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First Experience of Paulownia Bellissia® Cultivation in an Agroforestry System in the Czech Republic

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Abstract. *Paulownia* spp. comes from South-East Asia, where there is a tradition of its cultivation. Social pressure, in favour of the use of renewable sources of energy and sustainable agriculture, is on the rise. In this context, agroforestry has become a significant topic of interest. *Paulownia* spp. could be one of the species utilized in this field. That is why, in 2014, the experimental agroforestry system, which was intended for the production of fodder for farm animals, and also for the production of saw timber, was established in one of the warmest areas of the Czech Republic. The aim of this research was to evaluate the production potential of Paulownia Bellissia®. The measuring of the heights and thicknesses, and the determination of the extent to which the plants were damaged, were conducted during 2017–2020. The plantation consisted of two plots, where the plants on the first plot (treated plants) were regularly irrigated and annually pruned and those on the second (reference plants) were not. The treated plants reached a mean annual increment of 1.6 m in height and 2.8 cm in diameter at breast height, but almost 80 % were sunscalded, whereas the reference plants reached only 1.1 m and 2.0 cm but remained undamaged. Most of the damaged plants were also infested with parasitic fungi *Schizophyllum commune* and *Trametes hirsuta*, while the occurrence of *S. commune* on plantations of Paulownia was found as one of the first discoveries in the Czech Republic.

Keywords: sunscald, fungal pathogen, agroforestry system, dendrometric parameters, *Paulownia* spp., the Czech Republic

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Научная статья

Первый опыт выращивания Paulownia Bellissia в системе агролесомелиорации Чешской Республики

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Аннотация. В настоящее время увеличивается необходимость использования возобновляемых источников энергии и ведения устойчивого сельского хозяйства. В связи с этим агролесоводство представляет существенный интерес. *Paulownia* spp. может стать одним из видов, применяемых в этой области. Родина *Paulownia* spp. – Юго-Восточная Азия: здесь сложилась традиция ее выращивания. В 2014 г. в одном из самых теплых районов Чешской Республики была создана экспериментальная система агролесомелиорации, включающая посадки данного вида, предназначенная для производства сельскохозяйственных кормов, а также пиломатериалов. Цель исследования – оценить производственный потенциал деревьев Paulownia Bellissia. Измерения высоты и диаметра, а также определение степени повреждения деревьев проводились в период с 2017 по 2020 гг. Плантация была разделена на 2 участка: павловнию на 1-м участке регуляр-

но поливали и ежегодно подрезали, на 2-м участке (контроль) уходы не проводились. Обрабатываемые деревья характеризовались среднегодовым приростом 1,6 м в высоту и 2,8 см в диаметре на высоте груди, однако почти 80 % подверглись солнечным ожогам, тогда как контрольные деревья имели показатели 1,1 м и 2,0 см соответственно, но остались неповрежденными. Большинство поврежденных деревьев также оказались зараженными паразитическими грибами *Schizophyllum commune* и *Trametes hirsute*. При этом случай появления *S. commune* на плантациях павловнии стал одним из первых в Чешской Республике.
Ключевые слова: солнечный ожог, патогенный гриб, система агролесомелиорации, дендрометрические показатели, *Paulownia* spp., Чешская Республика
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Introduction

Paulownia spp., commonly, is a species characterized by extremely fast growth, intensive sprouting ability and adaptability to various climatic and soil conditions [16, 21, 60]. It produces wood that can be used for energy, or also as saw timber. It is therefore considered a suitable species for large-scale (i.e. plantation) production [2, 55]. Zhao-Hua et al. [60] state that one-year-old plants have a mean height of 4 m, and some can reach a height of more than 6 m. According to OXYTREE [36], six-year-old plants reach a height of up to 18 m and their mean diameter at breast height (DBH) should exceed 30 cm. The technical report published by UCLM [49] gave similar values (the six-year-old plants had a mean DBH of 30 cm, a mean height of 16 m, and a lumber log volume of 0.5 m^3).

The native area of *Paulownia* spp. extends from the middle to the lower section of the Yangtze River [60]. At present, it grows on all continents (except Antarctica) as a decorative tree in parks and gardens, or as a source of wood in plantations and stands [19]. On the territory of the Czech Republic (the CR), Paulownia was first planted as a decorative tree in 1844 [51], and the first plantations began to appear around 2010 [17].

