.20	–	–	–	–	–	0.20
		total	33.96	13.3	–	–	4.53	13.3	29.43
I – O	58	spruce	9.46	–	–	–	–	–	9.46
	50	fir	9.84	–	–	–	–	–	9.84
	50	beech	17.94	–	–	–	–	–	17.94
	50	s. maple	1.29	–	–	–	–	–	1.29
		other	0.36	–	–	–	–	–	0.36
		total	38.89	–	–	–	–	–	38.89
II – H	58	spruce	2.05	14.1	–	–	0.29	14.1	1.76
	50	fir	10.68	6.4	–	–	0.68	6.4	10.00
	50	beech	20.37	14.6	–	–	2.98	14.6	17.39
	50	s. maple	3.07	23.5	–	–	0.72	23.5	2.35
		other	0.50	–	–	–	–	–	0.50
		total	36.67	12.7	–	–	4.67	12.7	32.00
III – H	58	spruce	5.59	18.2	–	–	1.02	18.2	4.57
	50	fir	4.20	14.5	–	–	0.61	14.5	3.59
	50	beech	20.43	16.3	–	–	3.33	16.3	17.10
	50	s. maple	3.22	10.2	–	–	0.33	10.2	2.89
		other	–	–	–	–	–	–	–
		total	33.44	15.8	–	–	5.29	15.8	28.15
III – O	58	spruce	6.25	–	–	–	–	–	6.25
	50	fir	6.54	–	–	–	–	–	6.54
	50	beech	21.33	–	–	–	–	–	21.33
	50	s. maple	4.17	–	–	–	–	–	4.17
		other	–	–	–	–	–	–	–
		total	38.29	–	–	–	–	–	38.29

Explanatory notes: * – stem break or windthrow

Table 5. Development of the basal area and its decrease on the plots in 1998

Plot	Age (years)	Tree species	Total stand (m^2/ha)	Decrease (secondary stand) thinning of living trees (%)	dead trees (%)	other* decrease (%)	treatment intensity (m^2/ha)	(%) total	Main stand (m^2/ha)
I – H	88	spruce	12.56	–	6.8	–	0.85	6.8	11.71
	80	fir	2.54	–	–	–	–	–	2.54
	80	beech	13.84	0.5	0.8	–	0.18	1.3	13.66
	80	s. maple	2.05	–	4.4	–	0.09	4.4	1.96
		other	–	–	–	–	–	–	–
		total	30.99	0.2	3.4	–	1.12	3.6	29.87
I – O	88	spruce	13.54		3.6	–	0.49	3.6	13.05
	80	fir	7.71	–	0.8	–	0.06	0.8	7.65
	80	beech	21.91	–	3.9	–	0.86	3.9	21.05
	80	s. maple	1.68	–	–	–	–	–	1.68
		other	0.30	–	–	–	–	–	0.30
		total	45.14	–	3.1	–	1.41	3.1	43.73
II – H	88	spruce	3.02	–	–	–	–	–	3.02
	80	fir	5.20	–	1.3	–	0.07	1.3	5.13
	80	beech	21.20	3.2	0.4	1.7	1.12	5.3	20.08
	80	s. maple	2.02	–	–	–	–	–	2.02
		other	–	–	–	–	–	–	–
		total	31.44	2.2	0.5	1.1	1.19	3.8	30.25
III – H	88	spruce	6.82	–	–	–	–	–	6.82
	80	fir	2.33	–	6.0	–	0.14	6.0	2.19
	80	beech	19.61	5.0	–	0.4	1.06	5.4	18.55
	80	s. maple	1.53	–	–	–	–	–	1.53
		other	–	–	–	–	–	–	–
		total	30.29	3.3	0.5	0.2	1.20	4.0	29.09
III – O	88	spruce	9.82	–	4.1	–	0.40	4.1	9.42
	80	fir	3.91	–	–	6.1	0.24	6.1	3.67
	80	beech	26.89	–	1.4	–	0.38	1.4	26.51
	80	s. maple	5.75	–	–	–	–	–	5.75
		other	–	–	–	–	–	–	–
		total	46.37	–	1.7	0.5	1.02	2.2	45.35

For explanation see Table 4

ber of trees), 12.7–15.8% of *G* (basal area) and 11.0–15.0% of the volume of timber to the top of 7 cm o.b. (V_{7b}) was removed by the first thinning. Within the framework of the tree species, removal due to thinnings was highest in beech in accordance with its highest proportion on all plots. After 30-year tending 1.5–1.7% according to *N*, 0.2–3.3% according to *G* and 0.1–3.5% according to V_{7b} was removed by the 7th thinning.

Similar results were also found on other plots in mixed stands (Motyčky, Hrable) where the intensity of the first treatment (thinning of living trees) according to V_{7b} ranged from 10.2–16.2% on Motyčky PRP and 24.9% the Hrable PRP (ŠTEFANČÍK I., ŠTEFANČÍK L. 2001). Our results also correspond with the recommendations by MOLOTKOV (1966), who reported the thinning intensity of 15–30% of the growing stock and for later thinnings 10–20% for spruce, fir and beech stands of the Carpathian region in Ukraine.

