Growth of wild cherry (*Prunus avium* L.) in a mixture with other species in a demonstration forest

R. Stojecová, I. Kupka

Faculty of Forestry and Wood Sciences, Czech University of Life Sciences in Prague, Prague, Czech Republic

ABSTRACT: Wild cherry is one of the noble hardwood species that increase the biodiversity of our forests and at the same time it could increase the income for forest owners. The preconditions for achieving these goals are the high quality of stem and appropriate silvicultural management. This means that wild cherry should occupy the main crown layer in the stand. The height/frequency diagram depicts two groups of wild cherry trees in the stand belonging to dominant/codominant and suppressed tree classes. Height periodic increment (measured between the years 2001 and 2007) is significantly ($p < 0.01$) different in these two groups confirming that there is no transition chance for the trees from the suppressed group to become a part of the main crown layer and play the role of future crop tree. The same is true of the diameter/frequency diagram which also has a two-peak shape remaining also at the end of the surveyed period. Our result suggests that silvicultural care should be focused only on trees belonging to future crop trees.

Keywords: wild cherry; silviculture; stand forming species; stand crown layer; tree classes

Actual silvicultural and management regimes should ensure the sustainability of forest ecosystems in terms of production, their diversity and other goals expected by modern society. Species which fulfil these goals are in focus of modern silviculture. One of these species is wild cherry (*Prunus avium* L.) and that is why it is also a subject of research.

The wild cherry has its optimum in the first to the fourth (fifth) forest vegetation zone (Čížková, Bendíková 1999; Škvareninová, Škvarenina 2005) in a rich and floodplain forest. It shows the best growth performance on fresh, nutritious, loamy and calcareous soils (Škvareninová 1997). However, even at calcareous-poor, moderately acidic and drier sites wild cherry still has good growth performance (Vávra 1965; Fleder 1982; Spiecker 1994). Generally wild cherry develops a heart-shaped root system and far reaching lateral roots in top soil horizons. In easily rootable soils the root system reaches down to depths of about 3 m (Erlbeck et al. 1998). However, under unfavourable conditions such as shallow soils the root system is concentrated on upper soil layers. Under natural conditions wild cherry occurs at sites where the competition strength of European beech decreases as a consequence of less favourable water supply. Hence the natural niche of wild cherry at dry sites is not a result of optimal growing conditions; it is a result of competition (Erlbeck et al. 1998).

The wild cherry reaches maturity quite early at the age of 20 to 25 years. Its growth is fast till 40 years and expected senescence is about 80 to 90 years with breast height diameter of 50 cm and more and height of 20 to 30 m.

Most authors recommend for wild cherry to be grown in a mixture with other species or as an associated species only (Čížková, Bendíková 1999). Several authors have reported its superior height growth over *Fagus sylvatica* (Beck 1977; Wilhelm, Raffel 1993; Obal, Bartsch 2000), *Sorbus torminalis* (Schüte, Beck 1996) or other broadleaves such as *Quercus robur, Quercus petraea, Tilia* sp. and *Carpinus betulus* (Paris 2007).

The growth rate of wild cherry is similar to other fast growing broadleaves such as *Acer pseudoplatanus*, *Acer platanoides*, *Fraxinus excelsior* (Lüdemann 1988; Reif et al. 1999; Paris 2007). However, despite of its fast initial height growth the wild cherry appears to be a weak competitor towards other tree species and might rapidly be suppressed as soon as it is overtopped by its neighbours (Reif et al. 1999; Gavaland et al. 2002; Paris 2007). It seems that the wild cherry breeding program could influence the growth and vitality very efficiently (Kobliha 2002; Hajnala et al. 2007).

The wild cherry as a light-demanding species reacts to competition sensitively. Lateral crown shading causes a dieback of branches. Thus the competition of neighbouring trees must be regulated. This ensures high diameter growth and quality development. Since shade-tolerant tree species are highly competitive with wild cherry, mixtures with such species should be observed with special care.

