LIGHT TREATMENT AND GROWTH OF PLANTS IN THE SELF-SEEDING OF PEDUNCULATE OAK (*Quercus robur* L.) IN FLOODPLAIN FORESTS

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Abstract

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The most commercially important community in which pedunculate oak can be found is the floodplain forest. Rejuvenation of pedunculate oak that could become a foundation for the natural stand regeneration however occurs only rarely in these site conditions, and even if it appears, it dies very rapidly in the shade of the parent stand. Some experts can see a reason to this phenomenon in water deficiency but most of them claim that the main reason to the decline of seedlings is insufficient light. The work was therefore focused on measurements and analyses which would enable to specify conditions (light conditions in particular) in which the self-seeded pedunculate oak can do well. In 1999 (year with extremely good crop of acorns), several sample regeneration plots were aligned which differed by insolation of the self-seeding or – in other words - by the reduction of the parent stand above the self-seeding. Oak seedlings growing in full insolation were growing best. In contrast, a full shade by the parent stand resulted in rapidly dying seedlings of up to 3 years, and the self-seeding with only a half light treat exhibited only a negligible increment and vitality loss. The growth of seedlings can be restored only in the case of improved light treat by a total elimination of stand shelter above them after the first year of life of the self-seeding. However, favourable conditions for a sound growth of the self-seeding can be generated only by a stand with the pedunculate oak of good morphological quality, which has been long prepared for natural regeneration (with a proper vertical and horizontal structure).

Key words: natural regeneration, pedunculate oak, floodplain forest, light conditions, competition of vegetation, southern Moravia

Introduction

Quercus sp. is a broadleaved tree species with the highest share in the species composition of Czech forests – 6.5% (Collective of authors, 2003). The lowest altitudinal zones are naturally dominated especially by two oak species – pedunculate oak (*Quercus robur* L.) and sessile oak (*Quercus petraea* [M a t t u s c h k a] L i e b l.). Stands of the two species are regenerated mostly by using artificial methods of regeneration although there is some experience from the natural regeneration of sessile oak on low-nutrient and drying-out sites. The methods of regeneration would be however very problematic in pedunculate oak in which sowing or planting are used after large-scale clearcuts with a whole-area site preparation. This is why the research is focused on this oak species with the aim to find out possibilities of its natural regeneration.

The complexity of pedunculate oak natural regeneration consists in several aspects. One of them is a fact that seed year in which a great amount of acorns ripe, which could make a good base for the natural regeneration, are rather rare in our conditions (Vacek et al., 2000). And even if a certain number of seedlings from the natural self-seeding emerge, they die very rapidly under the shade of the parent stand (Lust, Speleers, 1990). In general terms of natural regeneration of trees, the shelter provided by the parent stand is important for seeding; on the other hand, it represents for the self-seeding a competition for light and nutrients during the emergence and growth of the seedlings. However, the parent stand shelter and its presence have also some advantages that must be taken into account. The parent stand provides a protection to the self-seeding against extreme climatic effects such as strong solar radiation and frost, reducing the development of other plants which would also represent a competition for light, water and nutrients for the self-seeding, and facilitating a subsequent self-seeding from the next seed crops. In the case of floodplain forests, some experts consider the main reason to the decline of self-seeded oaks under the parent stand to be light deficiency (Lüpke, 1998; Vaňková, Martinková, 2003 etc.), some other take water for being another limiting factor (Löf et al., 1998). A key to the successful natural regeneration of pedunculate oak stands in the case of a good seed year is thus a proper method of working with the parent stand, intensity of its reduction and rate of its removal in shelterwood felling.

With respect to desheltering of the pedunculate oak self-seeding it must always be born in mind that the species is light-loving (Úradníček, Chmelař, 1995) with a low tolerance to shade from above while side shading is indispensable for a sound development of high-standard stems without branches. This is why the parent stand must be removed much earlier than in other – more shade-loving - tree species in which the natural regeneration under the stand is currently used for stand regeneration (e.g. European beech (*Fagus sylvatica* L.), Norway spruce (*Picea abies* (L.) K a r s t.) on acidic sites). In fact, a number of experts confirm a certain early tolerance to shade even in pedunculate oak although their opinion about its duration differ and is explained mostly by availability of nutrient supplies from the acorns. For example – Rohring (1967 in Welander, Ottosson 1998) found out one- and two-year old oak seedlings to be able to grow at 1–2% of the full insolation. Research works made by Lüpke (1998) and Ziegenhagen, Kausch (1993) also confirm that an extremely dense crown shelter is tolerated in the first or second year of the regeneration. Welander, Ottosson (1998) claim that in their first year of life the oak seedlings are observed to show the same good growth under the shelter of the parent stand as those of beech and seem to be therefore adapted to shade equally well. Similar results are reported by Požgaj (1990).