A reduction in the category another decrease (breaks of stems, windthrows) during 30 years of investigation assumed negligible values and ranged from 0 to 1.3%. An exception was found only for the 6th biometric measurement (1993) when the forest managers mistakenly carried out the treatment on all plots with intensity 4.5–8.1% on tended plots and 9.1% and 7.8% on control plots.

The highest decrease in *N* by self-thinning (Table 6) was found on control plots amounting to 67.8% and 48.9% of total production while on tended plots it was 28.3–37.0%. According to the tree species by an absolute expression of the number of trees, the following or-

Table 6. The decrease of trees by self-thinning for 30 years

Plot	Tree species	Number of trees		Decrease by self-thinning			
				Basal area		Volume of timber to the top of 7 cm o.b.	
		(pcs./ha)	(% of TP)	(m^2/ha)	(% of TP)	(m^3/ha)	(% of TP)
I – H	spruce	87	27.8	1.46	9.3	15.09	7.7
	fir	338	60.0	6.30	56.6	60.95	57.8
	beech	425	22.2	1.10	4.4	1.54	0.7
	s. maple	113	39.4	0.28	9.6	0.59	2.2
	other	25	67.6	0.14	28.0	0.38	9.1
	total	988	31.7	9.28	16.8	78.55	13.8
I – O	spruce	100	36.4	1.03	6.9	8.79	4.3
	fir	450	81.8	5.25	40.7	42.66	29.8
	beech	2,051	67.8	5.81	19.2	23.20	7.0
	s. maple	175	70.0	0.54	20.1	1.26	5.0
	other	38	76.0	0.16	34.8	–	–
	total	2,814	67.8	12.79	20.9	75.91	10.7
II – H	spruce	58	50.0	0.24	6.7	0.86	1.9
	fir	466	69.0	5.77	45.9	53.18	39.0
	beech	834	30.2	2.22	6.0	4.64	1.3
	s. maple	184	30.3	0.57	10.4	1.16	2.5
	other	8	24.3	0.02	1.8	–	–
	total	1,550	37.0	8.82	14.9	59.84	9.9
III – H	spruce	80	34.8	0.69	7.8	3.64	3.3
	fir	180	46.1	1.75	34.0	10.97	25.0
	beech	250	21.9	1.38	4.2	6.78	1.7
	s. maple	60	24.0	0.26	4.7	0.63	1.1
	other	–	–	–	–	–	–
	total	570	28.3	4.08	7.8	22.02	3.7
III – O	spruce	140	50.0	1.18	11.1	7.23	5.2
	fir	340	75.6	3.94	48.1	32.77	37.0
	beech	350	38.0	3.49	10.7	27.40	6.4
	s. maple	100	40.0	0.72	9.6	4.46	5.0
	other	–	–	–	–	–	–
	total	930	48.9	9.33	15.8	71.86	9.7

Explanatory notes: TP – total production

der was found: beech, fir, sycamore maple, spruce, others. According to the percentage of total production the highest decrease was unambiguously registered for fir on all plots but differences between the other tree species were low, so that their order changed from plot to plot. This fact could be explained by the same words presented in the part of this paper related to tree species composition on Korytnica PRP. Moreover, it can be stated that especially during the first thinnings there were cases of fir decline at a crown level of the stand. It applied to intensively released fir individuals with smaller crown size. Due to an acute crown release at old age, their crown was not regenerated but dried up (ŠTEFANČÍK L. 1977b). The sensitivity of fir trees to more intensive and more acute release at older age was also reported by KORPEĽ, VINŠ (1965).

A total decrease (Table 7) over 30 years according to *G* on tended plots amounted to 44% and 49% of total production while it was 23% and 29% on control plots. A total decrease according to V_{7b} on tended plots was 35–40%, and 15% and 18% on control plots.

Total production (Table 8) during 30 years of investigation on tended plots ranged from 2,010 to 4,191 individuals per hectare, 52.32 m^2/ha to 59.33 m^2/ha (according to *G*) and 569.6 m^3/ha to 601.75 m^3/ha. The values on control plots were as follows: 4,150 and 1,900 individuals per hectare, 61.32 m^2/ha and 58.93 m^2/ha, 707.14 m^3/ha and

