Winter grafting of oaks *Quercus* L.

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ABSTRACT: In the years 1999–2004 the propagation technology of winter grafting was studied in five oak taxa: *Quercus frainetto*, *Q. macranthera, Q. pubescens* ssp. *anatolica*, *Q. virgiliana* and *Q. robur* Fastigiata. These species are suitable for the needs of intravilan revitalization and for various types of landscape. The yield (%) of one-year-old oak grafted plants (X/1/0) was evaluated in percentage by the portion of saleable grafted plants. In the year 2004 the yield of 75 to 97% was achieved. According to the numbers of young grafts (X/1/0) at the heights 15–30 cm, 30–50 cm, 50–80 cm it was possible to asset the prices and revenues. Grafts destined for expedition have been sold to nurseries in the Czech Republic. The best quality oaks of known origin (X/1/1 and X/1/2) have served to found a mother stock and clone archives in the Dendrological garden Silva Tarouca Research Institute for Landscape and Ornamental Gardening at Průhonice.

Keywords: oak – *Quercus*; taxon; propagation technology; winter grafting; rootstocks; scions; splice graft; cleft graft; propagation house; yield of 1-year-old grafted plants

Oaks belong among the most important broadleaved trees. They are dominant woody plants in natural plant communities. They are fundamental trees for landscape, but for nurserymen they are the most work-consuming group of deciduous woody species.

There is a lack of grafted broadleaved trees in the nurseries in the Czech Republic. Since the end of the 1990s the import of grown-up woody ornamentals and standard trees from the Netherlands, Germany, Hungary and Italy has been permanently increased.

The native oak species are propagated by seeds (Machala 1968; Bärtels 1982; Gordon, Rowe 1982). The vegetative propagation by grafting is used in cultivars that are resistant, important from the ecological point of view and have interesting forms. It is also used for propagation of valuable introduced woody species when their seed is not available. Grafting on a suitable rootstock is often the only way of propagating old valuable trees in our historical gardens and parks.

Oaks grafting is usually performed in a propagation house in January or February, however spring grafting outdoors is also possible. At the Research Station of the Department of Reproductive Sources in Uherské Hradiště, Kostelnicek reached high yield of grafted plants of various *Q. robur* and *Q. petraea* provenances after grafting outdoors in spring before sprouting buds (Mottl 1985). Two- or three-year-old well-rooted rootstocks were used for grafting. Grafting in hand onto healthy bare-rooted rootstocks is successful as well. Splice graft (whip graft) namely whip-and-tongue graft, or wedge and cleft graft are the most suitable grafts if we have strong scions with 1-year- or 2-year-old wood (Machala 1969; Howe 1976; Bärtels 1982, 1988; Mac Donald 1996; Hartmann, Kester 1997; Krüssmann 1997; Obdržálek et al. 2004).

Nurserymen have sometimes difficulties with oak winter grafting. Low yields are caused especially by unsuitable grafting material, rootstocks damaged by frost and rootstocks with bad roots. For this reason propagation firms abroad (Germany, the Netherlands) graft oaks also in summer. Mac Donald (1996) recommended grafting of oaks in September or October. At the Research Station in Boskoop (Proefstation voor Boomkwekerij) a better establishment of grafts was achieved at summer terms of grafting than in winter. In *Quercus coccinea* Splendens the survival of grafts grafted in March was 48%, those grafted in August survived in 98% (Jaarboek 1973, Boskoop).

The following rootstocks were recommended for grafting of several groups of oak species and cultivars (Bärtels 1982): *Quercus robur* and *Q. petraea*

for the group of cork oaks (*Q. robur*, *Q. petraea*, *Q. pontica*, *Q.* × *hickelii*, *Q. macranthera*, *Q. frainetto*, *Q. pubescens*, *Q.* × *turneri*, *Q. virgiliana*), for emperor oaks (*Q. dentata*) and for white oaks (*Q. alba*, *Q. bicolor*, *Q. lyrata*, *Q. macrocarpa*). *Q. cerris* for the group of Turkey oaks (*Q. cerris*, *Q. castaneifolia*, evergreen *Q. cerris* Ambrosyana). *Q. rubra* and *Q. palustris* for the group of scarlet oaks (*Q. ilicifolia*, *Q. palustris*, *Q. velutina*, *Q. coccinea*).