It further follows out from the literature that after a relatively short time when the oak self-seeding is capable of tolerance even to a deep shade the light shelter must be strongly reduced. Lust, Speleers (1990) corroborated by their research work that opening of the crown canopy is necessary after the first year of growth at a latest for the pedunculate oak self-seeding to survive. Welander, Ottosson (1998) add furthermore that the requirements of seedlings for a higher solar radiation intensity increases already in the second year, which implies that the parent stand should be reduced after the first year of the seedlings' growth. The radical reduction of parent stand shelter after one or two years of self-seeding growth is recommended by Lüpke (1998) with Nesterov (1954 in Vyskot, 1958), Larfouge (1990) and Duplat (1996) advising even a total removal of the parent stand.

Floodplain forest is a very fertile site in which stands are rapidly overgrown with weeds after having been exposed to even a weak light, which makes natural regeneration difficult and even unfeasible (Plíva, 2000). This is why methods recommended in Croatia and France advocate fast and intensive procedures in the implementation of shelterwood felling for pedunculate oak natural regeneration in the floodplain, which would enable the oak self-seeding to rapidly grow out from the influence of the competing vegetation (Larfouge, 1990; Matic, 2000 etc.) with the weed control measures being at all times a must in the first year of the self-seeding development. In Croatia and France, the self-seeding is fully insolated 3 to 5 years (4 to 8 years, resp.) after the start of regeneration (seeding). The more regular the seed years occur in the region, the lower is a possible incidence of late frosts, water-logging and weed infestation of the regenerated area, and the lesser is the number of gaps in the self-seeding, the more rapidly would be felled the stand shelter above the self-seeding and the light-treat of the self-seeding enhanced (Lanier, 1986).

Based on the above knowledge and experience, a research object was established in the largest stretch of floodplain forests at a confluence of the Dyje and Morava rivers with an objective to establish the best light conditions for the development of pedunculate oak self-seeding growth, which are specified by the rate and intensity of removing the parent stand shelter.

Material and methods

Characteristics of the locality

The measurements were made at the State Forest Enterprise of Lesy České Republiky in Židlochovice (Forest District Lanžhot) where a research facility was established in the complex of floodplain forests in 1999 to study natural regeneration of pedunculate oak. The site comes under a group of forest types 1L – Elm floodplain according to the ÚHÚL typological system, concretely Forest type 1L2 – Elm floodplain with goutweed on Fluvisol, which was verified by phytocoenological relevés and by a soil pit. In terms of geobiocoene type groups (GTG), the sites in question are Hornbeam-Elm Ash of the lower type (*Ulmi-fraxineta carpini inferiora*) 1 BC-C (3)4 (Buček, Lacina, 2002). The locality takes up the relatively driest parts of the flat alluvium, situated outside the reach of regular inundations.

Main tree species is pedunculate oak of above-average standard. A considerable share is also taken up by narrow-leaved ash (*Fraxinus angustifolia* V a h l.) and small-leaved linden (*Tilia cordata* M i l l.) in admixture, frequently occurring in the sub-level. The sub-level is further represented by field maple (*Acer campestre* L.) and hornbeam (*Carpinus betulus* L.). Other species occurring only sporadically are poplars (*Populus* sp.), wild pear (*Pyrus pyraster* L.) and some other oak species such as Turkey oak (*Quercus cerris* L.) and red oak (*Quercus rubra* L.). The shrub layer has an abundant representation of English hawthorn (*Crataegus laevigata* (P o i r e t) DC.).

Weeds (herbs and grasses) appear only sporadically in the dense stands with enclosed canopies. Their massive development in the sites is triggered however even after a minor opening of the canopy. Predominating species are those of stinging nettle (*Urtica dioica* L.), small-flowered balsam (*Impatiens parviflora* DC.), birthwort (*Aristolochia clematitis* L.) and *catchweed bedstraw* (*Galium aparine* L.). Dominating grasses are orchard grass (*Dactylis polygama* H o r v á t o v s z k y), wood false brome (*Brachypodim sylvaticum* /H u d s./ B e a u v.) and millet grass (*Millium effusum* L.). Otherwise the sites are characterized by an extraordinary species diversity both in the tree- and in the herb layer (Buček, Lacina, 2002).