On the other hand, a mixture with species of similar growth patterns is strongly recommended. Prudič (1996) recommended for a mixture the following species: sycamore, ash, lime, alder, elm and oak and as conifers larch, spruce, fir and Douglas fir. Especially mixtures with other valuable broadleaved species such as common ash (*Fraxinus excelsior*) or sycamore maple (*Acer pseudoplatanus*) are particularly suitable (Spiecker 1994). These species show comparable growth dynamics in the first 25 years.

Spiecker (1994) did not recommend pure wild cherry stands due to forest health reasons. To reduce the competition the planting of trees in small groups of single species is recommended. The minimum size of these groups is defined by the expected crown diameter at the end of production period. Silvicultural interventions are minimized in this manner. Possible admixtures are also rows along stand borders, forest roads or small pure patches in gaps.

A single tree mixture with or under European larch might be another option (Spiecker 1994). Both tree species fit together with their demand on light and their height growth dynamics. Larch will become older and thus can be managed as hold-on trees (Spiecker 1994). The mixture with oak is a further option. In oak stands open space between dominant trees or gaps resulting from removing trees of minor quality can often be filled by the fast growing wild cherry (Spiecker 1994).

There is not much knowledge of silviculture of wild cherry as a stand-forming species as the species is now rather rare (Spiecker 1994; Erlbeck et al. 1998).

The purpose of the contribution is to evaluate the stand-forming capacity of wild cherry as well as its capacity to keep its position in a stand.

MATERIAL AND METHODS

A large stand with wild cherry trees as a stand-forming species in the area of Demonstration Forests in Kostelec nad Černými lesy in the mixture with other species was found. The stand 39A5 is located at 49°57'28''N latitude and 14°49'20''E longitude. The total number of 16 circular sample plots was chosen, systematically placed in the stand, each of them 100 m^2. The tree inventory and all necessary measurements were done in 2001 and 2007. The measurements and calculation include breast-height diameter (to the nearest 5 mm), tree height (to the nearest 0.5 m), size of the crown (vertically and horizontally) and tree class evaluation (according to Konšel's classification).

The stand is at an altitude of about 350 m above sea level; its age is 59 years now. The stand grows at a rich site (labelled 3B3 in the Czech typological system) on a slight slope of south-west exposition.

Slenderness quotient was calculated as the ratio of total height to breast height diameter for each tree.

Table 1. The average stem data for species on sample plots

| Species	dbh 2001 (cm)	Height 2001 (m)	BA 2001 (cm^2)	Share of species 2001 (%)	dbh 2007 (cm)	Height 2007 (m)	BA 2007 (cm^2)	Share of species 2007 (%)
Wild cherry	24.5	21.2	505.2	15.7	25.8	22.4	564.0	14.4
Lime	18.6	18.6	301.4	9.3	21.0	20.4	387.9	9.9
Larch	24.0	24.9	473.8	14.7	27.1	27.8	605.5	15.5
Aspen	31.5	22.8	827.9	25.7	35.7	24.6	1,077.4	27.6
Pine	27.6	25.2	598.2	18.5	30.2	25.7	719.0	18.4
Spruce	20.8	20.1	356.0	11.0	21.9	22.4	395.7	10.1
Alder	14.4	17.0	162.8	5.0	14.3	14.2	159.4	4.1
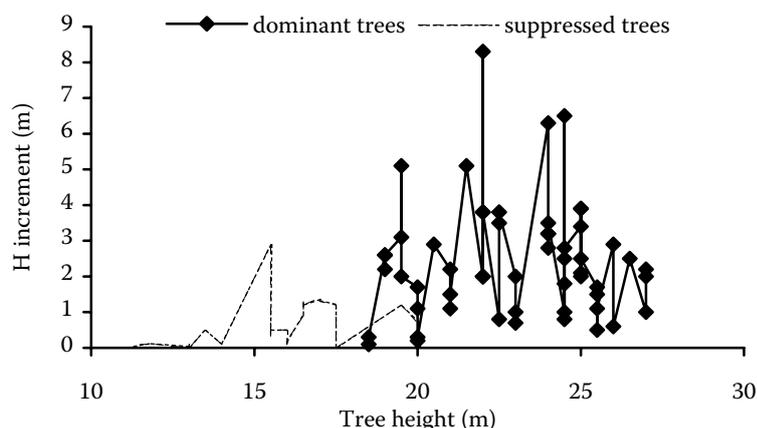
Fig. 1. Periodic height increment for dominant (including codominant) and suppressed trees of wild cherry

Crown size and its diameter as an average of diameters of north-south and east-west directions were also measured to the nearest 0.1 m.