Paulownia spp. species are classified according to the level of cultivation as:

1) Wild (*Paulownia albiphloea* Z.H.Zhu sp.nov, *P. catalpifolia* T. Gong ex D.Y. Hong, *P. fargesii* Franch etc.), which occur scattered and only in valleys in China [60]. They are small and have crooked stems and, therefore, growing them in plantations would bring no economic benefit.

2) Semi-wild (also called “naturally crossed”: *Paulownia fortunei* (Seem.) Hemsl., *P. elongata* S.Y.Hu, *P. tomentosa* Steud. etc.) are the result of a long-term and targeted acclimatization [30, 39, 57, 60]. These have more intensive growth and greater resistance to disease than the wild species (above), however, they too are not suitable for plantations and are therefore planted in small groups [30, 39, 57].

3) Art (also called "artificially crossed hybrids", hereinafter referred to as "hybrids") started to be bred from the 1980s in China [39, 57]. The plant breeders tried to develop a strong, resistant, highly-quality and voluminous individual through crossing and artificial selection [30, 39, 57]. At present, there are dozens of hybrids on the market: Paulownia Shan Tong, P. Bellissia®, P. Clon *in vitro* 112®, P. Paulemia®, P. Shan Dong etc.

Agroforestry is defined as the management of an area where the cultivation of trees is combined with some form of agricultural production [12]. The development of modern forms of agroforestry in the CR began around 2000, when the uniform agricultural land was unable to meet the ecological and social demands that were placed on it. During 2015–2019, the alternation of extreme droughts with torrential rains highlighted the negative aspects of the sterile monoculture landscape and provoked a nation-wide discussion leading to an intensive utilization of the agroforestry systems in the conditions of the CR [33].

Wang and Shogren [55] wrote that Paulownia had been used in the agroforestry systems in China, and they estimated that there were three million hectares of land used for the agroforestry systems in the early 1990s. Yin [59] states that the utilization of Paulownia in the agroforestry system increases the volume of agricultural production. The using of Paulownia with cereals, as a type of the agroforestry system, increased the yield of wheat by about 23 % and of millet by about 20 % [1, 60]. Puxeddu et al. [42] mention the utilization of Paulownia in the agroforestry systems in Sicily and Hungary. Leaves and non-lignified parts of Paulownia are used in animal production as feed, because their nutritional content is greater [6]. In China, for example, the leaves are used as fodder for sheep, cattle and pigs [60].

The CR is, according to the maps based on PLANTMAPS. International Hardiness Zone Maps [40], located in the 7th zone, which stretches from the south-eastern part of Germany, the foothills of the Alps, throughout the CR, Slovakia (except the Tatra Mountains), almost all of Poland and the eastern part of Hungary, up to the southern Balkans (in the south) and the Baltic states (in the north). According to Köppen's Climate Classification Map [27], the CR is located in the Dfb zone, which extends from eastern Germany, throughout Austria, the CR, Slovakia, Hungary and Romania to the upper part of the southern Balkans (in the south), the southern part of Scandinavia (in the north) and across the Baltic states, Belarus and Ukraine to the south-western part of Russia.

In 2014, the company JUKKA s.r.o. established an experimental agroforestry plantation, where the P. Bellissia® was intended as a source for saw timber, and the hay from the dried grass underneath for fodder for farm animals, which is basically a silvopastoral system, as one of the types of agroforestry system [12]. The measurement of the heights, DBH and finding of disease was conducted in 2017–2020, and its aim was to evaluate the production potential and possible occurrence of diseases of P. Bellissia® in the conditions of southern Moravia, as one of the warmest areas in the region of central and eastern Europe.

Research Objects and Methods

Description of the Research Plot. The plantation of P. Bellissia® was established in 2014 in two fenced areas at an altitude of ca 180–200 m a.s.l. One plot was in the centre of Uherský Ostroh (48°59'02.5" N; 17°23'42.9" E) and the second – in nearby

Ostrožská Nová Ves (48°59'59.0" N; 17°26'55.5" E). In the past, these two plots were used as agricultural lands and, according to our pedological survey, these types of soil are a Cambisol [22]. The plot in Uherský Ostroh had an area of ca 0.22 ha and the one in Ostrožská Nová Ves – an area of ca 0.02 ha. In the spring of 2014, the owner planted 60 plants in Uherský Ostroh and 12 in Ostrožská Nová Ves. The mean monthly air temperatures and precipitation within 2014–2020 that were obtained from the weather station in Staré Město (49°04'21.4" N; 17°26'16.5" E) are contained in the table below [8].

