Age and diameter classes or growth stages as criteria for the implementation of thinning

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ABSTRACT: Suitability of age and diameter classes or growth stages is evaluated with respect to the determination of a boundary between the tending part and yield (commercial) part of thinnings for the most important commercial tree species. The suitability was assessed according to the development of growth and production parameters such as mean height, mean diameter and particularly the proportion of round timber assortments in the stands that should be as low as possible. It resulted from the analysis that growth stages are most suitable and the boundary is between the small pole stage stand with mean diameter 6–12 cm and pole stage stand with mean diameter 13–19 cm.

Keywords: growth stages; thinnings; yield of thinnings

All tending treatments have a primary role to regulate increment and the growth of forest stands with the aim of obtaining their lifetime stability and production. Particularly thinnings play a very important role in the lifetime development of the forest. They influence its tree species composition, height and diameter structure, and in this connection also the growth and stability of individual trees and stand. Moreover, they also have a direct economic role regarding wood production expressed not only by the volume but also by the quality of wood from thinnings. Thus thinnings incorporate tending and felling in one management measure being performed in the stand. The ratio of these two important components alters during the stand development. In the beginning, thinnings play a role of tending measures contributing to the general formation of the stand but later their economic or commercial role, regarding wood production, becomes more important.

Despite this knowledge a provision laying down the compulsory intensity of thinnings in forest management plans was introduced into the Forest Act of the Slovak Republic in 1993. According to this provision the intensity of thinning is prescribed as minimal in a forest management plan for the stand below 50 years of age and as maximal in the stand older than 50 years. Such a legal provision had to force a forest manager to carry out thinnings of minimal intensity in the stand within 50 years of age as prescribed by the forest management plan. At the same time it had to impose some restrictions for the forest manager on heavy commercial thinnings in older stands as they could lead to a higher reduction of growing stock in older stands than it is prescribed by the forest management plan. A similar legal provision was also adopted by Forest Act in the Czech Republic in 1995. But more detailed and objective justification of this measure, particularly determination of one age limit, namely 50 years for all stands regardless tree species composition, has been missing in both countries. It is interesting that this provision was accepted without any significant criticism by all professional circles not only in forest management but also in forest practice.

In a more detailed assessment of age characteristics or age classes with the aim to determine or assess the importance of thinnings it is necessary to come out from their basic attributes. Though age of stands is the basic factor of their growth, it is not the only one and therefore also other factors, such as site quality, being indirectly expressed by the **site class** of the stand, should be taken into account. Thus minimally on the basis of age and site class of the stand it is possible to identify the growth of trees and stands very easily. The growth of trees and stands can be monitored as well as assessed by means of other parameters, such as height and diameter of tree, or timber volume, it means by quantitative parameters. For the planning of management measures, monitoring and assessment of the forest condition in addition to quantitative growth parameters qualitative parameters are also very important. They characterize for example the quality of timber production, stand development or the changes in the stand. As it is impossible to strictly separate the growth and development of the stand from each other, various characteristics were introduced into forestry. They describe the state of stands through incorporating the growth and development parameters. This issue was studied in great detail in Slovakia by GREGUŠ (1968), who proposed 9 growth stages. They have been introduced into forest management after slight modifications. To determine the first two growth stages of the stand, namely young plantation and advance growth, mean heights with respective limit values to 0.5 and to 1.0 m were used. Mean diameters of the stand with the following values were used for higher stages:

- Thicket below 6 cm
- Small pole stage stand 6–12 cm
- Pole stage stand 13–19 cm
- High forest of small diameter 20–27 cm
- High forest of medium diameter 25–35 cm
- High forest of large diameter 36–43 cm
- High forest of very large diameter above 43 cm.

Moreover, each growth stage is characterized by its own developmental stage and main management measure that should be most suitable for a particular stage.

The aim of this work is to evaluate the suitability of age, diameter classes and growth stages for the determination of the boundary between the tending component and yield (commercial) of component of thinnings for the most important commercial tree species and to set the required boundary according to the results.

