

Short communication

Light conditions in submountain beech stands in dependence on cutting intensity

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Abstract

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In 2001–2002 we ran a research on light intensity on three individual research plots (RP) at the BEES Kremnické vrchy Mts, representing environment of submountain beech stands. Our study followed with measurements realised by Střelec in year 1990 in the same stands and under the same conditions. For all partial plots, our measurements confirmed the light intensity peaks presence during midday hours. The absolute maxima representing 56 klx were recorded on open plot between 12.00–14.00 h in time of full developed foliage. On the other hand, the lowest values – 0.022 klx were obtained for the former plot with clear cut at 06.00 h, in period of full foliage. In period of full leafing, higher values were observed on the open and control plot, on the other hand, in period without foliage, higher values were recorded on the other plots.

Key words

beech stands, illumination, Kremnické vrchy Mts, light

Introduction

The amount of solar radiation reaching the Earth's surface belongs to key factors governing the existence of life across the whole planet. It is crucially important for the man, plants, animals and for all components of all ecosystems. The presence of light is a necessary condition for assimilation of carbon dioxide by plant leaves. It follows that the light is a very important vegetation factor for ecosystem's performance. This fact has been confirmed by a range of authors treating the issue: MITSCHERLICH (1977, 1978), SUNNER and ROHRING (1980),

LÜPKE (1982), HUSS and STEPHANI (1978), SANIGA (1990), STŘELEČ (1992) and others. The man can – due to its activities, significantly influence this determining factor, equally positive and in negative way. Purpose-oriented human activities in forest management have been primarily aimed at increasing production. This endeavour, however, was not always profitable for the forest, and finally, for the human itself. Consequently, the present situation requires as much as possible understanding the performance of individual components of ecosystems. Only management based on good understanding and thorough analysis of this information can improve mutual profits between the ecosystem components, the man himself included. Our aim was quantitative description of light conditions inside beech stands

in the Kremnické vrchy Mts, followed by analysis for assessment optimum intensity of cutting intervention in relation to the light conditions in the studied site.

The research plots BEES are situated in area of the Kremnické vrchy Mts (48°38' N and 19°04' E) belonging to the West Carpathians Mts. The stands on the plots mostly consist of beech trees, 80–110 years old. The local climate belongs to moderately warm, moderately hilly District B5 with an average annual temperature $t_{1951-1980} -6.8$ °C and an average precipitation total of 778 mm, STŘELEČ (1993). More detailed description of plots can be found in works of SCHIEBER (2006), KELLEROVÁ (2006), BARNA (2004). The soil conditions are described in KUKLA (2002) and ŠIRÁŇ (2003). In year 1989 were the plots subjected to shelterwood cutting with the aim to obtain the required stocking. The result was a series of 5 partial plots comprising also control plot, without intervention. In year 1990 ran the first study phase on light conditions on the individual partial plots (PP), STŘELEČ (1992). In year 2002 launched the second phase, following the methodical approach proposed by PETŘÍK (1968) as well as providing with the measuring points established by STŘELEČ (1992) in the first phase. The principle of the research was in establishment of sufficient number of measuring points (10) on each PP. The measuring points were fixed with sticks with a small horizontal tablet tightened to the top – for placing the photo-cell of the appliance. The tablets were 50 cm above the ground. For all measurements we used identical Luxmeters PU 150 (Metra Blansko) working with a precision of 10%. The measurements on all the plots were synchronised and ran at one-hour intervals, in afternoon reduced to half an hour. Both measurement phases ran under anticyclonal weather situations: on August 27, 2001 at time of full foliage, and on March 12, 2002 at time without foliage.

Results

Maximum value of illumination – 52.0 klx in beech stands before foliage was recorded on the open plot at

12.00 h. For comparison JOHNSON (1954) reports a value of 137.0 klx for the upper boundary of the atmosphere.

The average amount of light reaching this plot was 20.3 klx. On the contrary, the lowest value was obtained on control plot left without intervention – 0.246 klx at 6.00 h. The maximum on this plot was shifted to 13.00 h, and it represented a value somewhat lower than 20.0 klx. From these facts it follows that in period before foliage, the ground below beech crowns is reached by some 40.0% of the light reaching the open plot. In average, this amount is 33.0%. STŘELEČ (1992) reports for control plot an amount representing 52.0% of illumination on the open plot.

Table 1 and Fig 1 demonstrate that the amount of light increases with decreasing stocking density. This fact has also been confirmed by SANIGA (1990). PETŘÍK (1971) reports for non-foliated trees in a beech stand a relative value representing 23–45% of the external light supply. TRANQUILLINI (in MITSCHERLICH, 1971) found for a 70-year-old beech stand a relative value of 51.0 % in February, March and April and in November and December. In contrast, he observed only 5.0% values in July, September and October.

