

The relationship between height and crown characteristics of four-year-old common birch (*Betula pendula* Roth)

Adam Klepacki

Elk Forest District, Mrozy Wielkie 21, 19–300 Elk, Poland

Tel. +48 87 6202513, fax +48 87 6202513 wew. 210, e-mail: adam.klepacki@bialystok.lasy.gov.pl

Abstract. This paper presents the results of an analysis on characteristics of birch crowns (*Betula pendula* Roth) in relation to measures of the growth space occupied by a single tree at a young age. It also presents the relationships between the seedling height and certain crown characteristics.

The study focused on four-year-old common birches growing in four different areas in the Elk Forest District in either fresh mixed coniferous or broadleaved forest. The measurements conducted on the chosen trees were used to calculate their crown characteristics such as crown diameter, length, height to the crown base, relative length and spread. They were also used to determine the growth characteristics of a single tree's growth space, such as the crown area projected onto the ground, single tree space and the percentage use of unit area. Furthermore, fresh and dry leaf mass was determined.

The birches growing in the fresh mixed coniferous forest reached an average height of 1.30 m, whereas in the fresh mixed broadleaved forest, the height of the trees was lower and amounted to 0.67 m. 95% of the trees had crown diameters of 0.57 m to 0.74 m in the fresh mixed coniferous forest, but only 0.19 m to 0.25 m in the fresh mixed broadleaved forest. The average lengths of the crowns in the fresh mixed coniferous and broadleaved forests amounted to 0.97 m and 0.37 m respectively.

The author shows that there is a statistically significant correlation between the seedling height and the other examined characteristics. The best correlation was found between the height and the length of the crown ($r = 0.9858$) for birches growing in the fresh mixed coniferous forest and between the height and single tree space ($r = 0.8468$) for birches growing in the fresh mixed broadleaved forest.

Keywords: tree height, crown width, crown length, growth space, common birch, forest culture

1. Introduction

Structure and shape of the tree crown is the interest of study fields, such as dendrology, forest productivity and forest cultivation. Growth of the tree and its increments are highly based on the size of crown and its assimilatory apparatus, which has an effect on the scale and effectiveness of the assimilation process. Tree crowns of the particular species can vary in light dependency and requirement for nutrients as well as susceptibility to stress intensity. For instance, Burger (1939) who investigated the shape, structure and the size of tree crowns conceived a tree crown model of the spruce tree (*Picea abies* (L.) H. Karst). The model was divided into exterior part with the assimilatory apparatus and the tree crown

core without leaves. Burger also distinguished two types of canopies intertwined together into one: the tree crown that can cope in harsh bright light conditions and the tree crown that can manage in the poor light conditions. Another researcher, Assmann (1968), described the tree structure based on factors such as length and girth proportions to the tree height and the involvement of two tree crown types in the whole canopy structure. Moreover, Crecente-Campo et al. (2013) constructed a model for two pine trees (*Pinus pinaster* Aiton and *Pinus sylvestris* L.) growing in the northwest Spain. Lemke (1966, 1968, 1971) worked on the usefulness of the tree crown as a criterion that can determine the growth dynamics of the pine tree stands. The author proved that the maximal size of tree crown is reached at the age of 20 years by conceptual-