MATERIAL AND METHODS

The boundary between the tending and yield component of thinnings was sought by means of growth and production parameters of the stand such as mean height, mean diameter and growing stock, but especially according to the proportion of commercially most important assortments of raw timber. These are mainly the most valuable assortments intended for the production of veneers and saw logs, also called roundwood. According to the national standard for the sorting of raw timber we distinguish logs of quality classes I–III, which are also important for the yield component of thinnings.

To solve the problem models of yield tables for spruce, fir, pine, oak, beech (HALAJ et al. 1987) and for larch (PETRÁŠ, HALAJ 1993) and models of assortment yield tables (PETRÁŠ et al. 1996) were used. From the yield tables models of the development of mean diameter of the main stand and secondary crop (d) and growing stock (V) in dependence on their age (t) and yield class (q) were selected according to the formulas:

$$d = f(t,q) \quad (1)$$

$$V = f(t,q) \quad (2)$$

From the assortment yield tables models of the development of percentage of logs in quality classes I–III in dependence on age (t) and yield class (q) of the stand were selected according to the formula:

$$I - III\% = f(t,q) \quad (3)$$

By introducing formula (1) into formula (3) a simplified timeless dependence of the percentage of assortments of quality classes I–III in dependence on mean diameter (d) and yield class (q) of the stand was derived according to the following formula:

$$I - III\% = f(d,q) \quad (4)$$

RESULTS AND DISCUSSION

AGE CLASSES

To evaluate the suitability of the age itself or age classes for the determination of purposeful boundary between the tending and yield component of thinnings basic stand parameters, namely growing stock, mean diameter and height, were used from the yield tables. The data were used intentionally only at the age of 50 years for minimal and maximal yield classes from the range of yield tables. Yield class is expressed by mean height of stand at the age of 100 years. As it is obvious from the data in Table 1 for all tree species, there are minimal yield classes 10–12 and maximal ones 34–42. For minimal yield classes the growing stock practically equals zero, mean height reaches the value of about 4 m except for pine, and mean diameter is 4–5 cm, except for pine which has a diameter larger by about 2 cm. Maximal yield classes have these values significantly higher. The growing stock for all tree species ranges from 344 to 614 m^3, mean height is about 23–28 m and mean diameter 22–28 cm. We can draw a conclusion from the comparison of these three basic growth parameters that the yield class of the stand, which also

Table 1. Basic growth parameters for 50 years old stands according to yield tables of tree species in the range of their minimal and maximal yield classes

Tree species	Yield class min.–max.	Growing stock (large timber inside bark) (m^3)	Mean height (m)	Mean diameter (cm)
Spruce	12–42	8–614	4.1–28.4	4.7–27.7
Fir	12–40	0–537	3.8–25.9	4.7–27.4
Pine	12–34	29–378	6.6–23.1	6.8–23.9
Oak	10–36	0–344	3.7–27.6	5.3–22.9
Beech	10–38	0–396	3.7–25.9	3.7–21.8