Interesting is situation in illumination values on plot H (former clear-cut). In 1990 represented the illumination maximum for this partial plot almost 70.0 klx, 11 years later, it was only 20.1 klx. This 72.0% decrease was caused by the vigorous understorey, at present high more than 6 m. Similar situation is on plot I, in the past subjected to intensive cutting intervention resulting at a density of 0.3 (Table 1, Fig 1). In case of plot S with 0.5 stocking, the average illumination value was 7.9 klx, representing the highest amount compared to the other plots.

The situation on these plots at time of fully foliated beech trees that means on August 27, 2001 was the following: maximum values were again recorded on the open plot, making 56.0 klx from 12.00 noon to 14.00 h. This almost 10% increase was probably caused by declination of the Earth's axis in relation to the Sun.

Full foliage of saplings growing on the former clear cut plot has a very important influence on amount

Table 1. Average values of Illumination i in a beech stand on forest stands with different cutting

Partial plot	Ho	H	I	S	M	K
		before	foliation	(12. 03. 2002)		
Average values (klx)	20.258	6.656	6.997	7.983	7.881	6.720
		full	foliation	(27. 08. 2001)		
Average values (klx)	24.105	0.563	1.664	1.966	1.591	1.244

Ho, open plot; H, former clear cut; I, former stocking 0.3, in time of research 0.4; S, former stocking 0.5, in time of research 0.62; M, former stocking 0.7, in time of research 0.78; K, control plot, stocking 0.9, in time of research 0.87

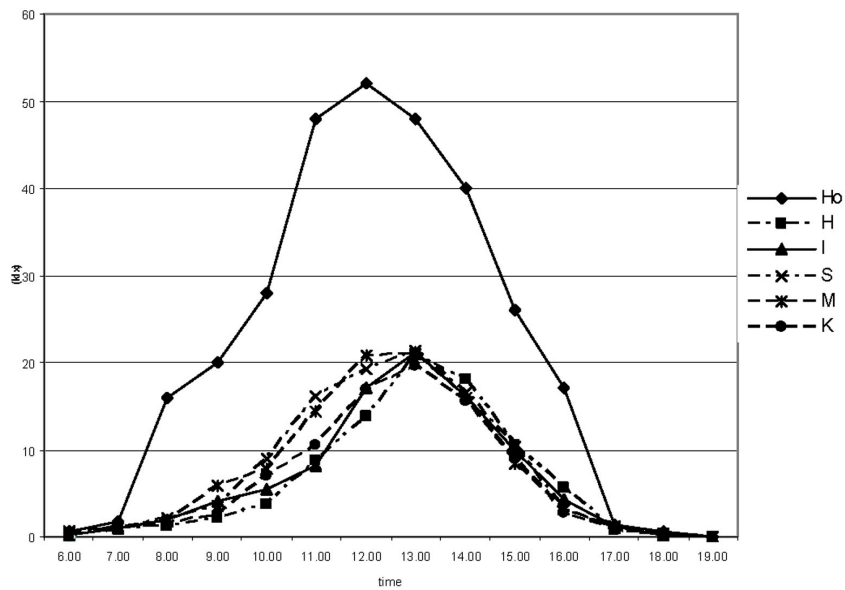


Fig 1. Illumination in a beech stand before foliation (13.03.2002) with different cutting

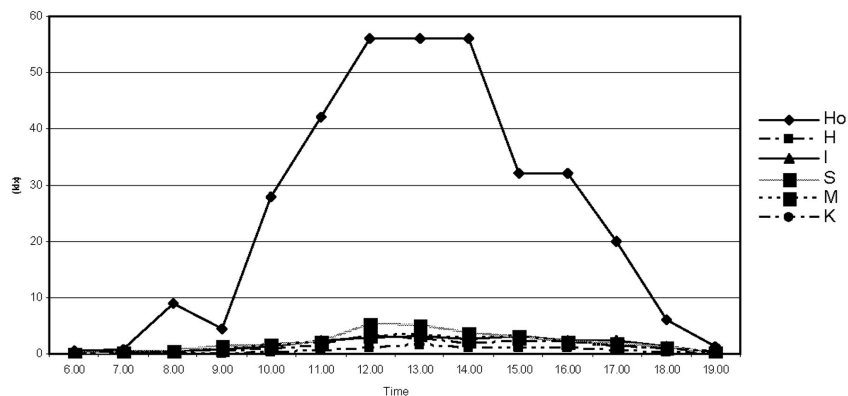


Fig 2. Illumination at the time of full foliation (27.08.2001) with different cutting