To grow the trunk forms of grafted oaks to bigger height standards in nurseries is work and time-consuming. This is shown in offers of some well-known European nurseries such as Bruns in Bad Zwischenahm, Lorberg near Berlinor Lorenz von Ehren near Hamburg, which produce tall grown trees. They grow especially the seedlings of main oak species, namely *Quercus frainetto, Q. coccinea, Q. cerris, Q. palustris, Q. petraea*, *Q. robur* and *Q. rubra,* whereas from grafts they offer only *Q. robur* Fastigiata and Fastigiata Koster. A wide assortment of oak specimens is grown by the firms Esveld in Boskoop and Bomer in Zundert.

MATERIAL AND METHODS

The growing experiments were performed in propagation houses at RILOG Průhonice. They had the technical equipment needed (regulation of temperature, ventilation and irrigation).

Propagation plant material – mother and selection trees

Oak species and cultivars important for a revitalization of town residential areas and various types of urbanized landscape (forest parks and natural landscape parks).

We obtained the seedlings from the Forest Nursery Řečany nad Labem and the Montano Nursery Přerov nad Labem. The nurseries were licensed by the Ministry of Agriculture of the Czech Republic for distribution of forest woody plants seed and young plant material.

Mother plants of oaks

Nursery stocks of oak species *Quercus frainetto*, *Q. macranthera*, *Q. pubescens* ssp. *anatolica* and *Q. virgiliana* for scions taking were planted in the floricultural garden at RILOG Průhonice in August 1998. Grafts X/1/0 and X/1/1 of the best quality in heights 30–50 and 50–80 cm were used. Every year at the beginning of April the mother trees were fertilized by a slow release fertilizer Cererit (11 N + 9 P + 14 K + 1.5 MgO) in the amount of 20 g/m^2.

A first scions taking from the 3-year-old and 4-year-old stock plants was performed in January 2000, simultaneously with the pruning training.

Terms and techniques of grafting

Winter grafting – January/February

The shoots were cut according to the weather in January and February. The scions were stored in a refrigerator box at +4°C. The length of the scions was adjusted before grafting. They were shortly washed in clean water. The grafting was performed by splice (whip) graft and cleft onto rootstocks rooted in units Quick Pot QP 15T.

Scions with one- and two-year-old wood and with 2 or 3 buds were used. A disinfection of the rootstock stem by diluted methylated spirit before grafting was necessary.

Species (cultivar)	Stock plants – place of scions taking	Mother trees origin
Quercus frainetto TEN.	RILOG Průhonice	MAFU Brno
Q. macranthera FISCH. MEY	RILOG Průhonice	MAFU Brno
Q. pubescens WILLD. ssp. *anatolica* O. SCHWARZ	RILOG Průhonice	MAFU Brno
Q. virgiliana TEN.	RILOG Průhonice	MAFU Brno
Q. robur L. Fastigiata	RILOG Průhonice	RILOG Průhonice

RILOG – Silva Tarouca Research Institute for Landscape and Ornamental Gardening Průhonice, MAFU – Botanic Garden and Arboretum of the Mendel University of Agriculture and Forestry Brno

Rootstocks used for grafting

Species	Stage	Unit/trees (m^2)
Quercus robur	1/0, 2/0	QP US 32T/20, P 15T(187/m^2)
	1/1	QP 12 T/18 (120/m^2)

Grafted oaks were placed on propagation beds 140 cm wide under tunnels of microten 0.015 mm.

The surface of the beds was leveled out by the geotextile on a layer of sand + UV stabilized textile Netex.

Two various temperature regimes were compared:

(a) air temperature t_i 20 ± 2°C, soil temperature t_p 18 to 20°C, propagation house S6 (6 × 30 m),
(b) air temperature t_i 15 ± 2°C, soil temperature t_p 15 to 16°C, propagation house H12 (12 × 25 m).

When the grafts sprouted, the foil tunnels were aired during daytime. In the course of the growth the grafts were fertilized 3 times by 0.2% solution of Kristalon Blue (19 N + 6 P + 20 K + 3 MgO) in the amount of 10 l/1 m^2.

A preventive plant protection against fungus diseases was done by Previcur (Propamocarb). It was used at 0.15% concentration for substrate watering just after oak grafting. Before bud sprouting one spray by 0.1% Rovral (Iprodion) against *Botrytis* sp. was applied.

Mode of experiment evaluation

Partial results were always evaluated after the end of the growing cycle, namely at the end of the vegetation period (October/ November).