A recent problem in our country and elsewhere has been the "mass decline of oak". An object to study the natural regeneration of pedunculate oak were stands not exhibiting any signs of damage.

Sample plots

The year of research facility establishment (1999) happened to be a very good seed year with abundant crop of acorns, unseen in the region for several decades. The object was divided into several sample regeneration plots of the so-called "first series" as follows:

Plot 1 Autumn-Winter 1999/2000; complete felling of the parent stand ("full insolation of the self-seeding"), with acorns worked into the soil.

Plot 2 Autumn-Winter 2000/2001; complete felling of the parent stand ("full insolation of the self-seeding").

Plot 3 Autumn-Winter 2000/2001; reduction of the parent stand to a stocking of 0.5 ("half insolation of the self-seeding, 41% solar irradiation of the open space).

Plot 4 Full shelter of the parent stand – no treatment ("full shading of the self-seeding", 1.4% solar irradiation of the open space).

Another – "second series" of sample plots was established in the autumn of 2001 but here the natural regeneration had to be simulated by spreading the acorns since their natural shedding was low. The regenerated stand was reduced by removing the sub-layer and ash trees in the main level to a stocking of 0.8 already in 1999, which resulted in a heavy weed infestation of the plots. This is why the soil had to be prepared mechanically prior to the acorn spreading. This indicates that there were two types of plots as follows:

Plot 5 Autumn-Winter 2001/2002: complete felling of the shelter of the regenerated stand ("full insolation of the self-seeding").

Plot 6 Shelter of the parent stand reduced to a stocking of 0.8 ("80% shading of the self-seeding").

All plots without a shelter of the regenerated stand above the self-seeding or the oak seedlings from acorn spreading were subjected to weed control measures.

Methods

A transect (length 30 m, width 70 cm) was ranged on Plot 2 in March 2000 for an inventory of naturally shed acorns. Each current meter of the transect was then subjected to the measurement of germinating, dead (soft, wormy) and fresh (non-germinating, unindentable by touch) acorns. A group of 100 acorns were sampled from the category of fresh non-germinating to analyse their germinating capacity.

At the beginning of June 2000 (Plot 1 as late as in 2001), other transects were ranged in the 1st series of sample plots for inventory of tree species and weeds (width 1 m and length 15–35 m, demarcated in the terrain by impregnated poles). Each current meter of the transect was for three years monitored and measured for the number of oak, field maple, ash, hornbeam, linden and other tree species seedlings (pcs) at two terms – at about the end of the spring growth (June) and at the end of the growing season (September). The second measurement at the end of the vegetation season included an additional monitoring of pedunculate oak height with the method of measurement being as follows: height of all pedunculate oak seedlings was measured to the precision of 1 cm in selected meters of the transect; aboveground part increment having been approximated from height differences between the individual measurements.

Weeds were categorized as grasses and herbs. Coverage area of the two weed types was measured in each current meter of the transect to the precision of 10% and the coverage of 10% was further refined to 5% and "+" (up to 5 individuals = 3%).

In the second series of sample plots the transects for inventory of tree species and weeds were ranged in spring 2002 with plants on them being assessed in the same way as in the preceding series but only for the time of one year.

At the end of 2002, all plots in the first and second series were subjected to a so-called production and morphological analysis of pedunculate oak seedlings. Dry weight of the seedlings and their morphological characteristics were measured on individuals originating from Plots 2, 4, 5 and 6. It means that a comparison was made of the fully insolated 3-year old pedunculate oak seedlings that were however grown 1 year in the shade of the stand, and the fully shaded seedlings; and the 1-year seedlings fully insolated and those with an 80% shading by the parent stand. Plants were taken from each of the plots with an exception of Plot 4 where only 12 pieces of seedlings were found, and they were first measured for the following morphological characteristics:

- above-ground part length to a precision of 1 cm
- number of above-ground part lateral branches (pcs)
- diameter of lateral branches at a distance of 1 cm from the setting to a precision of 0.1 mm
- stem diameter in root neck (KK) to a precision of 0.1 mm
- stem diameter at a distance of 5 cm above the root neck to a precision of 0.1 mm
- main root length (longest root or substitute root) to a precision of 1 cm
- rooting depth to a precision of 1 cm
- number of lateral roots[1] at places of setting with diameters over 1.0 mm
- number of leaves on the seedling (pcs).