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ising the dependence of annual increment volume to the ton of fresh coniferous leaves. The research shown that after the age of 20 years, the increment growth is steadily declining. The relations between tree crown health and girth of the tree increments was analysed, on the one hand, on Douglas fir (*Pseudotsuga menziesii* Carriere) in Netherlands by Kort and Baas (1997); on the other hand, the research was conducted on common oak and hornbeam in Sweden by Drobyshev et al. (2007). In both the studies, the connection between tree crown health and the growth of the year increments was observed. The highest increment was observed in case of trees that were healthy and had well-developed tree crown. The lowest was present in trees with reduced assimilatory apparatus. Research on the tree crown length of common pine (Żybura et al. 1977; Jaszczak et al. 1998) was conducted to determine the connection between the tree crown length and tree age as well as biosocial position (Żybura 1987). It proved that the growth of the crown's length occurs with the age and bonitation of the tree stand and bonitation time reduction is intertwined with the decline in the biosocial position. Turski and coauthors (2012) conducted analysis of the size of particular values of the pine tree crown of different ages in biosocial classes that establish existing tree stand and its connection with tree diameter and height. Additional to the pine crown research is analysis of the assimilatory apparatus efficiency that is broadened by the correlation between its efficiency and diameter, height and size of the tree (Turski et al. 2015). Bronisz and coauthors (2009) compared different types in order to define dry and fresh biomass of the assimilatory apparatus belonging to the pine tree stands. They distinguished three factors, which are forest habitat type, tree age and location of the researched tree stands. These factors have to be taken under consideration to precisely evaluate the tree biomass and their components by using empirical patterns. Radial increment correlation of native and alien trees of the particular crown parameters was done by Bijak (2013). On the one hand, he proved that there is an important correlation between the diameter increment and the crown length and girth in case of grand fir (*Abies grandis* Lindl.) or Caucasian fir (*Abies normanniana* (Steven) Spach). On one hand, research on the morphology of canopies in tree stands with multiple species in comparison with those with single species was conducted by Pretzsch (2014). On the other hand, the definition for the area required by single tree was developed by Miś and Sugiero (2004) and the percentage of the unitary area usage was proposed by Kaźmierczak and Stosik (2008). Particular measures of area required for the trees to grow were analysed and determined in the pine tree stands by Kaźmierczak (2009, 2010, 2012) and in larch tree stands by Kaźmierczak and others (2010). The size of crown was proposed as the biosocial measurement of trees in the 135-year-old oak tree stand by Kaźmierczak and Zawieja (2016). In turn, the growth of common birch bark was

undertaken by Dmyterko and Bruchwald (2000, 2005), who distinguished and described three stages of the tree crown development: youth phase, adult phase and elderly stage. They defined the main shoot of the common birch tree which empirical material was taken from 24 solid birch tree stands varying in age from 32 to 60. Moreover, they described the development of branching in the common birch crown based on the measurement taken from the 6-year-old cultivation (Dmyterko, Bruchwald 2001) and created a development model for the appendix shoot of the adult moor birch and its branching (Dmyterko, Bruchwald 2010). Dependencies between smoothness of the unattended 30-year-old common birch tree stand and selected crown traits of trees growing in such tree stand were presented by Korzeniewicz et al. (2016).

The goal of the present work is to analyse particular characteristics of tree crown and to find growth measurements responsible for space requirements for common birch in youth stage and to examine the correlation between its height and certain qualities of the crown. Four-year-old common birch trees growing in two different forest habitats were examined (from fresh mixed coniferous forest and fresh mixed deciduous forest) in Elk Forest District.

2. Methodology

The research was conducted on the cultivation in Elk Forest District (53°40'–54°00'N, 22°05'–22°48'E). Majority of the Forest District area is located in the II Mazury – Podlasie Region in the part of the Mesoregion of Elk, II. 6 (Zielony, Kliczkowska 2012). The southwestern part lies in the Mesoregion of Mazurian Forests (II. 4), and the southern part lies in the Mesoregion of Biebrzańska Valley (II. 13).

Forest cultivations were set up during spring 2014. Common birch was planted (Brz 2/0) from the seedbed schools belonging to the Elk Forest District of two habitat forests (coniferous mixed fresh forest and deciduous mixed fresh forest). Areas for the cultivation were adequately prepared for sowing. The areas were ploughed and the framing on each area was estimated on 1.4 m × 1.8 m. On the one hand, cultivation set on the coniferous mixed fresh zone is intensely characterised by the presence of the rust-coloured proper soil processed from the volatile sands. On the other hand, the deciduous mixed fresh forest habitat had rust-brown soils derived from the poorly clay sands, volatile sands and gravel (ps/pl, ps/uż) (PUL 2013). Research areas of around 243–280 m² were established on four cultivations ranging from 100 to 108 common birch trees. The altitude for the cultivations was similar and estimated to be about 132–147 m. In July 2015, the trees were numerated and, afterwards, their diameter was measured at the root neck position using devices (dsz) in two directions (N–S and E–W) with rounding to 0.001 m. The average from the conducted measurements was taken for the root neck dia-

Table 1. Statistical characteristics of tree height (h_p) and tree diameter of root collar of 4-year-old common birch trees in sample plots on the selected forest habitats