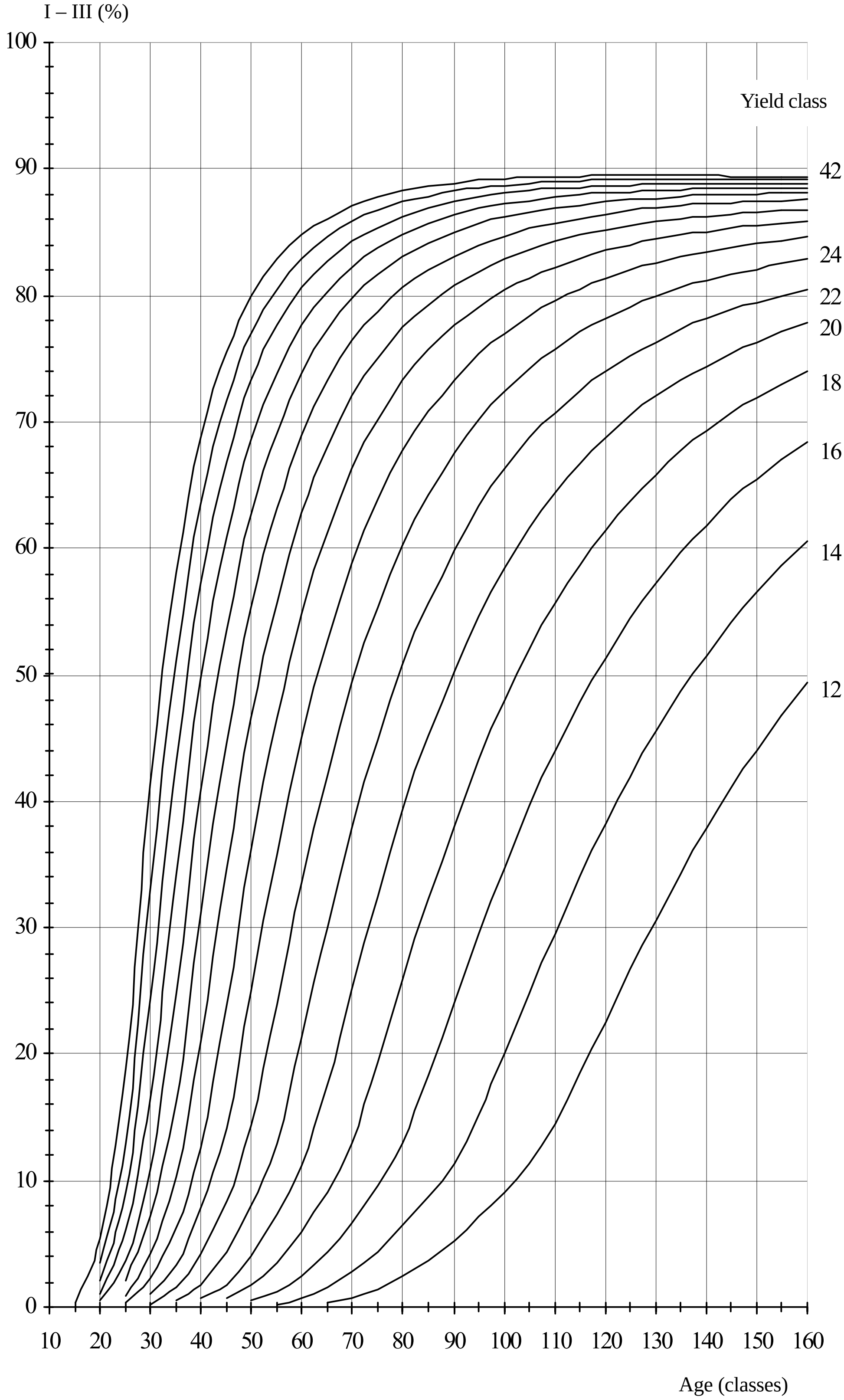

Fig. 1. Spruce – the proportion of class I–III assortments of the main stand in dependence on age and yield class of the stand