All seedlings were mechanically divided into a root system, aboveground part without foliage and foliage apparatus. These parts were separately put into paper bags and desiccated in a drier at 105 °C to constant weight. The plant parts were then weighed to a precision of 0.001g.

Results and discussion

Total fall of acorns found in the spring of 2000 was approx. 63 acorns.m^{-2}; of these about 8% were fresh but non-germinating, 45% germinating and 47% dead (Table 1). Results from the measurement of fresh acorns germinative capacity further showed that their germinative capacity after 14 and 28 days was 31% and 60%, respectively. It follows that there were approximately 32 acorns.m^{-2} that were potentially capable of developing the self-seeding (germinating + 60% fresh), i.e. about 50% of all shed acorns.

T a b l e 1. Number of acorns in the spring of 2000

Primary statistical characteristics	Acorns			
	germinating	dead	fresh	Σ
Average [pcs.m^{-2}]	28.4	29.6	5.4	**63.4**
Standard deviation [pcs.m^{-2}]	11.0	14.2	4.0	**22.5**
Proportion [%]	44.9	46.7	8.5	**100.0**

[1] Lateral roots are roots shooting directly from the main root. In the case of a root system with substitute roots, the category included lateral roots on all substitute roots. However, if a substitute root did not exhibit any lateral roots of diameter at the place of setting larger than 1 mm, the substitute root was considered to be one lateral root with the fact having no effect on the number of substitute roots.

Approximately 40% of the above mentioned promising number of acorns (germinating + 60% fresh) recorded a success, i.e. the number of emerged seedlings.m^{-2} was nearly 12 (according to the transect neighbouring with the transect for acorns inventory). Resulting total success of the seeding is therefore 20%. Not even the technical literature refers to a markedly higher success of naturally shed pedunculate oak acorns. Matic (2000) speaks of 20–30%, Lust and Speleers (1990) detected 6.4%. It is therefore advised that the natural regeneration planning counts with a relatively low success of the seeding.

Distribution of the emerged seedlings was considerably non-homogeneous. Acorns are heavy seeds which fall and spread only within a vicinity of the parent tree. Most seedlings are observed to emerge under the crown centres of these trees with their number decreasing towards crown projection margins. This is how even small gaps between the crowns can give rise to gaps in the self-seeding. The fact leads to a conclusion that the mature stand of pedunculate oak has to have a perfect horizontal structure with the crowns of parent trees regularly distributed across the whole stand area, optimally without another species' admixture. Only in such a stand it is possible to achieve a new high-standard oak stand by natural regeneration. It has been already said above in the introduction that oak is a tree species that requires side shading for the sound development of trees of high morphological quality (Úradníček, Chmelař, 1995), and the full canopy of plants must be established and maintained already in the self-seeding.

Plot 1 where the self-seeding was emerging on a fully insolated open area with no parent stand exhibited an abundance of emerged seedlings with remarkable annual increment, which were gradually reducing their number in apparent competition (Table 2). Plot 2 where seedlings were developing in a full shade of the parent stand in the first year and then grew in an open area fully insolated since the second year was observed to exhibit in the first year seedlings that were behind those grown in the open area (as compared with Plot 5). Furthermore, felling of the parent stand in the first year of life resulted in a decline of min. 30% individuals (variance in the numbers between year 1 and year 2 of the regeneration resulting both from the reduction of seedlings due to stand felling and from the emergence of more seedlings from the next crop of acorns), and the seedlings which suddenly ap-

T a b l e 2. Average number of pedunculate oak seedlings and their height in the respective years of regeneration on the sample plots

Plot	Pedunculate oak seedlings [pcs.m^{-2}]			Pedunculate oak self-seeding height [cm]		
	regeneration year 1	regeneration year 2	regeneration year 3	regeneration year 1	regeneration year 2	regeneration year 3
Plot 1	–	25.0	16.0	–	36.7	69.6
Plot 2	18.5	13.5	12.3		17.5	40.8
Plot 3	18.9	18.5	16.7	16.1	17.4	20.7
Plot 4	34.0	18.6	1.5		17.1	14.7
Plot 5	5.5	–	–	24.1	–	–
Plot 6	0.7	–	–	15.6	–	–