Habitat <i>N</i>	BMśw		LMśw	
[pcs.]	203		214	
	h_{pl} [m]	d_{sz} [cm]	h_{pl} [m]	d_{sz} [cm]
Mean	1.19	1.16	0.69	0.52
Standard deviation S_{dx}	0.31	0.41	0.20	0.16
coefficient of variation V	0.26	0.36	0.30	0.32
Significance -95%	1.14	1.10	0.66	0.50
Significance +95%	1.23	1.21	0.72	0.54
Minimum	0.43	0.30	0.24	0.10
Maximum	2.07	2.45	1.51	1.00
Skewness A	0.06	0.39	0.64	0.28

BMśw – fresh mixed coniferous forest, LMśw – fresh mixed deciduous forest

meter. Subsequently, the height of all trees was measured (h_p) with precision to 0.01 m. In Table 1, the statistical characteristics of the trees growing on the research areas accordingly to the forest habitat type are given.

Fifteen model trees were chosen from each area accordingly to the Draudt method (Grochowski 1973). These trees represent the full scale of diversity of the root neck (tree height has been taken under consideration). At the end of July, transparent nets were put on the tree canopies to determine the date of leaves falling. The beginning of this process was a signal for collecting leaves from the other trees that were previously examined and measured in September and at the start of October. When vegetation season was over, the height was measured again (h) with the accuracy to 0.001 m. This height was estimated as the final height that will be used in order to calculate the correlation of height with other crown characteristics. The height embedment for the crown (h_{ok}), which was measured to the first living branch of the dense crown with accuracy to 0.01 m, as well as the crown section, which was measured by conducting four vertical sections accordingly to the four directions (South, North, West and East), were measured. Model trees measurements were used to calculate the following characteristics:

d_k [m] – the tree crown girth. It is the average of the measurements from the West–East and North–South directions.

l_k [m] – the tree crown length. It is the difference between the tree height and the crown base height.

$\frac{l_k}{h}$ [m] – relative length of tree crown. It is the ratio of the tree length to the height

$\frac{d_k}{h}$ [m] – the degree of the tree crown spread (rate of the crown declination). It is the ratio of the tree girth to the height.

$\frac{d_k}{l_k}$ [m] – the degree of the tree crown flattening. It is the ratio of the tree girth to the length.

p_k [m²] – the crown area projected onto the ground. It is the surface circle area with the radius equal to half of the crown girth.

ppd [m³] – the area of single tree growth space. It is the product of the crown's section area and tree height.

$pwjp$ [%] – the percentage use of the unit surface area. This is the crown surface area projected onto the ground in unit area percentage. It is also the unit surface area value of the trees (the product of researched cultivation and trees surfaces areas).

sml [kg] – the fresh leaves weight evaluated after collecting.

sml [kg] – the dry leaves weight represented as the product of $sml_{10} \times 10$ (sml_{10} is calculated based on the randomly chosen leaves that constitute 10% of fresh leaves).

The tree height, chosen crown characteristics as well as growth space measurements were defined by using description statistics. The distribution was assessed, thanks to the Shapiro–Wilk experimental method (Shapiro, Wilk 1965). This experimental method is dedicated to few trials and is characterised by relatively high results what proves no normal distribution (Więckowska 2010–2016). The strength of a link between the height, certain crown characteristics and growth space measurements was determined using linear Pearson correlation method.

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}}$$

gdzie: kolejne cechy X i Y ; \bar{x} , \bar{y} – średnie z wartości X i Y ; n – liczebność próby.

where x_i, y_i is the following characteristic of X and Y , respectively; \bar{x}, \bar{y} is the average values of X and Y , respectively; n is the sample strength

The salience experimental method for the Pearson correlation factor was based on the trail statistics that has the distribution of Student's t-test with two degrees of latitude and has the following pattern:

$$t = r / SE, \text{ where } SE = \sqrt{1 - r^2 / n - 2},$$

Defined on experimental statistics, variable p was compared on the salience level.

PQStat v. 1.6.4. (Więckowska 2010–2016) software was used for the statistical calculations of the trees height, particular crown characteristics and growth space measurements of the 4-year-old common birch tree.