One-year-old grafted plants X/1/0 not transplanted were evaluated according to:

- the number of scions taken and sprouted (%),
- yield *y* (%) as the rate of young saleable grafts,
- height groups (cm) 15–30, 30–50, 50–80,
- prices (CZK) 30.00; 40.00; 50.00 (1 € = 31 CZK, Oct. 2004).

The results were evaluated statistically. The minimal conclusive difference was determined by Duncan test at the significance level α = 0.05 (*P* = 95%).

RESULTS AND DISCUSSION

Winter grafting of oaks

Trial 1 (2001/2002)

At the end of January and in February 2001 four taxa of oaks *Quercus frainetto*, *Q. macranthera*, *Q. pubescens* ssp. *anatolica* and *Q. virgiliana* were grafted on potted rootstocks of *Q. robur* 1/0 from direct sowing in Quick Pot units QP 40T. Scions with one- and two-year-old wood were collected. Splice technique of grafting was used. The grafted rootstocks were planted in units QP 12T/18. The yield of the grafts was evaluated in June/July immediately after the young shoots finished the growth.

In Table 1 survey of the influence of temperature on the yield and height of the grafted plants is shown. No statistical significance was found in the yield and average height of 4 grafted oak taxa (different temperatures × scions age). The yield of 1-year-old

Table 1. Survey of yield (*y* %) and average height of 1-year-old oaks grafted on pot grown rootstocks and placed under plastic in propagation houses at different temperatures (2001–2002)

Oak species date of grafting	Scions age	t_i 20 ± 2°C		t_i 15 ± 2°C		Average (x_j)
		yield (%)	average height (cm)	yield (%)	average height (cm)	
Q. frainetto 26. 1. 2001	1-year	32.7 a	43.3	25.7 a	37.2	29.2 a
	2-years	31.5 a	53.7	36.1 a	40.3	33.8 a
	x_i	32.1 a	48.5	30.9 a	38.8	
Q. pubescens ssp. *anatolica* 26. 1. 2001	1-year	22.9 a	18.6	16.4 a	33.1	19.7 a
	2-years	25.3 a	23.0	21.7 a	27.4	23.5 a
	x_i	24.1 a	20.8	19.1 a	30.3	
Q. virgiliana 28. 1. 2001	1-year	16.1 a	32.4	20.0 a	26.3	18.1 a
	2-years	25.8 a	40.8	20.5 a	28.4	23.7 a
	x_i	21.0 a	36.6	20.3 a	27.4	
Q. macranthera 29. 1. 2001	1-year	22.8 a	27.8	16.0 a	11.3	19.4 a
	2-years	19.7 a	19.4	9.1 b	14.7	14.4 a
	x_i	21.3 a	23.6	12.6 b	13.0	

Number of grafting 80 (4 replications at 20 grafts in each variant); Duncan test *P* = 95% (α = 0.05); values in columns (lines) indicated by the same letter had no statistical significance; plant species were evaluated as one file (set)

Table 2. Survey of yield and average height of 1-year-old oaks grafted on pot grown rootstocks and placed under plastic in propagation houses at different temperatures (2002–2003)

Oak species date of grafting	Scions age	Grafting number	Average height (cm)	t_i 20 ± 2°C yield y (%)	t_i 15 ± 2°C yield y (%)	Average (x_j)
Q. frainetto 4. 2. 2002	1 year	96	26.5 b	25.0 b	30.0 b	27.5 b
	2 years	96	41.8 a	58.3 a	63.3 a	60.8 a
	total	192	x_i 34.2	41.7 a	46.7 a	44.2
Q. macranthera 22. 2. 2002	1 year	96	8.8	33.3 a	–	–
	2 years	96	17.2	16.7 b	–	–
	total	192	x_i 13.0	25.0	–	–
Q. pubescens ssp. *anatolica* 6. 2. 2002	1 year	120	19.2 a	38.3 a	20.0 b	29.2 a
	2 years	120	15.3 a	35.0 a	36.7 a	35.9 a
	total	240	x_i 17.3	36.7 a	28.4 a	32.6
Q. robur Fastigiata	1 year	120	23.7 b	31.7 ab	35.0 a	33.4 a
	2 years	120	28.8 a	18.3 b	46.7 a	32.5 a
	total	240	x_i 26.3	25.0 b	40.9 a	33.0
Q. virgiliana 28. 1. 2002	1 year	120	18.5	23.3 b	60.0 a	41.7
	2 years	120	17.0	10.0 c	–	10.0
	total	240	x_i 17.8	16.7 b	60.0 a	25.9

Duncan test P = 95% (α = 0.05); values in columns (lines) indicated by the same letter had no statistical significance; plant species were evaluated as one file (set)

Q. frainetto ranged from 26 to 33% when using one-year-old scions and from 32 to 36% when using 2-year-old scions. The grafted plants were higher when grown at 20°C, for example the average height of *Q. frainetto* was 49 cm when grown at 20°C but only 39 cm when grown at 15°C. Similarly, in slower growing taxon *Q. virgiliana* the average height was 37 cm in the warmer greenhouse but only 27 in the cooler one.