Table 7. The total decrease of trees for 30 years

Plot	Tree species	Total decrease					
		Number of trees		Basal area		Volume of timber to the top of 7 cm o.b.	
		(pcs./ha)	(% of TP)	(m^2/ha)	(% of TP)	(m^3/ha)	(% of TP)
I – H	spruce	200	63.9	3.91	25.0	38.05	19.4
	fir	475	84.3	8.60	77.2	79.16	75.1
	beech	1,437	75.1	11.28	45.2	79.56	33.6
	s. maple	237	82.6	0.96	32.9	3.63	13.3
	other	37	100	0.50	100	4.17	100
	total	2,386	76.6	25.25	45.8	204.57	35.9
I – O	spruce	125	45.5	1.90	12.7	17.74	8.6
	fir	450	81.8	5.25	40.7	42.66	29.8
	beech	2,213	73.2	9.27	30.6	62.56	18.9
	s. maple	188	75.2	1.02	37.9	6.84	27.3
	other	38	76.0	0.16	34.8	–	–
	total	3,014	72.6	17.60	28.7	129.80	18.3
II – H	spruce	66	56.9	0.53	14.9	3.76	8.4
	fir	558	82.6	7.43	59.1	69.75	51.1
	beech	1,992	72.2	16.58	45.2	128.38	35.5
	s. maple	525	86.3	3.44	63.0	23.52	50.9
	other	33	100	1.10	100	13.19	100
	total	3,174	75.7	29.08	49.0	238.60	39.6
III – H	spruce	170	73.9	2.02	22.8	14.65	13.5
	fir	320	82.0	2.95	57.3	18.11	41.3
	beech	760	66.6	14.31	43.5	140.16	36.2
	s. maple	210	84.0	3.95	72.0	38.48	66.6
	other	–	–	–	–	–	–
	total	1,460	72.6	23.23	44.4	211.40	35.4
III – O	spruce	150	53.6	1.23	11.6	7.33	5.3
	fir	400	88.9	4.52	55.2	35.88	40.5
	beech	460	50.0	6.12	18.8	57.39	13.4
	s. maple	140	56.0	1.71	22.9	14.61	16.5
	other	–	–	–	–	–	–
	total	1,150	60.5	13.58	23.0	115.21	15.5

For explanation see Table 6

742.11 m^3/ha. An expression of total production over 30 years within the framework of tree species brought about the following order: beech, fir, spruce, sycamore maple – according to *N*, but according to V_{7b} it was: beech, spruce, fir and sycamore maple – apart from II – H plot.

On the whole, more favourable results were determined on all tended plots in comparison with control ones. Total current annual increment according to the tree species was highest for beech and spruce and lowest for fir and sycamore maple. A comparison of total volume production showed lower values in comparison with Hrable PRP because of its age higher by 24 years. On the other hand, a comparison of total current annual increment with Korytnica PRP showed somewhat higher values on this plot for beech and spruce but lower values for fir and whole stand.

SILVICULTURAL ANALYSIS OF THINNINGS

Tables 9 and 10 present a silvicultural analysis of free crown thinning at the first and the last treatment. The results show that by the first thinning the most intensive treatment was carried out at a crown level of the stand (52–73% according to *G*), followed by treatment at a suppressed tree level (19.1–31.7%), negative stem selection (1.8–25.9%) and finally sanitary selection (3.0–3.6%). These values unambiguously confirmed that until the establishment of research plot the stand was neglected from

Table 8. Total production of the stand for 30 years

Plot	Tree species	Number of trees (pcs./ha)	Total production			
			Basal area		Volume of timber to the top of 7 cm o.b.	
			(m^2/ha)	Index of total stand	(m^3/ha)	Index of total stand
I – H	spruce	313	15.62	1.624	195.91	2.072
	fir	563	11.14	1.092	105.47	1.196
	beech	1,912	24.94	1.986	236.81	3.390
	s. maple	287	2.92	2.116	27.24	4.223
	other	37	0.50	2.500	4.17	5.487
	total	3,112	55.12	1.623	569.60	2.192
I – O	spruce	275	14.95	1.580	205.53	2.120
	fir	550	12.90	1.311	143.06	1.654
	beech	3,025	30.32	1.690	330.16	3.282
	s. maple	250	2.69	2.085	25.07	4.242
	other	50	0.46	1.278	3.32	1.425
	total	4,150	61.32	1.577	707.14	2.419
II – H	spruce	116	3.55	1.732	44.40	2.229
	fir	675	12.56	1.176	136.43	1.447
	beech	2,759	36.66	1.800	361.54	2.923
	s. maple	608	5.46	1.779	46.19	3.151
	other	33	1.10	2.200	13.19	5.811
	total	4,191	59.33	1.618	601.75	2.362
III – H	spruce	230	8.84	1.581	108.84	2.022
	fir	390	5.14	1.224	43.87	1.449
	beech	1,140	32.86	1.608	386.90	2.350
	s. maple	250	5.48	1.702	57.77	2.479
	other	–	–	–	–	–
	total	2,010	52.32	1.565	597.38	2.196
III – O	spruce	280	10.65	1.704	138.80	2.402
	fir	450	8.19	1.252	88.50	1.617
	beech	920	32.63	1.530	426.40	2.387
	s. maple	250	7.46	1.789	88.41	2.709
	other	–	–	–	–	–
	total	1,900	58.93	1.539	742.11	2.292