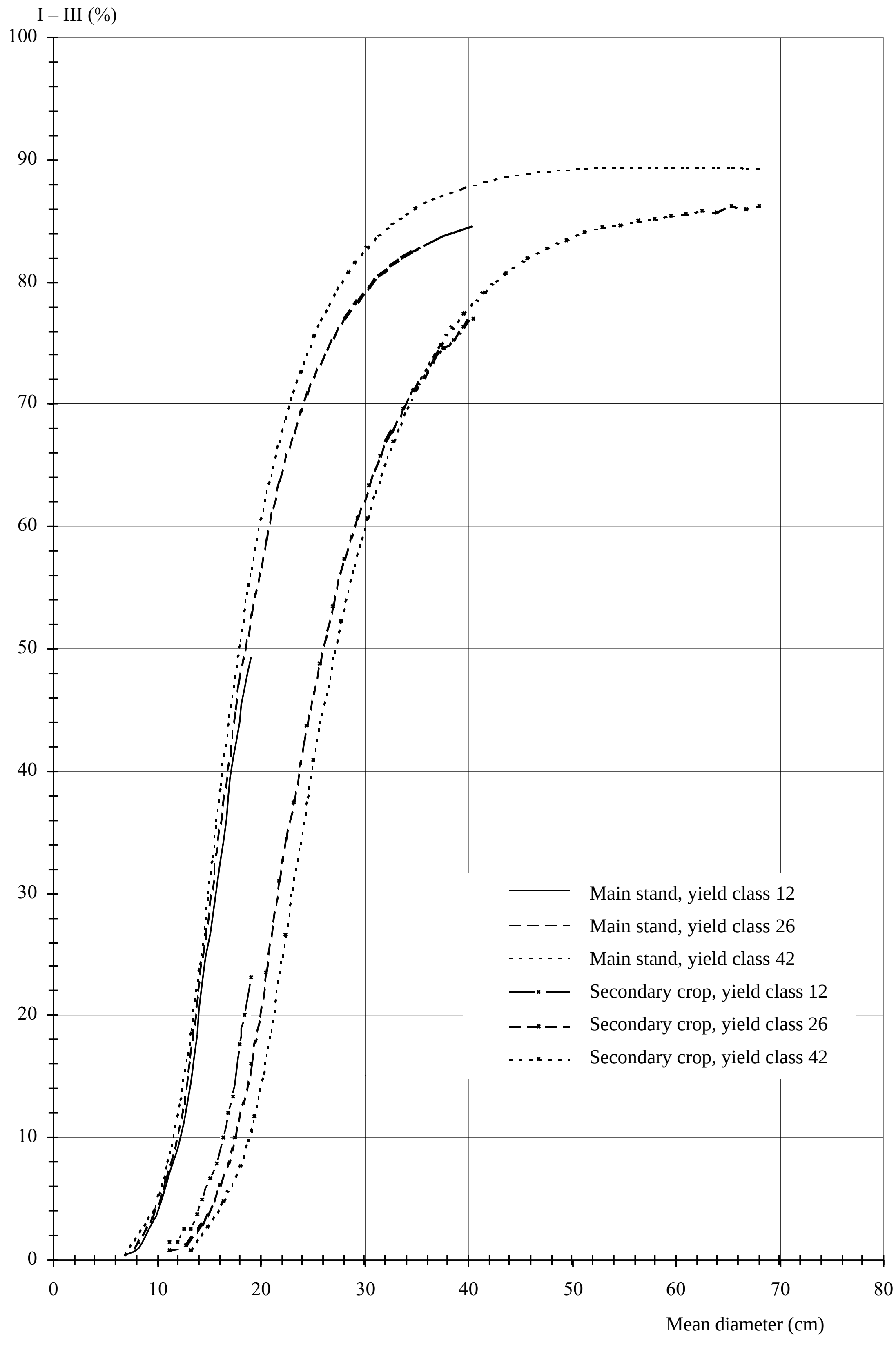

Fig. 2. Spruce – the dependence of class I–III assortments of the main stand and secondary crop on mean diameter and yield class of the stand

indirectly determines the site class, determines substantially growth rate. The stands with highest yield classes have substantially higher growing stock, mean heights and mean diameters already at the age of 50 years than the stands with lowest yield classes. Thus the yield class must not be excluded from the assessment of stand development. It is as important as age for every tree species and therefore it must be a part of all time relations not only in the assessment of stand growth and production but also of stand tending.

Fig. 1 illustrates the importance of yield class for the assessment of thinnings, for spruce showing a trend of the proportions of the assortments of class I–III in dependence on age and yield class of the stand according to formula (3). It is obvious that this proportion abruptly increases not only with higher age but also with higher yield class. At the age of 50 years only yield classes 12–16 have a zero proportion of these assortments. Yield class 18 has an about 2% proportion and highest yield class 42 almost 80%. It is obvious that the definition of the boundary between the tending and yield component of thinnings should take into account also the yield class of the stand. Determining this boundary only according to the age of stand or its direct determination for all tree species with the age higher than 50 years is extremely schematic.

DIAMETER CLASSES

Tree diameter, or in the case of stand its mean diameter, is a typical growth parameter whose development depends mainly on the age and yield class of the stand. It is generally a very good characteristic of stand maturity, structure and economic importance. It integrates the effect of stand age and yield class and if simplified, it can replace them.