of light penetrating this stand. On this plot, the photocells of the measuring appliance were lowest irradiated, with 0.6 klx, representing only 2.3% of light on the open plot. The maximum – 1.4 klx was observed at 13.00 h. The crown canopy on control plot – without intervention, transmitted 5.1% of light on the open plot, 1.2 klx on average. A maximum of 5.9 klx was measured at 14.00 h. The average amount of light penetrating the stand on plot S was the highest – reaching almost 2.0 klx. Comparing our results with the corresponding results obtained in year 1990, we can see that saplings in forest understorey as well as young trees can reduce the light having penetrated through the canopy by even 30.0% at moment of culminating illumination. Similar results also report other authors. SMOLEN (1976) measured a value of 73.8 klx for average illumination intensity in a stand at 16 m above the ground, that me-

ans above tree crowns. The measurement was carried out between 11.00–13.00 h. PETRIK (1986) observed only 5.0% light reaching the ground in a fully foliated 150-year-old beech stand. SANIGA (1990) suggests that relative illumination in spruce-beech forest stands is only 1.7–3.0% when the canopy density is 100–77.5%, which is consistent with our results obtained for control plot without intervention. At canopy density 62.0–40.5% is the relative illumination substantially higher: 15.0–23.3%. TUŽINSKÝ et al. (2003, 2004) declare that the illumination intensity in years 1982–1993 dropped to 9.0% in comparison with the clear-cut, and the relative light supply on the control plot was 2.0–1.5%. The history of illumination intensity values measured on individual partial plots is illustrated in Table 1 and Figs 1, 2.

The measurements of illumination intensity did not confirmed linear dependence of light amount penetrating tree crowns on stand stocking. In general, however, it holds that the intensity of natural illumination is directly dependent on the overall intensity of global radiation reaching a horizontal surface.

The highest average illumination values in the studied beech stand were measured, equally in period without leaves and in period of full foliage, on the open plot without forest stand. These values ranged between 20.3 and 24.1 klx, respectively. The absolutely highest value did not exceed 56.0 klx. Among partial plots subjected to shelterwood cutting of various intensity, the highest values of light supply were found on plot S with medium strong intervention and original stocking value of 0.5. At time without leafing (12. 03. 2002) we recorded on this plot a value of 7.9 klx, at time of full foliage (27. 08. 2002) it was on average 1.9 klx. In contrast with the first phase of measuring illumination intensity in year 1990, when the lowest values were obtained on control plot without intervention (STŘELEČ, 1992), in our case were the lowest values recorded on plot H – the former clear cut. At time of complete foliage, the average amount of light penetrating through crowns was only 0.5 klx, in spring it was 6.7 klx. These conditions were determined by the height and canopy density of the succession stand (10-year-old young growth). SANIGA (1990), evaluating height growth of a young beech stand obtained results similar to those of HUSS and STEPHANI (1978). In case of canopy density lower than 90.0% up to 40.0%, beech manifests a considerably plastic ability for adaptation in varying light conditions. In summer period, tree crowns are supplied with light amount by 18.0% higher than in spring. On the other hand, the amount of light transmitted through the tree crowns is higher in spring (10.0–90.0% – compared to summer). The other partial plots have the corresponding illumination values inside the above specified interval.

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Osvetlenie v podhorských bučinách v závislosti od sily ťažbového zásahu

Súhrn

V rokoch 2001–2002 sme v podmienkach podhorských bukových porastov BEES Kremnické vrchy uskutočnili merania intenzity osvetlenia na jednotlivých čiastkových plochách. Merania sa uskutočnili v dvoch obdobiach, a to v čase plného olistenia bukových porastov – 27. 8. 2001 a v dobe bez listov 12. 3. 2002.

Naše merania potvrdili výskyt maximálnych hodnôt intenzity osvetlenia v poludňajších hodinách, na všetkých plochách. Absolútne najvyššie hodnoty osvetlenia boli zaznamenané na voľnej ploche, a to 56,0 klux o 12–14 hod. v čase plného olistenia. Najnižšie hodnoty naopak na ploche bývalej holiny v priemere 0,022 klx o 6.00 hod. ráno. Výrazný vplyv na množstvo dopadajúceho svetla na pôdny povrch tejto plochy mala odrastajúca mladina. Do porastu kontrolnej plochy v čase pred olistením v roku 2002 preniklo 33 % svetla z plochy, kde bol uskutočnený holorub. V roku 1991 to bolo 52 % z hodnôt voľnej plochy. V čase plného olistenia do tých istých porastov preniklo len 2,3 % svetla voľnej plochy.

Vo všeobecnosti vyššie hodnoty osvetlenia boli zaznamenané v čase plného olistenia na voľnej ploche a kontrolnej. V porovnaní so stavom porastov bez olistenia to bolo o 16 %. Na zvyšných plochách sa vyššie hodnoty zaznamenali v čase bez olistenia, v priemere od 18–23 %.

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