The mean monthly air temperatures and precipitation for the studied territory

Year	Month												ϕ annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Air temperature, °C													
2014	1.8	4.1	8.2	11.4	14.2	18.3	21.4	17.7	15.7	11.3	8.0	2.3	11.2
2015	1.4	1.4	5.6	9.8	14.4	18.8	22.6	23.2	15.7	9.5	6.3	3.1	11.0
2016	–1.2	5.0	5.4	9.8	15.2	19.8	21.0	18.9	17.3	8.7	4.6	–0.2	10.4
2017	–5.1	1.4	7.8	8.9	15.6	20.4	20.9	21.7	14.1	10.4	4.9	1.6	10.2
2018	2.4	-2.0	2.6	15.0	18.3	19.9	21.6	23.2	16.1	12.0	6.2	1.5	11.4
2019	–1.4	2.4	6.8	11.4	12.1	22.2	20.3	21.1	14.9	11.2	8.0	2.7	11.0
2020	–0.1	5.0	5.4	10.3	12.3	18.1	19.3	20.9	15.5	10.3	4.8	3.0	10.4
Precipitation, mm													
2014	23.6	27.2	11.7	29.9	67.8	34.4	89.9	62.6	85.9	38.5	29.6	28.2	529.3
2015	37.9	11.7	31.0	23.7	46.1	19.7	50.6	91.3	39.8	31.5	33.7	11.8	428.8
2016	28.5	68.3	13.2	42.4	43.6	47.9	93.0	55.9	20.5	61.5	32.9	6.1	513.8
2017	23.7	21.5	18.9	59.7	49.5	46.7	78.5	21.7	96.7	52.1	40.4	38.5	547.9
2018	45.7	22.2	21.2	16.3	43.4	47.4	21.1	30.4	104.6	14.1	5.9	14.0	386.3
2019	34.2	19.0	32.5	19.6	92.6	39.7	56.3	46.8	62.1	45.9	41.4	47.9	538.0
2020	11.1	47.2	40.4	13.0	77.6	124.8	68.8	42.2	58.2	123.5	18.2	31.6	656.6

P. Bellissia® is a hybrid of *P. elongata* and *P. fortunei*. The resulting hybrid has been crossed with *P. elongata* [4]. P. Bellissia® has a trademark and it is registered in the Serbian Register of Protected Plant Varieties under no. 321-01-01676/2/2016-11, expiring on March 22, 2047 [46], and in the European Union under no. BR. 3417 [3].

Silvicultural Treatment. The planting material that had been cultivated from the root cuttings was planted in the form of container saplings, each of which had a volume of the root ball of about 1 litre, a height of ca 60 cm and a root collar ca 1.2 cm thick. The plots were fenced before planting. The plants were placed into the holes of 40 cm in diameter, 50 cm deep, and with a spacing of 4 × 3 m, where each was assigned a unique number, according to the row and its position within it. The dead plants were not replaced.

After the first year, at the beginning of the vegetation season, the stem of each plant was cut, leaving a 5 cm stump. After germination of the sprouts, the strongest (i.e. the healthiest and longest) sprout on each stump was chosen and the others removed. This silvicultural treatment is recommended for Paulownia [21, 49, 60]. The main objective of such treatment is to create a strong root system and, subsequently, a greater increment of the newly growing sprout [60].

The upper parts of the plants were damaged by frost each winter. Zhao-Hua et al. [60] stated that the above-ground parts of *P. fortunei, P. tomentosa* and *P. elongata* etc. are damaged by frost each winter, but there is no mention of what happens to P. Bellissia®. The terminal bud and the buds of the first two internodes are frequently damaged [60] and, if so, then the newly growing stem sprout, which is the highest on the stem, becomes the terminal shoot. The mulch tarps (50 × 50 cm in size) were laid out around the plants as protection against weed vegetation and removed after four years. All of the grass in the plantation was mowed and, successively, the hay was used as fodder for animals. The plants in Uherský Ostroh (hereinafter referred to as treated plants) were irrigated using a drip irrigation system during the drought, and regularly pruned up to a height of 5 m. The plants in Ostrožská Nová Ves (hereinafter referred to as reference plants) were not irrigated and pruned.