Fig. 2 illustrates according to equation (4) a very strong dependence of the proportion of roundwood assortments of quality class I–III on mean diameter and yield class of spruce stands, particularly for the main stand and secondary crop. It is obvious from the development of these proportions that in the main stand and secondary crop in addition to the strong dependence on mean diameter there is also a slight dependence on the yield class of the stand. In the main stand higher yield classes have slightly higher proportions of roundwood assortments. In the secondary crop these proportions are opposite. A comparison of the proportion of roundwood assortments in the main stand and in the secondary crop shows that for the same mean diameters the secondary crop has lower proportions by about 20–40% than the main stand. The largest differences were found for mean diameter, namely about 20 cm. For the smallest and the largest diameters these differences decrease approximately to the values 5–10%. In general, the lower proportion of roundwood assortments in the secondary crop is caused by the fact that the trees with worse quality and higher damage of stems should be included in thinnings.

Fig. 3 shows the same dependence but for beech. The proportion of roundwood assortments increases with mean diameter of the stand only to 30–35 cm. With larger diameter this proportion decreases unanimously due to a higher proportion of false heart in beech stems of larger diameter. Interrelations of maximal and mean yield classes are the same as for spruce. The only exception is minimal yield classes, which have the proportion of roundwood assortments lower by about 15–20% than mean and maximal yield classes.

In comparison with spruce the beech has only little higher proportions of roundwood assortments in the main stand than in the secondary crop. It is explained by the fact the trees in the secondary crop have only slightly worse quality of stems than the trees in the main stand. Summarizing the knowledge from this analysis we can state that mean diameter of stand is a more suitable characteristic to determine the boundary between the tending and yield component of thinnings than stand age. Very slight effect of the yield class of the stand could be omitted.

GROWTH STAGES

After the previous analysis of mean diameter the analysis of growth stages as criteria to determine the boundary between the tending and yield component of thinnings is relatively simple due to the fact that growth stages are unanimously determined by particular intervals of mean diameters of the stand. Thinning as the main management measure is intended especially for the growth stage – small pole stage stand and pole stage stand.

In the case of small pole stage stand the growth stage with mean diameter 6–12 cm is accepted as a boundary; we can expect 0–10% of roundwood assortments from the main stand according to Figs. 2 and 3 for spruce and beech. For pole stage stand with mean diameter 13–19 cm it is about 15–50%. A similar survey of the proportion of roundwood assortments was also made for other tree species. With the upper range of mean diameters for small pole stage stands of 12 cm, the proportions of roundwood assortments for other tree species are as follows: oak 1%, pine 4%, fir 10%, larch almost 23%. In the case of pole stage stand with its upper limit for mean diameter of 19 cm the proportions of roundwood assortments of tree species would be like this: oak 38%, fir 50%, pine and larch 52%. After general rounding up these values we can state that this proportion for all tree species is 40–50%.

As the thinned stands with dominant tending component should have this proportion as low as possible, the boundary between the tending and yield component of thinnings should be namely the boundary between the growth stages: small pole stage stand and pole stage stand. That means in small pole stage stands thinnings with dominant tending component should be carried out. In the following growth stage, pole stage stand, direct management effect should be enhanced and tending component of thinnings should be reduced. Regarding the