Table 2. Statistical characteristics of sample trees in 4-year-old common birch growing in the selected habitat and testing of normal distribution of analyzed traits

Measure	h [m]	h_{ok} [m]	d_k [m]	l_k [m]	$\frac{l_k}{h}$	$\frac{d_k}{h}$	$\frac{d_k}{l_k}$	p_k [m ²]	ppd [m ³]	$pwjpp$ [%]	$śml$ [kg]	sml [kg]	
Habitat (pcs.) N	BMśw (30)												
Mean \bar{x}	1.30	0.33	0.66	0.97	0.73	0.49	0.68	0.38	0.57	15.50	0.68	0.26	
Standard deviation S_{dx}	0.38	0.08	0.24	0.36	0.11	0.09	0.12	0.24	0.47	9.82	0.52	0.19	
Coefficient of variation V	0.29	0.25	0.36	0.37	0.15	0.19	0.18	0.63	0.83	0.63	0.77	0.74	
Minimum	0.61	0.04	0.20	0.28	0.46	0.33	0.45	0.03	0.02	1.28	0.09	0.03	
Maximum	2.05	0.42	1.12	1.74	0.94	0.71	0.98	0.99	2.02	40.54	1.96	0.73	
Shapiro-Wilk test for normality p -value	0.88	0.00	0.33	0.78	0.06	0.63	0.83	0.18	0.01	0.18	0.01	0.01	Habitat (pcs.) N LMśw (30)
Mean \bar{x}	0.67	0.31	0.22	0.37	0.55	0.32	0.61	0.04	0.03	1.72	0.05	0.02	
Standard deviation S_{dx}	0.15	0.10	0.09	0.11	0.11	0.10	0.22	0.03	0.03	1.23	0.04	0.02	
Coefficient of variation V	0.23	0.32	0.39	0.31	0.21	0.30	0.36	0.74	0.95	0.71	0.75	0.75	
Minimum	0.37	0.09	0.04	0.17	0.35	0.07	0.21	0.00	0.00	0.04	0.01	0.004	
Maximum	1.17	0.45	0.39	0.74	0.76	0.47	1.09	0.12	0.13	4.52	0.20	0.09	
Shapiro-Wilk test for normality p -value	0.07	0.17	0.51	0.07	0.53	0.32	0.99	0.01	0.00	0.02	0.00	0.00	BMśw – fresh mixed coniferous forest,

LMśw – fresh mixed deciduous forest

3. Results

Statistical characteristics of the model trees are represented in Table 2. Common birch trees growing in the fresh mixed coniferous forest at the age of 4 years reached the average height of 1.30 m. The variation coefficient amounted to 29%. The height-to-span ratio for the model trees on the fresh mixed coniferous forest varied from 0.61 to 2.05 m. It has been found that 95% of trees ranged between 1.16 and 1.44 m in height. The average crown length amounted to 0.97 m, whilst its girth 0.66 m. Four-year-old common birch trees growing in the fresh mixed deciduous forest reached the average height of 0.67 m. The estimated 95% of trees ranged between 0.62 and 0.73 m in height. The variation coefficient amounted to 23%. The same amount of trees (95%) in the fresh mixed deciduous forest had their crown girth ranging from 0.19 to 0.25 m, whereas the length ranges from 0.32 to 0.41 m. The distribution of the examined characteristics was very similar to the normal distribution with only difference being present in the fresh leaves weight ($śml$), dry leaves weight (sml) and the growth space of the single tree (ppd) on the mixed fresh coniferous and deciduous habitats. Moreover, in mixed fresh habitat conditions, distribution of the height embedment of the crown (h_{ok}) for model trees were different significantly from the normal distribution. It was alike for the area of the crown projected

onto the ground section (p_k) and percentage use of the unit surface area ($pwjpp$) for the mixed fresh deciduous habitat.)

Pearson linear correlations between the height and selected crown characteristics as well as growth space measurements are indicated in Table 3. The strongest link for tree height (h) and crown length (l_k) occurred at the mixed fresh coniferous habitat and the correlation factor amounted to 0.9858. At the mixed fresh deciduous habitat, the correlation factor was $r=0.8468$ (with inclusion of single tree space (ppd)). The link between h and characteristics such as crown girth (d_k) (BMśw $r=0.8968$ LMśw $r=0.7611$) and projected crown area onto the ground (p_k) (BMśw $r=0.9149$ LMśw $r=0.7679$) is highly statistically important for the trees growing in both the habitat types of forest (Figures 1–6).