Notes: Scions from a selective tree *Quercus frainetto* No. 1 harvested a year earlier and splice grafted in January 2000 had high yield and longer growth as well, the yield was 38 to 63%, the scions survival 48 to 81%.

Trial 2 (2002/2003)

In January 2002 five taxa of oaks *Q. frainetto, Q. macranthera, Q. pubescens anatolica, Q. robur*

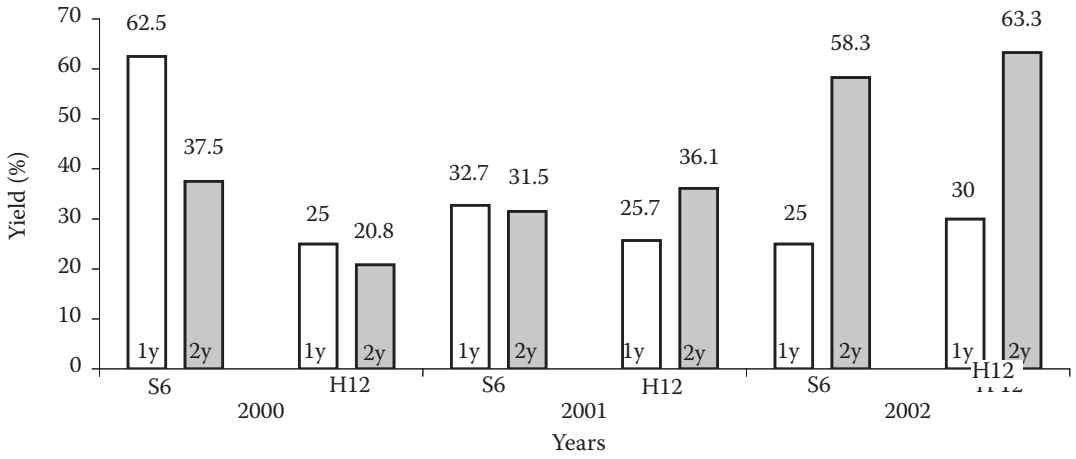

Fig. 1. Yield comparison of 1-year-old oaks *Q. frainetto* X/1/0 splice grafted using scions with one- and two-year-old wood grown in propagation houses at different temperatures (2000–2002)
Scions age one-year-old wood (1y), two-year-old wood (2y), types of grafts splice (s) cleft (c)
Environment (temperature): S6 – propagation house (6 × 30 m), temperature 20°C, H12 – propagation house (12 × 25 m), temperature 15°C

Fastigiata and *Q. virgiliana* were grafted on one- and two-year-old rootstocks grown in units QP 15T and QP 12T/18. Successfully grafted plants were transplanted in September 2002 in containers and in autumn 2003 they were evaluated as two-year-old grafts X/1/1 designated for planting and for sale.

In Table 2 a survey of the influences of scion age and temperature on the yield and height of the grafted plants is shown.

Scion age: In *Q. frainetto* the scions with 2-year-old wood survived better and the grafted plants were higher. There was a significant difference in statistical evaluation of the yield (y %) of *Q. frainetto* grafted plants from 2-year-old scions grown at higher temperature (y 58%) in comparison with 1-year-old scions (y 25%). A similar difference was obtained also for the plants grown at lower temperature with results (y 63%) against (y 30%) for the older and younger plants, respectively.

Temperature: A significant difference in the yield was proved in *Q. robur* Fastigiata (41%) and *Q. virgiliana* (60%) grown at lower temperature in comparison with those grown at higher temperature: *Q. robur* Fastigiata (25%) and *Q. virgiliana* (17%).