Methods of Measurement. The first time that the treated and reference plants were measured was 4 years after planting (i.e. autumn 2017), and then each year until autumn 2020. The total height of each plant was measured from the stem foot to the top using a telescopic measuring pole (in 2017 and 2018) and a Nikon Forestry pro II laser altimeter during 2018–2020. The circumference was measured at breast height with a circumference tape and recalculated to diameter, thus determining the DBH. The mean annual increments were obtained when the total heights and DBHs (that were measured / recalculated in 2020) were divided by 7 (i.e. the number of years of the existence of our plantation).

Each plant was measured (i.e. its height and circumference), examined and, if damaged, the cause was investigated.

Statistical Analysis. Statistical analysis of the data was performed using TIBCO Statistica™ with a reliability interval of 95 %. The normality of the data distribution was examined before the main analysis. The main effects were analysed using ANOVA, after which Fisher's LSD test was applied, in order to identify the differences in the main effects and interactions.

Results and Discussion

Dendrometric Parameters. After the 4th vegetation season, the mean height of the treated plants exceeded 7 m, which was about 35 % more than that of the reference plants ($p = 0.0001$; Fig. 1). In the years 2018 and 2019, the mean height differences between the treated and reference plants were similar to that in 2017 (2018: 42 %; $p = 0.0001$ and 2019: 34 %; $p = 0.0001$). During the last measurement (autumn 2020), the mean height of the treated plants was 11.5 m (± 0.8 m), which was about 33 % more than that of the reference plants ($p = 0.0001$). The mean annual height increment was 1.3 m (± 0.1 m), whereas that of the reference plants was only 1.1 m (± 0.3 m; with $p = 0.0001$).

After the 4th vegetation season, the mean DBH of the treated plants was greater than 14 cm, which was about 24 % more than that of the reference plants ($p = 0.0001$; Fig. 1). In the years 2018 and 2019, the DBH differences between the treated and reference plants were similar to that in 2017 (both 24 %; $p = 0.0001$). During the last measurement, the mean DBH of the treated plants was 20.1 cm (± 4.3 cm), which was about 33 % more than that of the reference plants ($p = 0.0001$). The mean annual thickness increment was 2.8 cm (± 0.6 cm), whereas that of the reference plants was 2.0 cm (± 0.4 cm; $p = 0.0093$).

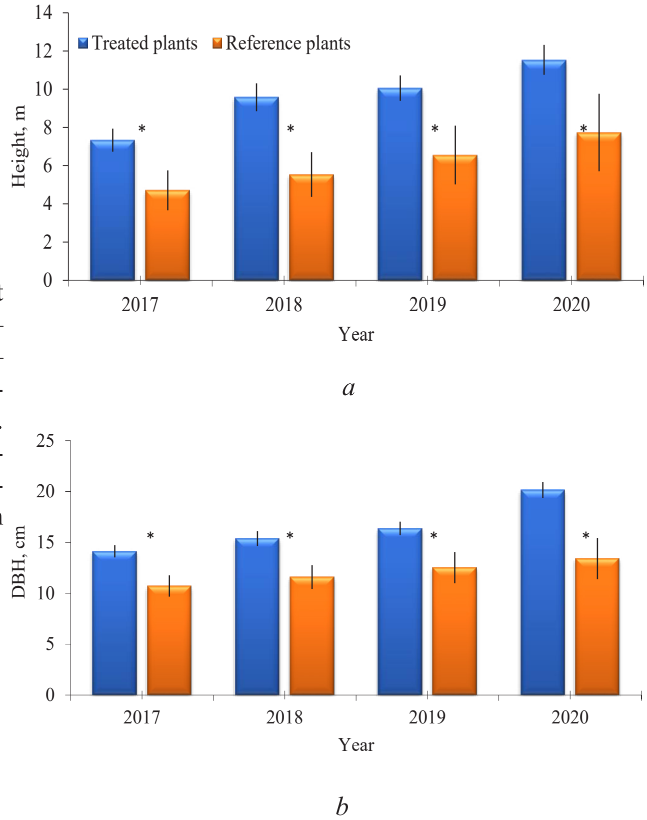
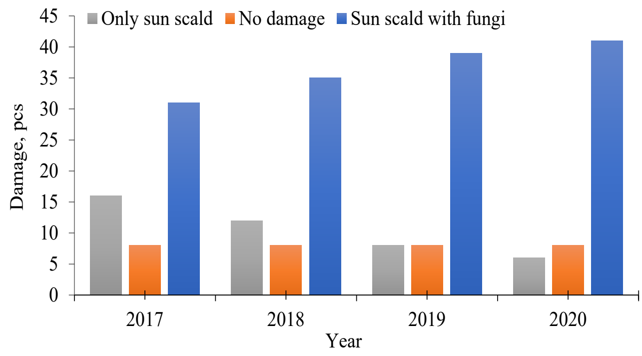