The stand is under a normal silvicultural regime, i.e. after the last thinning carried out in the ninetieth. After that there have been only sanitary cuttings.

RESULTS AND DISCUSSION

The share of wild cherry on sample plots varies from 10 to 58%. The other species on the plots are aspen, pine, larch, spruce, lime and alder (in accordance with their share of BA). Basic data on the stand species composition and mean stem are given in Table 1.

Average stand height is about 21 m, which is reached by stand-forming species, i.e. aspen (26%), pine (18%), larch (15%) and wild cherry (15%). The other species are admixtures with small proportions in stand basal area.

The paper is focused on detailed analysis of wild cherry trees, their growth dynamics and capability to keep their position as a stand-forming species. As a light-demanding species wild cherry crop trees need not be overtopped by the other species. The height periodic increment for the surveyed period (2001–2007) is 1.9 m. There are significant differences in height increment between dominant and co-dominant trees (2.4 m) while the height periodic increment of suppressed trees is only 0.7 m (highly significant differences, $p < 0.01$). It means that differences between these two crown layers (tree classes) are not only maintained but also they become more pronounced in the surveyed period. The situation is illustrated in Fig. 1.

One can see that with one exception (where the periodic increment of suppressed tree reaches nearly 3 m) the periodic increment of suppressed trees is significantly lower than the average periodic increment of dominant and codominant trees. This is true of trees with the same dbh (about 20 cm). The data confirm that once the light-demanding species lost their position in the main crown layer, they never get back (SPIECKER 1994). It also means that suppressed trees could only play the role of "help and clean position" in the stand and they cannot be considered as future crop trees from a silvicultural point of view.

The height development of the stand is illustrated in Fig. 2, where a shift (height increment) is clearly visible in the height/frequency diagram.

Both height/frequency curves have two peaks revealing that two crown layers are conserved in the vertical structure of the stand. The diagram shows that development of stands conserves their structure
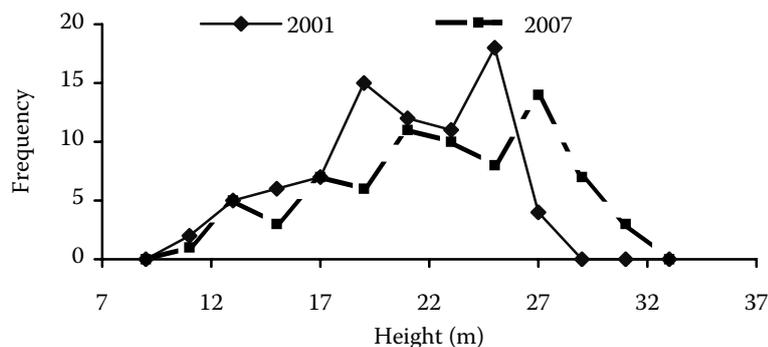

Fig. 2. Height/frequency diagram of the wild cherry stand (starting age 53 years) in the time period of 6 years
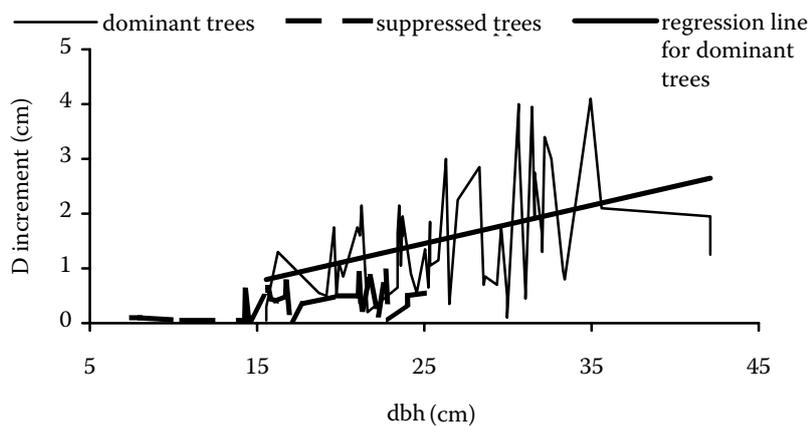
Fig. 3. Diameter increment of dominant and codominant trees and suppressed trees (Konšel tree classes lower than 2)