a silvicultural point of view. Similarly, it was also found on Hrable PRP (ŠTEFANČÍK I., ŠTEFANČÍK L. 2001) that the crown level of the stand was most intensively tended by the first thinning (54.8%). The thinning intensity on the mentioned plot was 28.6%, which was almost twice higher in comparison with other treatments performed on this plot as well as on other PRP in mixed spruce, fir and beech stands (ŠTEFANČÍK L. 1981). It was caused by the fact that on Hrable PRP the first treatment was carried out at the age of 80 years while on Korytnica PRP at the age of 50 years. Corresponding thinning intensity of the first treatment was 12.7–15.8% – according to *G* and 11.0–15.0% – according to V_{7b}, which is in accordance with the statement of MOLOTKOV (1966). He recommended the thinning intensity of the first treatment performed in mixed spruce, fir and beech stands to be 15–30% of growing stock and the following ones with intensity 10–20%. On Korytnica PRP the thinning intensity of the following treatments ranged from 2.7–14.5% of basal area and from 2.2–14.7% of growing stock.

The intensity of the 7th thinning (Table 10) was from 0.2% to 3.5%, especially due to another decrease (break of stems). These values are the same as those found on Hrable PRP, where the intensity of the 7th thinning amounted to 3.5%.

A comparison of thinning intensity (according to the basal area) during the 30-year period of investigation (Fig. 2) showed that every second treatment was more intensive (approximately twice) opposite to the previous ones. According to the analysis of the first two treatments

Table 9. Silvicultural analysis of the free crown thinning (felling of living trees) on treated plots H by the first thinning in 1968

Plot	Measured parameter	Tree species	Selection positive at crown level (%)	positive at suppressed level (%)	stem (%)	negative sanitary (%)	maturity (%)	Other* decrease (%)	Thinning treatment intensity (%)
I – H	*N*	spruce	50.7	–	49.3	–	–	–	24.0
		fir	16.0	66.7	–	17.3	–	–	13.3
		beech	29.4	64.7	5.9	–	–	–	22.2
		s. maple	32.4	32.4	35.2	–	–	–	12.9
		total	30.6	55.1	12.2	2.1	–	–	19.7
	G	spruce	68.3	–	31.7	–	–	–	13.5
		fir	20.8	63.4	–	15.8	–	–	10.0
		beech	59.8	38.3	1.9	–	–	–	15.8
		s. maple	76.6	11.7	11.7	–	–	–	15.5
		total	54.2	31.7	10.5	3.6	–	–	13.3
	V_{7b}	spruce	74.7	–	25.3	–	–	–	11.8
		fir	23.5	61.0	–	15.5	–	–	8.4
		beech	88.7	11.3	–	–	–	–	12.5
		s. maple	100	–	–	–	–	–	18.8
		total	66.8	19.3	9.9	4.0	–	–	11.0
II – H	*N*	spruce	100	–	–	–	–	–	6.9
		fir	19.0	81.0	–	–	–	–	6.2
		beech	31.9	59.7	8.4	–	–	–	14.2
		s. maple	26.4	73.6	–	–	–	–	20.6
		total	30.7	63.5	5.8	–	–	–	13.5
	G	spruce	100	–	–	–	–	–	14.2
		fir	87.8	12.2	–	–	–	–	6.4
		beech	67.2	30.0	2.8	–	–	–	14.6
		s. maple	72.1	27.9	–	–	–	–	23.3
		total	73.0	25.2	1.8	–	–	–	12.7
	V_{7b}	spruce	100	–	–	–	–	–	14.6
		fir	99.2	0.8	–	–	–	–	6.7
		beech	84.5	14.7	0.8	–	–	–	14.6
		s. maple	95.2	4.8	–	–	–	–	28.3
		total	90.3	9.3	0.4	–	–	–	12.4
III – H	*N*	spruce	50.0	33.3	16.7	–	–	–	26.1
		fir	14.3	28.5	28.6	28.6	–	–	17.9
		beech	19.0	28.6	52.4	–	–	–	18.4
		s. maple	50.0	50.0	–	–	–	–	8.0
		total	25.0	30.6	38.9	5.5	–	–	17.9
	G	spruce	83.4	12.7	3.9	–	–	–	18.2
		fir	41.0	21.3	11.5	26.2	–	–	14.5
		beech	45.1	17.1	37.8	–	–	–	16.3
		s. maple	45.5	54.5	–	–	–	–	10.2
		total	52.0	19.1	25.9	3.0	–	–	15.8
	V_{7b}	spruce	93.3	5.9	0.8	–	–	–	15.7
		fir	59.5	14.6	3.4	22.5	–	–	12.5
		beech	52.2	13.5	34.3	–	–	–	15.8
		s. maple	45.7	54.3	–	–	–	–	11.1
		total	60.9	14.6	22.4	2.1	–	–	15.0