Relation between the height of trees (h) and the height embedment of the crown (h_{ok}) ($r=0.7493$), degree of the crown spread ($\frac{d_k}{h}$) ($r=0.3533$) and the degree of the tree crown flattening ($\frac{d_k}{l_k}$) ($r = -0.1373$). There are some statistically insignificant numbers in case of common birch trees growing in the mixed fresh coniferous habitat. Statistically insignificant relation was found for height (h) and relative length of tree crown ($\frac{l_k}{h}$) ($r = -0.0527$), degree of the crown spread ($\frac{d_k}{h}$) ($r = 0.2556$) and the degree of the tree crown flattening ($\frac{d_k}{l_k}$) ($r = 0.2161$) for the trees growing in the mixed fresh deciduous habitat.

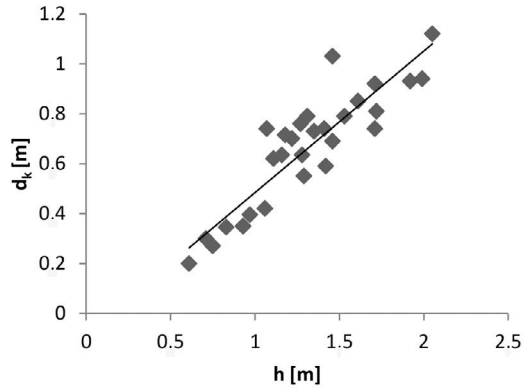


Figure 1. Pearson product-moment correlation coefficient between height (h) and crown diameter of 4-year-old common birch sample trees growing in BMśw habitat

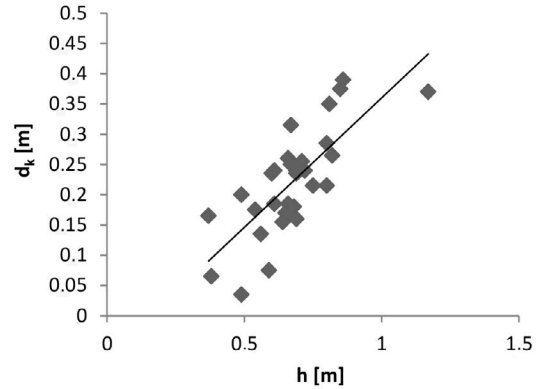


Figure 2. Pearson product-moment correlation coefficient between height (h) and crown diameter of 4-year-old common birch sample trees growing in LMśw habitat

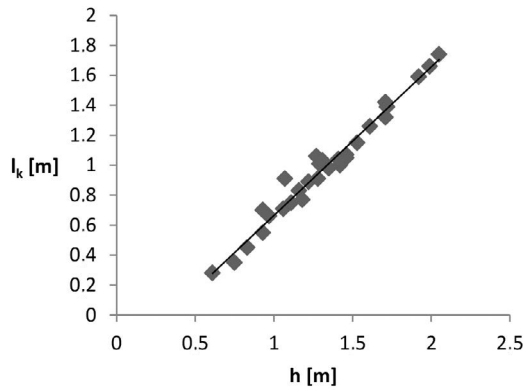


Figure 3. Pearson product-moment correlation coefficient between height (h) and crown length (l_k) of 4-year-old common birch sample trees growing in BMśw habitat

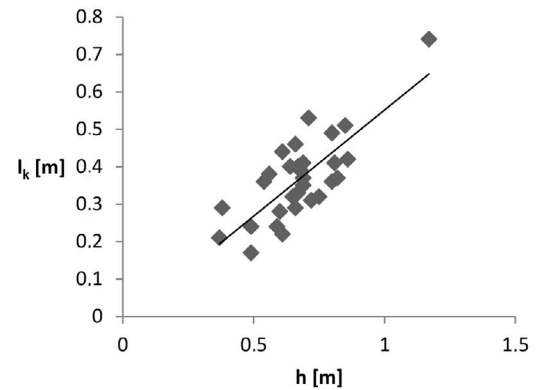


Figure 4. Pearson product-moment correlation coefficient between height (h) and crown length (l_k) of 4-year-old common birch sample trees growing in LMśw habitat

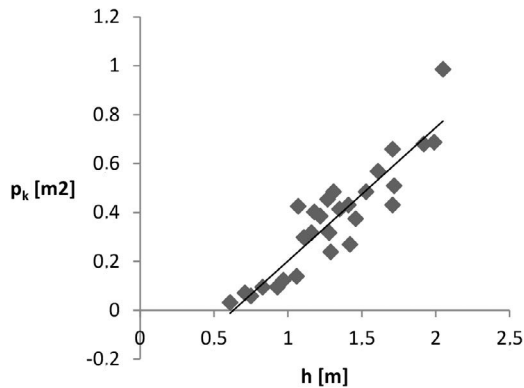


Figure 5. Pearson product-moment correlation coefficient between height (h) and crown projection area (p_k) of 4-year-old common birch sample trees growing in BMśw habitat