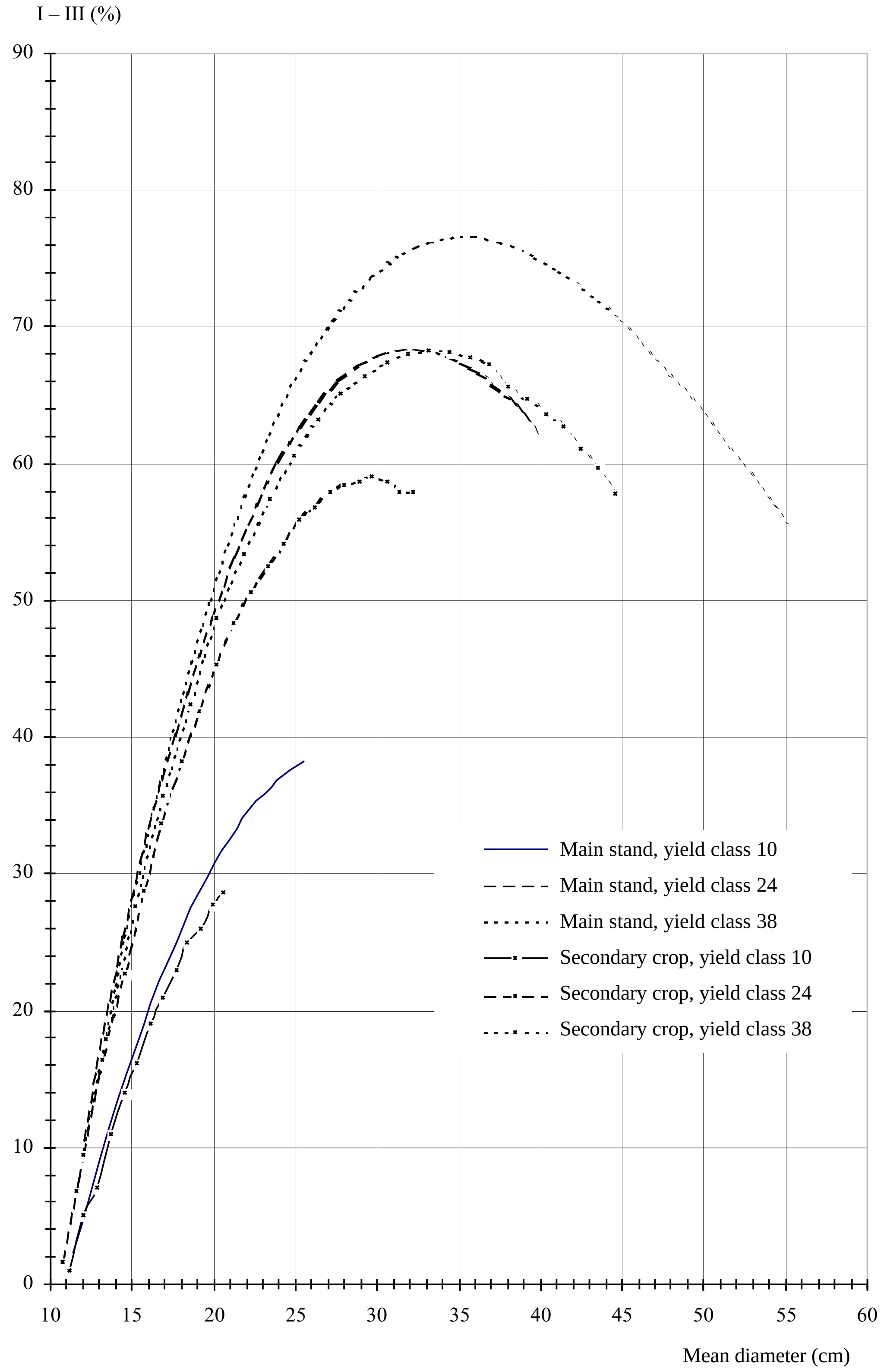

Fig. 3. Beech – the dependence of class I–III assortments of the main stand and secondary crop on mean diameter and yield class of the stand

lifetime existence of the stand, its production, stability and fulfilment of non-production functions as well the tending effect of thinnings is decisive in the growth stage – small pole stage stand. Possible regulation and modification of the intensity and quality of thinnings should be aimed particularly at this growth stage.

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Vekové, hrúbkové alebo rastové stupne ako kritérium na realizáciu prebierok

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ABSTRAKT: Práca hodnotí vhodnosť vekových, hrúbkových a rastových stupňov na určenie hranice medzi výchovnou a výnosovou (komerčnou) časťou prebierok hospodársky najvýznamnejších drevín. Ich vhodnosť sa posudzovala podľa vývoja rastových a produkčných veličín, ako sú stredná výška, hrúbka a najmä podiel guľatinových sortimentov v porastoch, ktorý mal byť čo najnižší. Z analýzy sa ukázalo, že najvhodnejšie sú rastové stupne a hľadaná hranica sa nachádza medzi rastovým stupňom žrďkoviny so strednou hrúbkou porastu 6–12 cm a žrďoviny s hrúbkou 13–19 cm.