Explanatory notes: *N* – number of trees per 1 ha, *G* – basal area, V_{7b} – volume of timber to the top of 7 cm o.b. per 1 ha, * – stem break or windthrow

Table 10. Silvicultural analysis of the free crown thinning (felling of living trees) on treated plots H by the seventh thinning in 1998

Plot	Measured parameter	Tree species	Selection positive at crown level (%)	Selection positive at suppressed level (%)	Selection stem (%)	Selection negative sanitary (%)	Selection maturity (%)	Other* decrease (%)	Thinning treatment intensity (%)
I – H	N	spruce	–	–	–	–	–	–	–
		fir	–	–	–	–	–	–	–
		beech	–	–	100	–	–	–	2.5
		s. maple	–	–	–	–	–	–	–
		total	–	–	100	–	–	–	1.5
	G	spruce	–	–	–	–	–	–	–
		fir	–	–	–	–	–	–	–
		beech	–	–	100	–	–	–	0.5
		s. maple	–	–	–	–	–	–	–
		total	–	–	100	–	–	–	0.2
	V_{7b}	spruce	–	–	–	–	–	–	–
		fir	–	–	–	–	–	–	–
		beech	–	–	100	–	–	–	0.1
		s. maple	–	–	–	–	–	–	–
		total	–	–	100	–	–	–	0.1
II – H	N	spruce	–	–	–	–	–	–	–
		fir	–	–	–	–	–	–	–
		beech	25.0	–	–	25.0	–	50.0	4.1
		s. maple	–	–	–	–	–	–	–
		total	25.0	–	–	25.0	–	50.0	3.1
	G	spruce	–	–	–	–	–	–	–
		fir	–	–	–	–	–	–	–
		beech	59.3	–	–	6.3	–	34.4	4.9
		s. maple	–	–	–	–	–	–	–
		total	59.3	–	–	6.3	–	34.4	3.3
	V_{7b}	spruce	–	–	–	–	–	–	–
		fir	–	–	–	–	–	–	–
		beech	68.1	–	–	2.6	–	29.3	5.2
		s. maple	–	–	–	–	–	–	–
		total	68.1	–	–	2.6	–	29.3	3.4
III – H	N	spruce	–	–	–	–	–	–	–
		fir	–	–	–	–	–	–	–
		beech	50.0	–	–	–	–	50.0	5.0
		s. maple	–	–	–	–	–	–	–
		total	50.0	–	–	–	–	50.0	3.3
	G	spruce	–	–	–	–	–	–	–
		fir	–	–	–	–	–	–	–
		beech	93.4	–	–	–	–	6.6	5.4
		s. maple	–	–	–	–	–	–	–
		total	93.4	–	–	–	–	6.6	3.5
	V_{7b}	spruce	–	–	–	–	–	–	–
		fir	–	–	–	–	–	–	–
		beech	97.8	–	–	–	–	2.2	5.4
		s. maple	–	–	–	–	–	–	–
		total	97.8	–	–	–	–	2.2	3.5

For explanation see Table 9

carried out on Korytnica PRP (ŠTEFANČÍK L. 1977a,b) it was stated that the second treatment with thinning interval of 5 years was urgent only for beech on plots I – H and III – H while for other tree species it was not urgent. It is clear from our long-term results that as for the thinning intensity and interval, one more intensive treatment could be done (15–25%) for a period of 7 to 10 years. These results are also in accordance with recommendations by OTT et al. (1995), who suggested that almost all pure spruce or mixed spruce stands situated in the 6th altitudinal forest zone with thinning intensity lower than 15% were intensively destroyed. On the contrary, stands with the intensity of treatment higher than 25% were damaged less significantly. The mentioned authors recommended a thinning interval of 7 to 10 years.

CONCLUSIONS

Evaluation of 30-year changes in the tree species composition, stand structure, qualitative and quantitative production of more than 80-year mixed spruce, fir and beech stand, located in the 6th altitudinal forest zone, at a fertile site brought about the following results:

– In the initial stage, the proportion of coniferous trees on tended plots H was from 29% to 58% while on control plots O it was 50% and 33%. According to the tree species the highest proportion was found for beech (37–61%), followed by fir (13–30%), spruce (6–28%) and sycamore maple (3–11%). After 30 years, a decrease in the proportion of coniferous trees was found on tended plots, the values ranged from 27% to 48% while on control plots they were 47% and 29%. Within the framework of individual tree species an increase in the spruce (by 4–11%) and also beech (by 3–11%) proportion was registered on tended plots. On the other hand, a decrease in the fir proportion by 5–22% was found. On control plots there was an increase in the spruce proportion by 5% and/or 4%, and in the proportion of beech by 2% and 3%. The greatest changes in the investigated period of 30 years were registered for fir (decrease by 8–9%) in favour of the other tree species (spruce, beech, sycamore maple).
– In the initial stage the proportion of spruce at the crown level of the stand on all plots ranged from 21% to 56%, fir 13–30%, beech 19–50% and sycamore maple 4–52%. After the 30-year period the proportion of spruce at the crown level of the stand on tended plots ranged from 33% to 89%, fir 14–36%, beech 32–47% and sycamore maple 25–50%. On two control plots the proportion of spruce at the crown level of the stand was 46% and 75%, fir 50% and 60%, beech 32% and 48%, sycamore maple 40% and 45%.
– At the time of Korytnica PRP establishment, the number of promising trees (future crop trees) ranged from 210 individuals per hectare to 363 individuals per hectare, with the share of growing stock 32–48%. After the 30-year period the number of crop trees decreased, their number ranging from 176 individuals per hectare to 226 individuals per hectare on tended plots while there were 162 individuals per hectare and 140 individuals per hectare on control plots. The proportion of crop trees in growing stock was from 53% to 74% on tended plots, and only 40% and 42% on control plots.

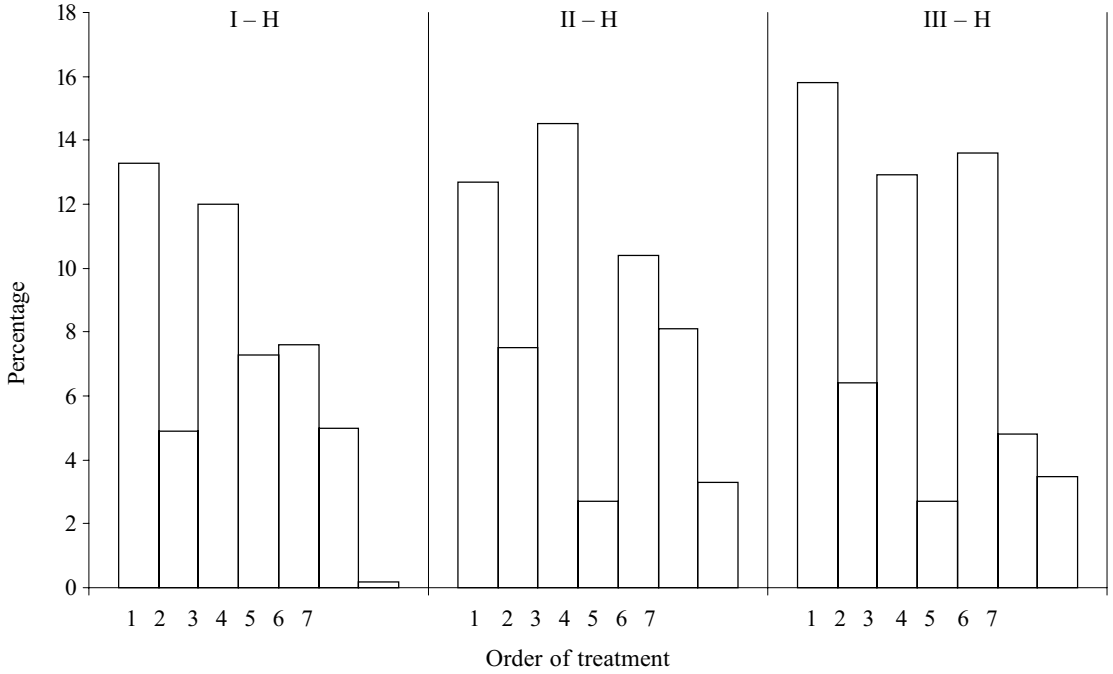

Fig. 2. Comparison of thinning intensity (according to the basal area) during the 30-year period of investigation on treated plots in PRP Korytnica I, II, III

– On tended plots H for all tree species 13.5–19.7% of *N* (number of trees), 12.7–15.8% of *G* (basal area) and 11.0–15.0% of the volume of timber to the top of 7 cm o.b. (V_{7b}) was removed totally by the first thinning. Within the framework of the tree species the removal of beech by thinnings was highest in accordance with its highest proportion on all plots.
– Reduction in the category another decrease (breaks of stems, windthrows) assumed negligible values during 30 years of investigation and ranged from 0 to 1.3%.
– The highest decrease in *N* by self-thinning was found on control plots – 67.8% and 48.9% of the total production while on tended plots it was 28.3–37.0%. According to the tree species expressed by an absolute number of trees, the following order was found: beech, fir, sycamore maple, spruce, others. According to the percentage in total production the highest decrease was unambiguously registered for fir on all plots but differences between the other tree species were low, so that their order changed from plot to plot.
– The total decrease according to *G* over 30 years on tended plots was from 44% to 49% of total production while it was 23% and 29% on control plots. Total decrease according to V_{7b} on tended plots was 35–40%, and 15% and 18% on control plots.
– Expression of total production during 30 years within the framework of tree species brought about the following order: beech, fir, spruce, sycamore maple – according to *N*, but according to V_{7b} it was: beech, spruce, fir and sycamore maple – apart from II – H plot.
– The silvicultural analysis showed that the most intensive treatment was carried out by the first thinning at the crown level of the stand (52–73% according to *G*), followed by a treatment at the suppressed tree level (19.1–31.7%), negative stem selection (1.8–25.9%) and finally sanitary selection (3.0–3.6%).
– It is clear from our long-term results that as for the thinning intensity and interval one more intensive treatment could be done (15–25%) for a period of 7 to 10 years.