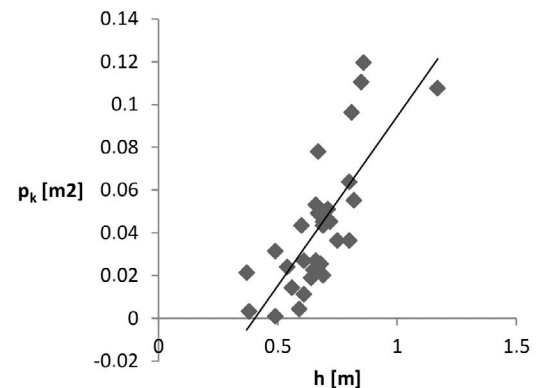


Figure 6. Pearson product-moment correlation coefficient between height (h) and crown projection area (p_k) of 4-year-old common birch sample trees growing in LMśw habitat

Table 3. The relationship between height (h) and selected crown characteristics and measures of the growth space of 4-year-old common birch

	r	r^2	Significance -95%	Significance +95%	p	Linear equation
Height to the crown base (h_{ok})						
BMśw	0.0493	0.0024	-0.3231	0.4084	0.7996	-
LMśw	0.6839	0.4677	0.4294	0.8377	0.0000	$y=0.014+x(0.434)$
Crown diameter d_k						
BMśw	0.8968	0.8042	0.7925	0.9501	0.0000	$y=0.082+x(0.567)$
LMśw	0.7611	0.5793	0.5523	0.8801	0.0000	$y=0.068+x(0.428)$
Crown length l_k						
BMśw	0.9858	0.9719	0.9697	0.9934	0.0000	$y=0.326+x(0.992)$
LMśw	0.7735	0.5984	0.5729	0.8867	0.0000	$y=0.014+x(0.566)$
Relative crown length $\frac{l_k}{h}$						
BMśw	0.7754	0.6012	0.5712	0.8892	0.0000	$y=0.432+x(0.220)$
LMśw	-0.0527	0.0028	-0.4053	0.3135	0.7819	-
Crown spread $\frac{d_k}{h}$						
BMśw	0.3533	0.1248	-0.0080	0.6330	0.0555	-
LMśw	0.2556	0.0653	-0.1153	0.5640	0.1728	-
Crown flattened $\frac{d_k}{l_k}$						
BMśw	-0.1373	0.0189	-0.4741	0.2346	0.4693	-
LMśw	0.2161	0.0467	-0.1564	0.5347	0.2515	-
Crown projection area p_k						
BMśw	0.9149	0.8370	0.8250	0.9596	0.0000	$y=0.345+x(0.546)$
LMśw	0.7679	0.5896	0.5635	0.8837	0.0000	$y=0.064+x(0.158)$
Single tree space ppd						
BMśw	0.9170	0.8408	0.8291	0.9606	0.0000	$y=0.777+x(1.016)$
LMśw	0.8468	0.7170	0.7001	0.9249	0.0000	$y=0.082+x(0.169)$
Percentage use of a unit area $pwjp$						
BMśw	0.9146	0.8365	0.8245	0.9595	0.0000	$y=-14.172+x(22.419)$
LMśw	0.7685	0.5906	0.5645	0.8840	0.0000	$y=-2.388+x(6.088)$
Leaves wet biomass $\acute{s}ml$						
BMśw	0.8722	0.7607	0.7465	0.9378	0.0000	$y=-89.167+x(120.467)$
LMśw	0.6752	0.4558	0.4101	0.8350	0.0001	$y=-3.993+x(13.226)$
Leaves dry biomass sml						
BMśw	0.8805	0.7752	0.7619	0.9419	0.0000	$y=-32.235+x(44.550)$
LMśw	0.6412	0.4111	0.3591	0.8160	0.0002	$y=-1.515+x(5.489)$