Kľúčové slová: rastové stupne; prebierky; výnos prebierok

V práci sa hodnotí vhodnosť vekových, hrúbkových a rastových stupňov na určenie hranice medzi výchovnou a výnosovou (komerčnou) časťou prebierok hospodársky najvýznamnejších drevín. Hranica sa hľadala pomocou rastových a produkčných ukazovateľov porastov, ako sú stredná výška, hrúbka a zásoba dreva, ale najmä podľa podielu hospodársky najvýznamnejších sortimentov surového dreva. Sú to predovšetkým najcennejšie sortimenty triedy I a II, určené na výrobu dýh, a piliarske výrezy triedy III. Všetky triedy I–III sú spolu označované aj ako guľatinové výrezy a sú predmetom hlavného záujmu aj výnosových prebierok.

Podkladom na odvodenie výsledkov sa stali modely rastových tabuliek pre smrek, jedľu, borovicu, dub, buk (HALAJ et al. 1987) a pre smrekovec (PETRÁŠ, HALAJ 1993) a modely sortimentačných rastových tabuliek (PETRÁŠ et al. 1996). Z rastových tabuliek sa vybrali modely vývoja strednej hrúbky hlavného a podružného porastu (d) a zásoby dreva (V) v závislosti od ich veku (t) a bonity (q) podľa vzťahov (1) a (2). Zo sortimentačných rastových tabuliek sa vybrali modely vývoja percentuálneho podielu akostných tried výrezov I–III tiež v závislosti od veku (t) a bonity (q) porastu podľa vzťahu (3). Dosadením vzťahu (1) do vzťahu (3) sa odvodila zjednodušená bezčasová závislosť percentuálneho podielu sortimentov triedy I–III v závislosti od strednej hrúbky (d) a bonity (q) porastu podľa vzťahu (4).

Pre posúdenie vhodnosti len samotného veku alebo vekových stupňov na určenie účelnej hranice medzi výchovnou a výnosovou časťou prebierok sa vybrali z rastových tabuliek základné porastové veličiny, a to zásoba dreva, stredná hrúbka a výška. Údaje sa vybrali zámerne len vo veku 50 rokov pre minimálne a maximálne bonitné stupne z rozsahu ich rastových tabuliek. Ako je vidieť z údajov v tab. 1, je pri minimálnych bonitách 10–12 zásoba dreva prakticky nulová, stredná výška dosahuje až na borovicu hodnoty približne 4 m a stredná hrúbka 4–5 cm s výnimkou borovice, ktorá má približne o 2 cm väčšiu hrúbku. Maximálne bonitné stupne 34–42 majú však tieto hodnoty už podstatne väčšie. Zásoba porastu všetkých drevín je v rozsahu 344–614 m^3, stredná výška približne 23–28 m a stredná hrúbka 22–28 cm.

Z porovnania týchto troch základných rastových veličín môžeme konštatovať, že aj bonita porastu veľmi významne určuje rýchlosť rastu. Pre každú drevinu je minimálne tak významná ako vek, a preto musí byť súčasťou všetkých časových závislostí nielen pri hodnotení rastu a produkcie porastov, ale aj ich výchovy. Na obr. 1 je pre smrek znázornený aj vývoj podielu sortimentov triedy I–III v závislosti od veku a bonity porastu. Z obr. je vidieť, že tento podiel veľmi prudko stúpa, a to nielen s vyšším vekom, ale aj bonitou. Vo veku 50 rokov majú nulový podiel týchto sortimentov len bonity 12–16. Bonita 18 má už približne 2% podiel a najvyššia bonita 42–80% podiel. Teda aj tu sa ukázalo, že pri hľadaní hranice medzi výchovnou a výnosovou časťou prebierok je nutné okrem veku zvažovať aj bonitu porastu. Určenie tejto hranice len podľa veku porastu, prípadne jeho priame stanovenie na 50 rokov pre všetky dreviny je až extrémne schematické.