peared to enjoy the full insolation in the second year showed only a minimum increment due to the "insolation shock". Nevertheless, their growth was restored in the third year and the number remained unchanged in the comparison with the previous year. Plot 3 where the parent stand was reduced to a half after the first year of regeneration the self-seeding was observed to show a similar response in the first two years as that on the plot which was fully deshelted after the first year (Plot 2). Only the damage to the self-seeding by felling the stand after the first year of regeneration was not so severe and the abundance of seedlings was observed to show only a negligible decrease. However, as compared with the open area (Plot 2) the self-seeding did not exhibit any larger increment even in the third year. The height of seedlings showed only a minimum increase although the parent stand above the self-seeding was strongly reduced and the light treat of seedlings considerably enhanced. Being shaded by the fully enclosed parent stand canopy on Plot 4 the self-seeding was observed to considerably reduce its abundance (by about 45%) and vitality in the second year of life and to nearly die within three years not showing almost any increment since the second year of regeneration. Plot 6 was observed to exhibit only a minimum number of seedlings under the stand shelter and heavy weed infestation (see below), which showed only a half increment in comparison with those in Plot 5 with a comparable amount of acorns supplied by spreading in the autumn.

It follows from the above statistically verified results that a relatively large amount of seedlings is observed to emerge in the shadow of the parent stand provided that the plot is not weed-infested and the crop of acorns is good (as compared with a minimum number of pedunculate oak transplants required for the reforestation of regenerated plots at a floodplain site – 1 pc.m^{-2} (Collective of authors, 1996), which would rapidly die if their light treat is not improved after the first year, though. However, the mere increase of light access to the self-seeding by reducing the parent stand by a half is not enough for a successful development of pedunculate oak seedlings which exhibit only an insufficient increment. The best growth is recorded by the self-seeding insolated from the first year of its life; the growth was well recovered also in the pedunculate oak seedlings that grew in the stand shade during the first year of their life and enjoyed full insolation from the second year; here, a certain damage to the regeneration must be counted with when felling the parent stand.

Figure 1 brings further evidence to the development of the fully insolated pedunculate oak seedlings and to their stagnation in the full - or 80% stand shade. The fully insolated seedlings (Plots 2 and 5) surpass the shaded seedlings (Plots 4 and 6) in the production of biomass from the very first year of their life, with the dry weight of all their parts (root system, vegetative part, foliage apparatus) increasing proportionally to their age. The seedlings developing in the stand shade would terminate their biomass production at a stage that was achieved by them in the spring of year 1 of their age with the biomass production being focused mainly into their root system (percentual share of the root system in total dry matter on Plots 4, 6 as compared with Plots 2, 5).

Table 3 indicates that the largest size was achieved by the 3-year old pedunculate oak seedlings in full insolation (Plot 2) although a statistically significant difference in root system parameters between them and the 1-year old fully insolated seedlings (Plot 5) was

Production of pedunculate oak self-seeding dry matter on selected plots

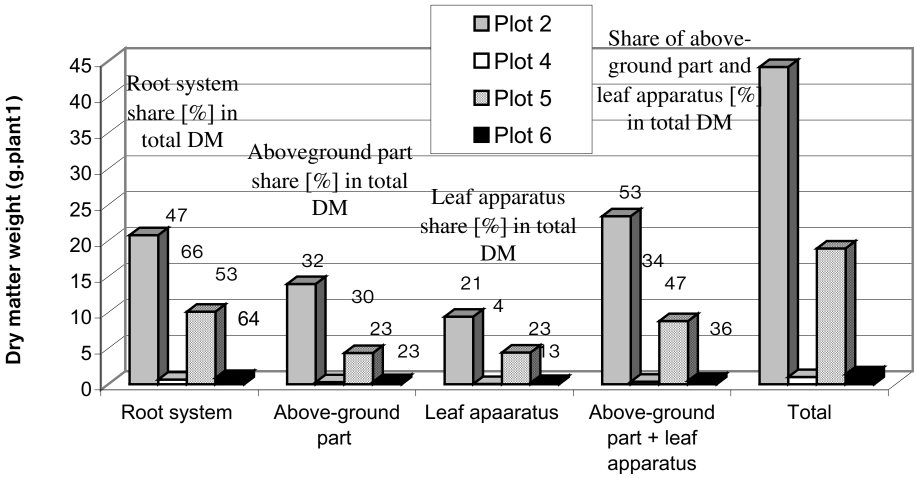


Fig. 1. Dry matter (DM) production in 1-year and 3-year old pedunculate oak seedlings in different conditions of insolation.