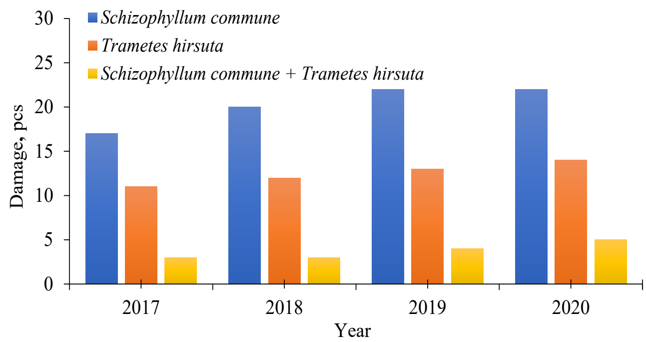
Fig. 1. The development of dendrometric parameters: *a* – development of height; *b* – development of DBH. The whiskers indicate standard deviation. Statistically significant differences between the treated and reference plants are marked with the asterisks

Damage. The first observation of the type and extent of the damage was conducted in 2017. In this year, all reference plants remained undamaged and 78 % of the treated plants were sunscalded (Fig. 2). During the following measurements, there was no increase in the numbers of the damaged plants (treated or reference). The sunscald always appeared on the lower half of the stems on the south or south-east side. During 2017–2020, we found the fruiting bodies of the wood-decaying parasitic fungi on most of the damaged stems. These bodies were always situated in the lower half of the stem, in places where the bark was sunscalded.

In 2017, the fruiting bodies were detected on the stems of 31 treated plants from a total number of 47 damaged plants (i.e. 66 %; Fig. 2). They were found to be *Schizophyllum commune* Fr. on 17 stems and *Trametes hirsuta* Wulfen (Lloyd) on 11 stems. The fruiting bodies of both fungi occurred on 3 stems. In 2018, the number of uninfected sunscalded plants decreased. In this year, 12 treated plants were only sunscalded. Moreover, we found the fruiting bodies of *S. commune* on 3 additional plants and *T. hirsuta* on 1 additional plant. Cumulatively, with the values from 2017, there were 20 plants infected with *S. commune* and 12 with *T. hirsuta*. In 2019, the number of uninfected sunscalded plants decreased further. There were only 8 sunscalded plants. On the other hand, the number of plants with the fruiting bodies increased. In this year (cumulatively with the previous years), there were fruiting bodies of *S. commune* on 22 plants and those of *T. hirsuta* on 13 plants and those of both fungi on 4 plants.



a



b

Fig. 2. The development of damage: *a* – development of the non-damaged plants and damaged plants; *b* – development of the fruiting bodies of the wood-decaying parasitic fungi on the sunscalded plants

In 2020, there were 6 uninfected sunscalded plants, 22 plants infected with *S. commune*, 14 with *T. hirsuta* and 5 with both.

We recorded different mean annual height increments of the treated and reference plants. The seller of P. Bellissia® promotes a total height of more than 15 m after 8–9 years from planting [5], which corresponds to a mean annual height increment between 1.6 and 1.8 m. On the other hand, Gyuleva et al. [18] describe the growth of a five-year-old plantation of hybrid *P. elongata* × *P. fortunei* in Bulgaria, and they state that the total height was 5 m five years after planting (i.e. the mean annual height increment was 1 m). The treated plants had a mean annual height increment of 1.3 m, which is slightly less than is the minimum value stated by the seller, and that of the reference plants was much less than that stated by the seller, however, both the treated and the reference plants had a greater mean annual height increment than those described by Gyuleva et al. [18].