and confirms that there is no *"transition"* between the future crop tree and suppressed tree layer.

A similar situation can be observed in diameter analysis. The trees that do not belong to dominant/ codominant trees have statistically significantly lower ($p < 0.01$) dbh increments. The situation is illustrated in Fig. 3.

Periodic dbh increment (for the years 2001–2007) as an average for all measured trees was 1.2 cm, i.e. annual increment was 2 mm, which is slightly behind the expectation (SPIECKER 1994), but again the figure is an average for all wild cherry trees. While dominant and codominant trees have the periodic increment of 1.6 cm for the same time period, the suppressed trees have only 0.35 cm. The differences are statistically highly significant. The differences are clearly visible in Fig. 3, where also linear trends are given. Trees with nearly the same dbh – but belonging to dominant/codominant trees – have significantly higher diameter increment that those belonging to suppressed trees.

The diameter/frequency diagram shows the diameter structure at the beginning and the end of surveyed period (see Fig. 4).

The existence of two layers within the stand is also visible from the diameter structure. Both curves have the same shape depicting a two-layer structure.

Some silviculturists recommend to conserve wild cherry only in the main layer as target trees (SPIECKER 1994). Recommended target trees/ha are in that way only 51, which is less than one target tree per our sample plots (100 m^2), supposing that the crown diameter will be about 10 m. Our stand situation is clearly quite different (more than 5 wild cherry trees per plot with the crown diameter less than 5 m), which could explain lower diameter increment.

Finally the slenderness quotient (the ratio of height to dbh) was evaluated for each tree class (Konšel). The results are given in Table 2.

The slenderness quotients of wild cherry trees according to their diameters are clearly different for trees with small diameter and trees with large diameter. The slenderness quotient development in the studied period shows quite a stable situation in the codominant (main) layer while trees belonging to class 3 have slimmer stems. However, data indicate that a silvicultural intervention also in the main layer is needed in the nearest future as the slenderness quotient has slightly increased for the surveyed period. This is in correspondence with SPIECKER's (1994) proposal of low density of wild cherry target trees.

Basically the same picture is given by crown diameters according to tree classes. While dominant and codominant trees have the crown size corresponding
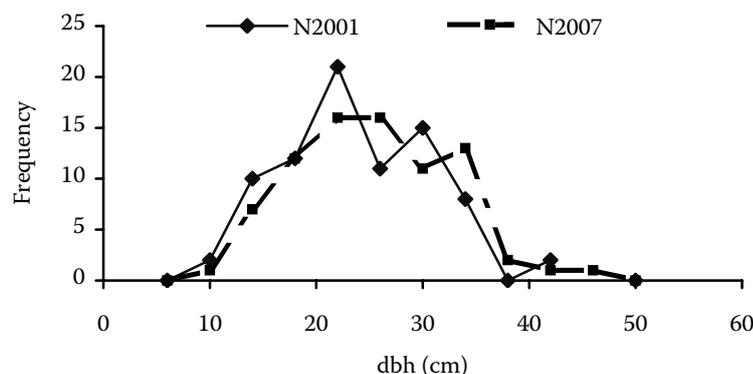

Fig. 4. Diameter/frequency diagram for the wild cherry stand (starting age 53 years) revealing two peaks in the diameter structure

Table 2. Slenderness quotient of wild cherry trees according to their tree classes