T a b l e 3. Basic morphological characteristics of the seedlings on selected sample plots

Parameter		Selected sample plots			
		Plot 2	Plot 3	Plot 5	Plot 6
Diam. at root neck [mm]	arith. av.	12.7	3.3	8.5	4.1
	standard dev.	2.0	0.5	1.7	1.0
Diam. 5 cm above RN [mm]	arith. av.	8.5	2.1	5.6	2.1
	standard dev.	1.6	0.2	0.7	0.5
Above-ground part length [cm]	arith. av.	64.3	16.6	42.1	14.5
	standard dev.	9.2	3.3	7.2	3.9
Main root length [cm]	arith. av.	60.0	17.8	52.3	24.0
	standard dev.	12.9	3.9	10.3	7.5
Rooting depth [cm]	arith. av.	52.5	14.0	46.6	20.6
	standard dev.	11.2	2.6	9.9	6.9
Lateral roots >1mm [pcs.plant^{-1}]	arith. av.	23.8	0.6	18.1	1.2
	standard dev.	8.7	1.0	9.0	1.6
Lateral branches [pcs.plant^{-1}]	arith. av.	7.7	0.6	2.9	0.1
	standard dev.	3.4	0.6	2.0	0.3
Diam. of lateral branches [mm]	arith. av.	2.3	0.6	1.8	1.2
	standard dev.	0.5	0.5	0.4	0.0
Number of leaves [pcs.plant^{-1}]	arith. av.	108.3	3.4	46.8	5.6

not demonstrated. The certain stagnation in the growth of the root system in the 3-year old seedlings apparently resulted from their growth in the parent stand shelter during the first year of regeneration. It also means that the oak trees developed a strong root system in the first year of their development but their general growth stopped in the condition that was reached by them during emergence within 2–3 months in the spring (not exhibiting optimum increment) as already corroborated by DM production analysis. In the second year – after full insolation - their increment was poor again, and it was only in the third year of their age when the increment was actually corresponding with their development and conditions. It is assumed that in order to adapt to the change of conditions they apparently made use of reserves deposited into roots in the previous years. The difference between the fully shaded seedlings (Plot 4) and the seedling shaded only at 80% (Plot 6) was not statistically demonstrated and is practically negligible. These seedlings exhibit the lowest parameters of all with the fully insolated 1-year old seedlings (Plot 5) surpassing them often by several times. The fact leads again to a conclusion that the self-seeding in the shade of the parent stand shows growth stagnation.

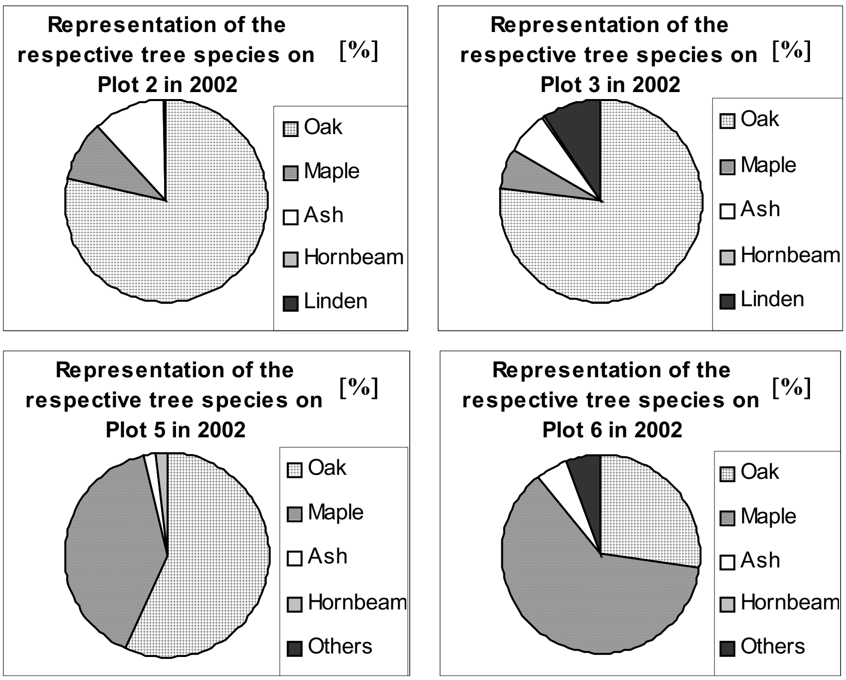
The abundance of pedunculate oak seedlings on Plot 1 that were fully insolated from the very beginning was sufficient enough to allow for emergence of only a minimum and insignificant amount of woody, herbaceous and grassy weeds in the entire period of study. The weed coverage on other plots depended mainly on the plot insolation and on the weed control measures (Table 4). The number of tree species other than oak was at all times minimal (up to 2 pcs per a square meter) in the full shade of the parent stand (Plot 4) or in the shade reduced to 80% (Plot 6) as illustrated in Table 4. An increased number was recorded already at a half insolation of the plot (Plot 3) and corresponded to the fully insolated plots (Plots 2 and 5) in which the increased number of tree species competitive to oak remained about the same despite control measures adopted against them. A major oak competitor in the self-seeding of other tree species on all plots is field maple (Figs 2–5). Ash competes with oak especially on plots with no mechanical soil preparation and linden dominates in a self-seeding that is not fully insolated.