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Zhodnotenie dlhodobej výchovy v zmiešanom smrekovo-jedľovo-bukovom poraste na výskumnej ploche Korytnica

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ABSTRAKT: Príspevok sa zaoberá problematikou prebierok v zmiešanom (sm-jd-bk) poraste 6. lesného vegetačného stupňa. Tri z piatich sledovaných plôch sa dlhodobo vychovávali úrovňovou voľnou prebierkou, resp. dve plochy sa ponechali bez úmyselného zásahu ako kontrolné. Vyhodnotili sa dynamické zmeny drevinového zloženia, porastovej štruktúry, kvalitatívnej a kvantitatívnej produkcie za obdobie 30 rokov. Zistené zmeny sa porovnali aj z hľadiska rozdielov medzi dlhodobo vychovávanými plochami a kontrolnými plochami (bez zásahu).

Kľúčové slová: horské lesy; prebierky; zmiešané porasty; smrek – jedľa – buk

Cieľom práce bolo zistiť a zhodnotiť zmeny v drevinovom zložení, porastovej štruktúre, v kvalitatívnej a kvantitatívnej produkcii zmiešaného smrekovo-jedľovo-bukového porastu na výskumnej ploche Korytnica za 30-ročné obdobie výchovy.

Objektom výskumu bol zmiešaný smrekovo-jedľovo-bukový porast v rastovej fáze žrďoviny až tenkej kmeňoviny na trvalej výskumnej ploche (TVP) Korytnica, ktorá sa nachádza v obvode Lesnej správy Liptovská Osada, Odštepný závod Liptovský Hrádok. TVP bola založená v roku 1967 na výskum problematiky pestovno-produkčných vzťahov v zmiešaných smrekovo-jedľovo-bukových porastoch. Sériu TVP Korytnica tvorí päť čiastkových plôch – tri s výmerou 0,08, 0,10 a 0,12 ha (označené ako H), kde sa aplikuje úrovňová voľná prebierka (ŠTEFANČÍK L. 1984), dve sú kontrolné (označené ako O) s výmerou 0,08 a 0,10 ha. Plochy sú medzi sebou i od ostatného porastu oddelené 10 m širokými pásmi stromovia, tzv. izolačným pásom. Pred založením výskumných plôch sa v sledovanom poraste len zriedkavo vykonávali prebierkové zásahy, aj to slabé, zamerané na odstraňovanie tenkých, resp. hynúcich jedincov.

Na plochách sú stromy očíslované s označením meriska hrúbky vo výške 1,3 m. Na každej ploche sa vykonávajú kompletné biometrické merania očíslovaných stromov v päťročných intervaloch v súlade so štandardnými metodikami, ktoré sú vypracované pre dlhodobý výskum pestovno-produkčných otázok prebierok (ŠTEFANČÍK L. 1977a). V rámci nich sa okrem kvantitatívnych znakov (hrúbka $d_{1,3}$, výška stromu, rozmery koruny pri horizontálnej projekcii) hodnotili stromy aj podľa pestovnej a hospodárskej klasifikácie s orientáciou na pestovanie stromov výberovej kvality, ktoré sú jej hlavným nositeľom. Od založenia TVP sa tu vykonalo sedem biometrických meraní a súčasne s meraniami sa vždy vykonal aj prebierkový zásah.

Z hľadiska fytotechniky sa na zasahovaných plochách (H) aplikovala metóda nádejných a neskôr cieľových stromov (ŠTEFANČÍK L. 1984), ktorá sa zameriava na individuálnu výchovu tzv. stromov výberovej kvality. Pred započatím výskumu bol pre TVP Korytnica vypracovaný model drevinového a produkčného cieľa (ŠTEFANČÍK L. 1977b), ktorý určil počet a drevinové zloženie cieľových stromov (tab. 2).

V príspevku sme vyhodnotili prvé meranie (v roku 1968) vykonané pri založení plochy a posledné meranie (v roku 1998), aby sme porovnali dynamické zmeny sledovaných znakov na čiastkových TVP za obdobie 30 rokov.