Tree class (Konšel)	2001	2007
2a	84.0[a]	86.2[a]
2b	105.3[b]	104.7[b]
3	95.7[c]	100.6[b]
4	83.4[a]	72.8[a]
Average	90.0[a]	91.5[a]

The same letter denotes insignificant differences ($p = 0.01$)

Table 3. Average crown diameter according to their tree classes

Tree class (Konšel)	2001	2007
2a	5.3[a]	5.1[a]
2b	4.9[a]	4.8[a]
3	2.9[b]	2.5[b]
4	2.5[b]	2.5[b]

The same letter denotes insignificant differences ($p = 0.01$)

to their position, the suppressed trees have crowns of the too small size which is significantly smaller (see Table 3). The crown development during the surveyed period suggests that the competition is growing and the thinning that will bring the larger growing space is needed immediately.

CONCLUSION

Wild cherry trees are growing mostly as admixed and/or scattered trees in our forest stand. However, there are some stands where the wild cherry is a stand-forming species. The silvicultural measures recommended for these stands are not very common and/or very general ones and therefore the detailed analysis of its growing capacity and required crown space was done.

Our data suggests that the wild cherry could be used as a stand-forming species and auxiliary (help and clean position) species at the same time. The height/frequency curve depicts two layers (two groups belonging to dominant/codominant tree classes and suppressed tree classes) of wild cherry trees in the stand. The height periodic increments for these two groups are statistically significantly different ($p < 0.01$) confirming that there is no transition between these two groups, i.e. suppressed trees probably never reach the future crop tree group. The practical meaning of the finding is that silvicultural operations should not be focused on these losers. The same is true of the diameter/frequency curve which basically has the same shape with two peaks depicting two layers of wild cherry trees in the stand.

The vertical and horizontal structure analysis also shows that in middle aged stands wild cherry trees which are still vital could be suppressed. Their quality is low but they fulfil their auxiliary role in stands and therefore they could be kept in the stand for the nearest future.

The slenderness quotient has an increasing tendency suggesting that stronger silvicultural interventions will be needed in the stand in the nearest future. The same conclusion could be drawn from data on the crown size (see Table 3).

References

BACK O.A., 1977. Die Vogelkirsche (*Prunus avium* L.). Ein Beitrag zur Ökologie und wirtschaftlichen Bedeutung. Forstarchiv, *48*: 154–158.

ČÍŽKOVÁ L., BENDÍKOVÁ M., 1999. Záchrana genofondu vybraných lesních dřevin v přírodních lesních oblastech Jihomoravských úvalů a Moravských Karpat. [Závěrečná zpráva.] Uherské Hradiště, VÚLHM: 155.

ERLBECK R., HASEDER I.E., STINGLWAGNER G.K.F., 1998. Das Kosmos Wald- und Forstlexikon. Stuttgart, Franckh-Kosmos Verlags-GmbH & Co.: 890.

FLEDER W., 1982. Die Waldkirsche (*Prunus avium*). In: Bäume und Wälder in Bayern. Bayrischer Forstverein (Hrsg.). Pfaffenhofen, W. Ludwig Verlag: 572–576.

GAVALAND A., GAUVIN J., MOREAU A., BOUVAREL L., 2002. De l'intérêt de planter le merisier avec un accompagnement d'aulne: les enseignements de trois essais INRA. Revue Forestière Française, *54*: 143–160.

HAJNALA M., LSTIBŮREK M., KOBLIHA J., 2007. First evaluation of growth parameters in clonal test with wild cherry. Journal of Forest Science, *53*: 57–65.

KOBLIHA J., 2002. Wild cherry (*Prunus avium* L.) breeding program aimed at the use of this tree in the Czech forestry. Journal of Forest Science, *48*: 202–218.

LÜDEMANN G., 1988. Anbauerfahrungen mit der Vogelkirsche in Ostholstein. Allgemeine Forstzeitschrift, *43*: 535–537.

OBAL K.H., BARTSCH N., 2000. Anwuchs und Jugendwachstum der Vogelkirsche unter Schirm. Forst und Holz, *55*: 616–621.