The mean annual thickness increment should reach at least 3 cm [4, 5]. It is evident that that of the treated plants came only close to this value. The reference plants had an even smaller mean annual thickness increment. Gyuleva et al. [18] showed that the mean annual thickness increment was 1.2 cm in Bulgaria, which is smaller than those of the treated and reference plants.

A lack of precipitation was obviously one of the main factors affecting plant development. According to CHMI [8], the mean precipitation (that fell throughout the existence of the plantation) was 515 mm per year (i.e. ca 40 mm per month) and 320 mm per vegetation season (from April to September, i.e. ca 55 mm per month in the vegetation season). It seems that there is less precipitation than Paulownia needs. UCLM [49] state that the minimum annual precipitation necessary for proper growth is 750 mm and Jabloński [23] states at least 800 mm. Zhao-Hua et al. [60] wrote that Paulownia grows in areas where the amount of the precipitation varies in the range of 500 to 3,000 mm. However, they stress that if the precipitation drops to the minimum of this interval, then most of the precipitation should fall during the vegetation season. That did not happen at our locality because only slightly more than half of the total precipitation fell during the vegetation season. Also, BIO TREE and TGG [4, 48] described that Paulownia needs most of the precipitation to fall during the vegetation season. Moreover, TGG [48] claims that the monthly precipitation in the vegetation season should be at least of 150 mm in the first year after planting. The mean monthly precipitation in the vegetation season was only 55 mm on our plantation, which is only a third of the necessary amount given by TGG [48]. A possible precaution against drought – lack of rainfall – is irrigation [4, 23, 48, 49, 60], at least in the first years after planting [4, 48, 49]. Only the treated plants had drip irrigation installed. Due to this, it was possible to observe the influence of insufficient water. While these plants had a height of 11.5 m and a DBH of 20.1 cm in 2020, the reference plants had a height of 7.7 m and a DBH of 13.4 cm, which was very different and statistically significant.

The treated plants were pruned every year in such a way that the leaves and branches were removed from the lower part of the stem up to a height of 5 m (i.e. the crown was created at a height of 5 m and more). The same procedure is recommended by Martiník et al., Neilsen and Pinkard, Waugh and Yang and Zhao-Hua et al. [33, 35, 56, 60]. The reference plants were not pruned, which could also be one of the reasons as to why their growth slowed down [15, 35, 41, 60]. We assume that the pruning had a positive influence on the plant increment, however, this also brought about more damage by sunscald and subsequent attacks to the stem by the wood-decaying fungi.

Clatterbuck and Hodges, Kays et al., Paulownia Moravia and Zhao-Hua et al. [9, 25, 38, 60] describe the occurrence of damage by sunscald to Paulownia. We found out that it was only the treated plants (78 %) that had been damaged, whereas the reference plants remained healthy and undamaged. Moreover, we found the damage only during the first measurement and did not record other damage to the plants by sunscald during subsequent measurements. We therefore assume that this finding corresponds to the assumption that the sunscald appeared on the stem in the first years after planting, when the bark of younger Paulownias is thin and smooth [51], and therefore susceptible to this kind of damage [29]. Later, the bark becomes rougher and thicker [54] and, although it is exposed to solar radiation, it is no longer sunscalded [9, 25]. Moreover, we assume that the damage was caused by the activity of more factors – not only by solar radiation. In our case, it seems that other significant factors can be pruning in the first years because the sunscald appeared only on the treated plants. Jančařík, as well as Kays et al. [24, 25], show that species with smooth bark are sunscalded when their bark is suddenly exposed to solar radiation after pruning or felling of the surrounding trees.