Table 4 shows that the plots with full insolation and regular weed control are dominated by herbs (Plots 2 and 5). Weed coverage is relatively high even after the weed control measures (Plot 2 – 86%). The plots with increased light penetration under the parent stand crowns (even only slightly increased – i.e. at 80% shading) are observed to exhibit a similar heavy weed infestation and a dominance of grasses (Plots 3 and 6). However, the more insolated plot, the later their dominance in total weeds (Plot 3). The fully enclosed canopy stand shows only a low weed infestation (Plot 4).

It follows from the above results that should the natural regeneration of pedunculate oak in the floodplain be successful, the access of light to the self-seeding must be improved very early (at the best immediately after the fall of acorns) by removing the parent stand. The operation is however connected with a rapid increase of weed coverage, and intensive weed control measures have to be adopted which is also recommended in France and Croatia where the natural regeneration of oak stands in floodplains has been long experienced. Weed infestation of the plot before the fall of acorns should be prevented, which may occur in case that the stand canopy is not fully enclosed (does not have a perfect vertical struc-

T a b l e 4. Abundance of tree species other than oak and weed coverage on the sample plots in the respective years of regeneration

Plot	Abundance of other tree species [$pcs.m^{-2}$] and coverage area of grassy and herbaceous weeds [%]								
	regeneration year 1			regeneration year 2			regeneration year 3		
	other tree species	herbs	grasses	other tree species	herbs	grasses	other tree species	herbs	grasses
Plot 2	4.2	26	2	3.5	62	8	3.4	69	17
Plot 3	3.7	16	12	4.0	30	20	5.0	38	44
Plot 4	0.9	4	8	1.6	7	13	1.9	6	8
Plot 5	4.2	66	11	–	–	–	–	–	–
Plot 6	2.0	24	58	–	–	–	–	–	–



Figs 2–5. Percentual share of individual self-seeded tree species on the respective regeneration sample plots.

ture). Even its slight opening (80%) would do to make mechanical soil preparation prior to the fall of acorns in the mature stand inefficient and the regenerated plot gets heavily infested by weeds next year in the spring when the seedlings can hardly emerge in the competition of other vegetation (Plot 6). Soil preparation among trees in the stand is considerably problematic and usually insufficient to prevent the repeated growth of weeds. Maintenance of the fully enclosed canopy of the regenerated stand until the fall of acorns is therefore crucial for natural regeneration.

Conclusion

A reason to the exceptional occurrence of regeneration in the stands of pedunculate oak in Czech floodplains consists in long years of poor acorn cropping. Nevertheless, in five recent years oak recorded relatively good seed years that can be utilized for the natural regeneration of stands. It is however always necessary to count with a relatively low success of the self-seeding and certain principles must be observed based on the light requirements of the species.

Stands for natural regeneration must have a suitable vertical and horizontal structure and they should be therefore consisting of 2 tree species storeys at minimum. The main level must contain only the pedunculate oak of good morphological standard. Other species possibly individually admixed in the main level, particularly those that might suppress the oak self-seeding, should be eliminated some 20 years before the regeneration. Gaps arisen in the crown canopy should be filled with the crowns of neighbouring oak trees so that oaks would cover the whole stand area. Regular distribution of high-standard pedunculate oak across the entire stand area is a vital condition for natural regeneration with an exceptional individual interspersion of other tree species not hampering its implementation (Bastien, 1997). The sub-level of nurse species should be present at such an abundance that it could provide for a perfect coverage of the soil surface either alone or together with the shrub layer in order to prevent its weed infestation. Weeds inhibit the emergence of seedlings from acorns and suppress their further development. It is only in the stands of above described standard that a rejuvenation can be achieved with using oak individuals of high morphological standard.