PARIS E., 2007. Les travaux en phase de qualification en hêtraie mélangée de plateau calcaire. [Thesis.] Nancy, ENGREF: 185.

PRUDIČ Z., 1996. Nové poznatky o pěstování třešně ptačí. Lesnická práce, *75*: 158–159.

REIF A., JOLITZ T., MUNCH D., BUCKING W., 1999. Sukzession vom Eichen-Hainbuchen-Wald zum Ahorn-Wald. Prozesse der Naturverjüngung im Bannwald 'Bechtaler Wald' bei Kenzingen, Südbaden. Allgemeine Forst- und Jagdzeitung, *170*: 67–74.

SCHÜTE G., BECK O.A., 1996. Entwicklung einer Verjüngung mit Elsbeere und Kirsche von 1976–1995. Forst und Holz, *51*: 627–628.

SPIECKER M., 1994. Wachstum und Erziehung wertvoller Waldkirschen. Mitteilungen der FVA Baden-Württemberg: 181.

ŠKVARENINOVÁ J., 1997. Premenlivosť kvality populácií čerešne vtáčej (*Cerasus avium* (L.) Moench.) a jej vertikálne rozšírenie v niektorých oblastiach Slovenska. Acta Facultatis Forestalis Zvolen, *39*: 21–31.

ŠKVARENINOVÁ J., ŠKVARENINA J., 2005. Bioklimatická charakteristika vybraných pestovateľských lokalít čerešne vtáčej (*Cerasus avium* L. Moench.) na Slovensku. Acta Horticulturae et Regiotecturae, *8*: 9–12.

VÁVRA M., 1965. Pěstování a zužitkování švestek a třešní. Praha, SZN: 176.

WILHELM G.J., RAFFEL D., 1993. La sylviculture du mélange temporaire hêtre-merisier sur le plateau lorrain. Revue Forestière Française, *45*: 66–68.

Růst třešně ptačí (*Prunus avium* L.) ve směsi s jinými dřevinami na území Školního lesního podniku ČZU

ABSTRAKT: Třešeň ptačí je dřevinou, kterou počítáme mezi cenné listnáče; může významným způsobem zvyšovat nejen biodiverzitu našich lesů, ale může znamenat i významný ekonomický přínos. Podmínkou pro splnění těchto cílů je dostatečná kvalita kmene, které lze dosáhnout, pokud ji udržíme v hlavní porostní úrovni. Frekvenční diagram výšek třešní v analyzovaném porostu ukazuje, že třešně tvoří dvě výškové skupiny, z nichž jedna patří k nadúrovňovým a úrovňovým stromům, zatímco druhá skupina patří do skupiny stromů potlačených. Výškový periodický přírůst (zjištěný během sledovaného období 2001–2007) těchto dvou skupin je statisticky vysoce významný ($p < 0{,}01$). Zjištěné výsledky ukazují, že mezi těmito dvěma porostními složkami neexistuje možnost (schopnost) přesunu z potlačené skupiny stromů do úrovně. Nelze tedy počítat s tím, že by potlačený strom mohl být zařazen mezi cílové stromy. Podobný obrázek dostaneme při analýze tloušťkové struktury porostu. Zjištěné výsledky ukazují na to, že pěstitelská péče musí být zaměřena zejména na stromy hlavní úrovně, resp. cílové stromy. Naše výsledky rovněž potvrzují slabou kompetiční schopnost třešně ptačí a z ní vyplývající nutnost intenzivního a pravidelného uvolňování koruny úrovňových třešní tak, aby nedocházelo k odumírání laterálních větví v koruně.

Klíčová slova: třešeň ptačí; pěstování lesa; porostotvorná dřevina; korunová vrstva porostu; stromové třídy

Corresponding author:

Ing. Renata Stojecová, Česká zemědělská univerzita v Praze, Fakulta lesnická a dřevařská, 165 21 Praha 6-Suchdol, Česká republika

tel.: + 420 224 383 791, fax: + 420 234 381 860, e-mail: stojecova@fld.czu.cz