Vyhodnotenie 30-ročných zmien v drevinovom zložení, porastovej štruktúre, v kvalitatívnej a kvantitatívnej produkcii vyše 80-ročného zmiešaného smrekovo-jedľovo-bukového porastu, v 6. lesnom vegetačnom stupni na živnom stanovišti prinieslo nasledujúce výsledky:

– Pri východiskovom stave bol podiel ihličnanov na vychovávaných plochách (H) od 29 % do 58 %, kým na kontrolných plochách (O) 50 % a 33 %. Podľa drevín mal najvyššie zastúpenie buk (37–61 %), potom jedľa (13–30 %), smrek (6–28 %), a napokon javor horský (3–11 %). Za 30 rokov došlo k zníženiu podielu ihličnanov na vychovávaných plochách na 27–48 %, kým na kontrolných plochách na 47–29 %. V rámci jednotlivých drevín sa na zasahovaných plochách zvýšilo zastúpenie smreka (o 4–11 %) a tiež buka (o 3–11 %). Na druhej strane sa znížilo zastúpenie jedle o 5–22 %. Na kontrolných plochách sa zvýšilo zastúpenie smreka o 5 %, resp. 4 %, a tiež zastúpenie buka o 2 % a 3 %. K najväčším zmenám za sledované 30-ročné obdobie došlo u jedle (redukcia o 8–9 %) v prospech ostatných drevín (smrek, buk, javor horský).
– Pri východiskovom stave sa zastúpenie smreka v úrovni porastu na všetkých plochách pohybovalo v rozpätí 21–56 %, jedle 13–30 %, buka 19–50 % a javora horského od 4 % do 52 %. Po 30-ročnom období bol na zasahovaných plochách smrek zastúpený v úrovni od 33 % do 89 %, jedľa od 14 % do 36 %, buk od 32 % do 47 % a javor horský od 25 % do 50 %. Na dvoch kontrolných plochách bolo zastúpenie smreka v úrovni porastu 46 % a 75 %, jedle 50 % a 60 %, buka 32 % a 48 %, javora horského 40 % a 45 %.
– Pri založení TVP sa počet nádejných stromov (budúcich cieľových stromov) pohyboval od 210 stromov na ha do 363 stromov na ha, pričom na zásobe porastu sa podieľali v rozpätí 32–48%. Po 30-ročnom období sa počet cieľových stromov znížil, takže na zasahovaných plochách sa ich počet pohyboval od 176 stromov na ha do 226 stromov na ha, kým na kontrolných plochách to bolo 162 stromov na ha a 140 stromov na ha. Na zasahovaných plochách sa cieľové stromy podieľali na zásobe porastu v rozpätí od 53 % do 74 %, kým na kontrolných plochách to bolo iba 40 % a 42 %.
– Na zasahovaných plochách H sa prvou prebierkou súhrnne za všetky dreviny odstránilo z celkového počtu stromov N 13,5–19,7 %, z celkovej kruhovej základne G 12,7–15,8 % a z celkového objemu hrubiny V_{7b} 11–15 %. V rámci drevín sa zásahom odstránilo najviac buka, čo súvisí s tým, že bol aj drevinou s najväčším zastúpením na všetkých plochách.
– Zmeny počtu stromov z hľadiska iného úbytku (zlomy, vývraty) dosahovali počas 30 rokov sledovania zanedbateľné hodnoty a pohybovali sa od 0 do 1,3 %.
– Najväčší úbytok počtu stromov samoprerieďovaním sme zistili na kontrolných plochách, a to 67,8 % a 48,9 % z CP, kým na zasahovaných plochách to bolo 28,3–37,0 % z CP. Podľa drevín pri absolútnom vyjadrení z počtu stromov bolo poradie buk, jedľa, javor, smrek, ostatné, ale pri vyjadrení podľa percenta z CP bol jednoznačne najväčší úbytok zaznamenaný u jedle na všetkých plochách, rozdiely medzi ostatnými drevinami neboli veľké, pričom ich poradie sa menilo z plochy na plochu.
– Pri vyhodnotení celkového úbytku za 30 rokov sme zistili, že na zasahovaných plochách podľa G tvoril 44–49 % z celkovej produkcie (CP), kým na kontrolných plochách 23–29 %. Pri vyjadrení celkového úbytku podľa V_{7b} to činilo na zasahovaných plochách 35–40 %, resp. na kontrolných plochách 15 % a 18 %.
– Pri vyjadrení celkovej produkcie za 30 rokov podľa drevín je poradie nasledovné: buk, jedľa, smrek, javor – podľa počtu stromov, ale podľa V_{7b} je to: buk, smrek, jedľa, javor (okrem plochy II – H).
– Pestovná analýza prebierok ukázala, že pri prvom zásahu sa najviac zasahovalo v úrovni porastu (52–73 % podľa kruhovej základne), ďalej nasleduje podúrovňový zásah (19,1–31,7 %), potom negatívny tvarový výber (1,8–25,9 %) a nakoniec zdravotný výber (3,0–3,6).
– Z našich dlhodobých výsledkov vyplýva, že čo sa týka prebierkového intervalu, postačoval by jeden silnejší zásah (15–25 %) za obdobie 7–10 rokov.

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