The best growth of the pedunculate oak self-seeding was observed in full insolation from the very beginning of its life; another possibility is to leave the self-seeding in the parent stand shade and then to expose it to a full solar radiation. Therefore, it is necessary to fell the parent stand shading the self-seeding within a year after seeding at the latest and immediately after the fall of acorns at the best. The full shade of the parent stand is a cause to the rapid decline of the self-seeding and even a strongly reduced (50%) stand shelter was observed to result in the stagnating growth of the seedlings, impaired vitality and massive weed infestation. A fully insolated self-seeding can very rapidly grow out of the impact of this competing vegetation, its abundance preventing a further spreading of weeds. The self-seeding grown in these conditions was not even observed to show any damage due to the impact of extreme climatic factors. The self-seeding emerges in the same conditions as in the currently applied sowing. In addition, its regeneration after mechanical injury such as during the parent stand felling is very good although some losses in the self-seeding must be counted with.

Reduction of the competing weeds through weed control measures is a must in the first years of regeneration. Access of solar radiation to soil surface (due to the absence or reduction of stand shelter) supports the development of weeds that represent a severe competition for oak trees on fertile sites such as floodplain forests. Most problematic in this respect are woody species of pioneer character (field maple, ash and linden), herbaceous and grassy weeds. Mechanical soil preparation and manual or chemical control measures can weaken their impact to a tolerable level.

An early full insolation of the self-seeding gives a guarantee of good prosperity to pedunculate oak seedlings and hence to a successful natural regeneration. Natural regeneration of pedunculate oak can be therefore effectively implemented if certain rules are adhered to while working with the parent stand. A possible use of natural regeneration is of a great importance not only on this site; it would enable a better protection of the floodplain forest ecosystem and maintenance of its natural processes at respecting the ecological requirements of pedunculate oak.

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Houšková K.: **Světelný požitek a odrůstání rostlin v náletu dubu letního (*Quercus robur* L.) v lužních lesích.**

Přirozená obnova dubu letního (*Quercus robur* L.) je velmi problematická. Semenné roky dubu letního, při kterých dozrává velké množství žaludů a které tudíž mohou být základem přirozené obnovy, jsou totiž v podmínkách České republiky vzácností. A i když určité množství semenáčků z přirozeného nasemenění vzejde, velmi rychle pod mateřským porostem odumírá. Klíčem k úspěšné přirozené obnově porostů dubu letního v případě silného semenného roku bude tedy postup práce s mateřským porostem a zajištění vhodných světelných podmínek pro semenáčky dubu. Proto byly na LZ LČR Židlochovice (Polesí Lanžhot) založeny zkusné obnovní plochy, kde nálet (popř. síje po rozhozu žaludů) odrůstal na ploše s mateřským porostem v různou dobu odstraněným či s různou intenzitou redukovaným, tedy v různých světelných podmínkách. Bylo zjištěno, že přirozenou obnovu dubu v lužních lesích lze realizovat pouze v porostech dlouhodobě připravovaných, kde hlavní úroveň je tvořena pouze morfologicky kvalitním dubem letním s maximálně slabší jednotlivou příměsí jiné dřeviny. Není-li tato podmínka zajištěna hrozí „ovládnutí" plochy jinými dřevinami. Porost musí mít dokonalou vertikální strukturu tvořenou 2–3 patry dřevin, aby půdní povrch nezabuřenil, což znemožňuje vzcházení semenáčků. Pro správný vývoj náletu je potom nutné co nejrychleji odstranit clonu mateřského porostu, nejlépe ihned na podzim, nejpozději do 1 roku po nasemenění. Plné oslunění náletu umožňuje semenáčkům nejlépe odrůstat. Plný stín mateřského porostu je příčinou rychlého odumírání náletu a i silně redukovaná (80%) clona porostu způsobuje stagnaci v růstu semenáčků, snížení jejich vitality a mohutný rozvoj buřeně. Plně osluněný nálet pak rychle odrůstá z vlivu konkurující vegetace, jeho vysoká četnost navíc brání silnějšímu zabuřenění. Zásahy proti dřevinné, bylinné a travnaté buřeni jsou při plném oslunění obnovované plochy v prvních letech obnovy nutností.