The occurrence of the fruiting bodies of the wood-decaying fungi *S. commune* and *T. hirsuta* was recorded only on the sunscalded plants. It can be assumed that the sunscald was the gateway via which the spores of these fungi entered the stems [24]. *S. commune* (Basidiomycota, Agaricales, *Schizophyllaceae*) is a fungal parasite and saprotroph that causes white decay [10, 26]. This fungus has a wide range of potential hosts (broadleaves and coniferous species), it can adapt, and therefore occurs in other types of biome, and on all continents, with the exception of Antarctica [7, 20, 26]. Holec et al. [20] describe very abundant occurrence on all the other parts of the tree, including those that are illuminated by sunlight. The fruiting bodies of *S. commune* appear a few weeks after the penetration of infection. They grow one year, then die, but they stay dry on the tree for a year or longer, and then fall to pieces. Sinclair and Lyon [45] show Paulownia as a possible host of *S. commune* in the cases, where the species is stressed by a lack of water and/or high temperature or has damage to the bark. Takemoto et al. [47] state that *S. commune* attacks trees through the sunscalded bark. Boháčová and Gáper [7] state that the infection penetrates the tree, causes its death and subsequent saprotrophic decomposition of the stump. Also, Černý [11] mentions that *S. commune* very quickly attacks live rough wood, including the stump.

The fungal pathogen – *T. hirsuta* – was also found on the sunscalded plants. Just like *S. commune*, *T. hirsuta* (Basidiomycota, Polyporales, *Polyporaceae*) is a fungal parasite and saprotroph attacking broadleaved species [31] worldwide [37]. It also has white rot and enters the tree through the sunscalded bark [31]. In the last century, in the region of Czechoslovakia, *T. hirsuta* was found even on *P. tomentosa* [28]. Milenković et al. [34] describe its occurrence on Paulownia in forest nurseries and plantations in Serbia. On our plantation, we recorded increasing occurrence of *S. commune* and *T. hirsuta* during the observation period. We always noticed the fruiting bodies of *S. commune* and then those of *T. hirsuta.* Boháčová and Gáper [7], who confirm this, wrote that *S. commune* is able to create suitable conditions for the colonization of the plant by other types of fungi.

From the economic point of view, the rough wood attacked by white decay cannot be used for the production of saw assortments but only for the production of wood-pulp, wood-based panels, chips etc. [50]. Moreover, we assume that the plants damaged by these pathogens will die. The new silvicultural rotation of these plants through stump coppicing will be problematic because, after felling: a) *S. commune* and *T. hirsuta* will remain in the stumps of the damaged plants, and b) the fresh cut on the stump of the undamaged plant is a gateway through which the spores of *S. commune* and *T. hirsuta* can enter the plants.

Conclusion

We observed the growth of and damage to the plants of Paulownia Bellissia® on our agroforestry plantation in the Czech Republic.

The annual height increment of the treated (i.e. irrigated – in periods of drought – and pruned) plants was slightly smaller than is the minimum stated by the seller [5] and the reference (i.e. unirrigated and unpruned) plants had an annual height increment, which was significantly lower (by about 33 %) than that stated by the same seller. The annual thickness increments of the treated and reference plants were smaller than that stated by the seller [5] but greater than that in Bulgaria [18].

The two factors which affected the growth of the plants were drought and pruning. Regarding drought, we measured evident differences between the treated and reference plants, where the treated plants grew more. The smaller growth of the reference plants was caused by less precipitation throughout the vegetation period (i.e. 55 mm vs. the 150 mm recommended by TGG [48]) and, therefore, when we compared the treated and reference plants, we found out that the height and thickness increment was greater due to irrigation. The other factor, pruning, positively affected the increment of the plants. On the other hand, after the branches were removed, the stem was exposed to the sun and, successively, sunscalded. We were led to this conclusion by the fact that more than 80 % of the treated plants were sunscalded, while all the reference plants remained undamaged. Subsequently, the occurrence of the fruiting bodies of the wood-decaying fungi *Schizophyllum commune* and *Trametes hirsuta*, were noted on most of the sunscalded plants. These fungi are typical wound parasites of broadleaved species. Individuals affected by fungal pathogens will die, and their wood will become worthless due to decay.

It is possible to assume that the vegetation regeneration of all plants will be problematic. If the stump is left untreated, there is a high risk (according to the sources, from 64 to 100 %) that it will be a gateway for spores of fungal pathogens [43, 52, 53, 58], as a result of which the newly growing plants will die in the following years [13, 44, 52].

It is therefore necessary to protect the pruned plants from sunscald (for example by white painting) and treat all the major cut wounds (after the removal of thicker branches, especially those on the stumps) with a tree balm or a resin-based product, which reduces the amount of vapour from the wounds and, also, their primary permeability, thus preventing the entry of fungal pathogens [14].

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