r – correlation coefficient, r^2 – coefficient of determination, p – value

BMśw – fresh mixed coniferous forest, LMśw – fresh mixed deciduous forest

4. Summary and discussion

Selection of the trees is fundamental for the forest cultivation and proper blending; therefore, it is advisable to be aware of the given trees growth, especially in the cultivation phases. The trees height is determined by the decision management for the date of maintenance procedures and forest preservation treatments, for example, protecting young trees from animals (Jaworski 2004). The average height (h) of the common birch tree growing in the cultivation in the mixed fresh coniferous habitat is almost twice as big as that of the common birch tree from the cultivation planted on mixed fresh deciduous habitat. The reason for this difference can be a more fertile habitat where a higher number of plants are present. Other plants compete with the common birch trees for the growth space and nutrients, especially in the first years since the cultivation was set up. These kinds of observations require additional confirmation through research. Studies conducted by Szymański in 1982 show that common birch tree growing on the mixed fresh coniferous habitat reached the average height of 2.04 m at the age of 4 years. Similar results for the common birch trees were presented by Dengler in Switzerland as well as Pogrebnjak who did research on common birch trees in Ukraine.

The average relative length for the common birch tree ($\frac{l_k}{h}$), which indicates the share of tree crown in the overall height of a silver tree growing in the mixed fresh deciduous habitat, is 0.55. It signifies that crown constitutes 55% of the whole tree height. The exact same results were achieved by Badoux (after Assmann 1968) who examined the crowns of common beech. The highest average percentage share of the tree crown in the overall tree height was reached by the common birch trees growing on the mixed fresh coniferous habitat – 73%. Similarly, Bijak (2003) received approximate results for the Caucasian fir (*Abies nordmanniana*) growing on the Forestry Experimental Management premise in Rogów, which belongs to the University of Life Sciences in Warsaw. Research conducted on common fir by Jaworski and others in 1995 indicates that the tree crown length seriously affects the girth increment. Tree crown morphological characteristics – its shape and structure – may be a reproductive indicator for the tree (Jaworski 2004). The final stage for the shoot increment (the extension for the trunk pivot which influences the tree height proximity) occurs between fifth and tenth year. This period of crown development is named as the youth phase or exploration phase. During this time, the tree crown grows rapidly, covering the space increasingly (Dmyterko, Bruchwald 2000). Received results should be treated as an output; therefore, it seems justifiable to carry on the research on the sample trees in the following years.

It is relatively simple to measure the trees height; thus, finding the correlation between height and other characteristics that are more difficult to obtain is understandable. Correlation between the tree height (h) and the tree crown length

(l_k) on the mixed fresh deciduous habitat was estimated at 0.7735. Very similar correlation has been drawn by Turski et al. (2012), on the one hand, for the pine tree belonging to the I–III Kraft class and IV class of age. On the other hand, this particular correlation for the common birch tree growing on the mixed fresh coniferous habitat was more vehement and amounted to 0.9858. It implies that the tree crown length (l_k) is reliant on the tree height (h) about approximately 99% of time. The correlation factor between the tree height (h) and the growth space of a single tree (ppd) amounted to 0.9170 for the mixed fresh coniferous habitat and 0.8468 for the mixed fresh deciduous habitat. These relations are stronger than relations presented by Kaźmierczak (2010, 2012) for the 50- and 35-year-old common pine trees. A correlation between tree' length (h) and other characteristics of tree crown as well as space growth measurements was proved. Relations between height (h) and the degree of the crown spread ($\frac{d_k}{h}$), the degree of the crown flattening ($\frac{d_{lk}}{l_k}$) (for both types of habitat), height to the crow base (h_{ok}) (for the mixed fresh coniferous habitat) and the relative tree crown length ($\frac{l_k}{h}$) (for mixed fresh deciduous habitat) are not statistically essential.

Correlation between smoothness and height of the 30-year-old unattended common birch tree growing in the mixed fresh coniferous habitat was analysed by Korzeniewicz et al. (2016). The linear correlation factor was estimated to be –0.0946 and deemed not important statistically.

5. Conclusions

The study has shown that common birch grows faster in fresh mixed coniferous than in fresh mixed deciduous forest.

There is a significant positive correlation between the height of the trees and the width of the crown and its length, so it can be expected that trees that grow faster will have bigger crowns and reach the youth phase of growth earlier.

The timetable for breeding and protection should include the height of the trees and related significant morphological features of the crown.

Correlations between tree height and crown traits can be used to determine the productivity of the young common birch tree.

Conflict of interests

Author declares no potential conflicts.

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