Hrúbka stromu je všeobecne veľmi dobrou charakteristikou vyspelosti, štruktúry a hospodárskeho významu porastu. Integruje v sebe vplyv veku a bonity porastu a pri určitom zjednodušení môže ich aj nahradiť. Na obr. 2 je podľa vzťahu (4) dokumentovaná veľmi silná závislosť podielu guľatinových sortimentov akostných tried I–III od strednej hrúbky a bonity smrekových porastov, konkrétne pre hlavný a podružný porast. Z vývoja týchto podielov je zrejmé, že v hlavnom a podružnom poraste je okrem silnej závislosti od strednej hrúbky aj nepatrná závislosť od bonity porastu.

Na obr. 3 je znázornená rovnaká závislosť, ale pre drevinu buk. Je vidieť, že podiel guľatinových sortimentov sa so strednou hrúbkou porastu zvyšuje približne len do 30–35 cm. S vyššou hrúbkou porastu sa tento podiel len znižuje a jeho príčinou je jednoznačne len vyšší podiel nepravého jadra v bukových kmeňoch väčších hrúbok. Buk má v porovnaní so smrekom len o málo vyššie podiely guľatinových sortimentov v hlavnom ako podružnom poraste. Vysvetľuje sa to najmä tým, že stromy podružného porastu majú len o málo horšiu kvalitu kmeňov ako stromy hlavného porastu. Po zhrnutí poznatkov z tohto rozboru môžeme konštatovať, že stredná hrúbka porastu je vhodnejšou charakteristikou na určenie hranice medzi výchovnou a výnosovou časťou prebierok, ako je vek porastu. Nepatrný vplyv bonity porastu by sa v tomto prípade mohol vynechať.

Analýza rastových stupňov je po predchádzajúcom rozbore strednej hrúbky pomerne jednoduchá, a je to preto, že rastové stupne sú jednoznačne určené konkrétnym intervalom stredných hrúbok porastu. Prebierky ako hlavné hospodárske opatrenia sú určené najmä pre rastový stupeň žŕďkoviny a žrďoviny. V prípade, že by sa akceptovala žŕďkovina ako hraničný rastový stupeň so strednou hrúbkou 6–12 cm, môžeme z hlavného porastu podľa obr. 2 a 3 očakávať pri smreku a buku 0–10 % guľatinových výrezov. Pre ďalší stupeň, a to žrďoviny so strednou hrúbkou 13–19 cm, je to už približne 15–50 %.

Podobný prieskum o podiele guľatinových sortimentov sa urobil aj pre ostatné dreviny. Pri hornom rozpätí stredných hrúbok žŕďkovin – teda 12 cm – majú ostatné dreviny približne tieto podiely guľatinových sortimentov: dub 1 %, borovica 4 %, jedľa 10 % a smrekovec až 23 %. V prípade, že by sa prešlo aj do ďalšieho rastového stupňa, a to žrďoviny s jej hornou hraničnou strednou hrúbkou 19 cm, mali by podiely guľatinových výrezov týchto drevín po väčšom zaokrúhlení už podiel 40–50 %. Keďže prebierkové porasty s hlavným výchovným zameraním by mali mať čo najnižší podiel týchto výrezov, hranicou medzi výchovnou a výnosovou časťou prebierok by mala byť potom hranica medzi rastovým stupňom žŕďkovina a žrďovina. Teda v žŕďkovinách by sa mali realizovať prebierky s vysokým výchovným účinkom a efektom. V ďalšom rastovom stupni – v žrďovinách – by sa už zvyšoval len priamy hospodársky a znižoval výchovný význam prebierok. Z hľadiska celoživotnej existencie porastu, jeho produkcie, stability a plnenia aj neprodukčných funkcií je však rozhodujúci výchovný efekt prebierok v rastovom stupni žŕďkoviny. Na tento rastový stupeň by sa mala zamerať aj prípadná regulácia a kontrola sily a kvality prebierok.

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