Comparison of the results of *Q. frainetto* winter grafting in the years 2000–2002 grown in propaga-

Table 3a. Yield percentage (y %) of 1-year-old oaks grafted on pot grown rootstocks 1/0 and grown at different temperatures – two different grafting techniques used (2004)

Oak species, cv., date of grafting	Technique and number of grafting (pieces)	t_i 20 ± 2°C	t_i 15 ± 2°C	Average (x_j)
		yield y (%)	yield y (%)	
Q. frainetto 27. 1. 2004	cleft 120	97.0 a	85.0 a	91.0 a
	splice 150	81.0 a	89.0 a	85.0 a
	total 270 x_i	89.0 a	87.0 a	
Q. pubescens ssp. *anatolica* 23. 2. 2004)	cleft 150	73.0 a	40.0 b	56.5 a
	splice 150	78.0 a	40.0 b	59.0 a
	total 300 x_i	75.5 a	40.0 b	
Q. robur Fastigiata 21. 1. 2004	cleft 120	90.0 a	75.0 a	82.5 a
	splice 150	92.0 a	87.0 a	89.5 a
	total 270 x_i	91.0 a	81.0 a	
Q. virgiliana 2. 2. 2004	cleft 90	80.0 b	56.0 c	68.0 b
	splice 120	93.0 a	80.0 b	86.5 a
	total 210 x_i	86.5 a	68.0 b	

Table 3b. Average height of 1-year-old oaks X/1/0 grafted by two different techniques and grown at different temperatures – evaluated at the end of the growing cycle (October 2004)

Oak species, cv., date of grafting	Technique and number of grafting	t_i 20 ± 2°C	t_i 15 ± 2°C	Average (x_j)
		height (cm)	height (cm)	
Q. frainetto 27. 1. 2004	cleft 120	27.2 b	30.0 a	28.6 a
	splice 150	27.4 b	30.2 a	28.8 a
	total 270 x_i	27.3 b	30.1 a	
Q. pubescens ssp. *anatolica* 23. 2. 2004	cleft 120	27.8 b	26.7 b	27.2 a
	splice 120	27.0 b	33.0 a	30.0 a
	total 240 x_i	27.4 b	29.8 a	
Q. robur Fastigiata 21. 1. 2004	cleft 120	31.0 a	32.0 a	31.5 a
	splice 150	31.0 a	34.0 a	32.5 a
	total 270 x_i	31.0 a	33.0 a	
Q. virgiliana 2. 2. 2004	cleft 90	27.5 a	–	27.5 a
	splice 120	29.0 a	28.4 a	28.7 a
	total 210 x_i	28.3 a	28.4 a	

Table 4. Technical and economical indexes of 1-year-old grafted plants *Quercus frainetto* grown under glass at different temperatures (2004)

Oak species (grafting technique)	Technological and economical indexes	Temperature t_i	
		20 ± 2°C	15 ± 2°C
Q. frainetto X/1/0 (splice)	height 15–30 (pcs)	42	38
	30–50	18	25
	50–80	1	4
	average height (cm)	27	30
	yield (pcs/%)	61/81	67/89
	earnings (CZK)	2,030	2,340
Q. frainetto X/1/0 (cleft)	15–30	38	29
	30–50	19	20
	50–80	1	2
	average height (cm)	27	30
	yield (pcs/%)	58/97	51/85
	earnings (CZK)	1,950	1,770
Total earnings (CZK)		3,980	4,110

tion houses at different temperatures is shown in Fig. 1.

Trial 3 (2004)

Q. robur as one year old seedlings 1/0, 25–35 cm high, were used as rootstocks for grafting in January/February 2004. They were grown in plastic tunnels from direct sowing in units Quick Pot QP US 32T/20.

Mature scions of *Q. frainetto*, *Q. robur* Fastigiata and *Q. virgiliana* were cut at the end of January from stock trees showing signs of selective trees in their habit and leaf form. Scions with one-year-old and two-year-old wood were used for splice graft and cleft graft. The grafted oaks were planted in the Quick Pot unites QP 15T. The root balls were broken by pruners before planting into the larger QP units. The cut of fibrous roots is a precondition of rooting deformations.

The yield of one year old grafts ranged in *Quercus frainetto* from 81 to 97%, in *Q. robur* Fastigiata from 75 to 92% and in *Q. virgiliana* from 56 to 93% (Table 3a).

The graft technique used (splice or cleft) depended on the scions and rootstock thickness. Splice graft was easy and better than cleft graft. Its effect was not statistically significant in *Q. frainetto* and *Q. robur* Fastigiata. In *Q. frainetto* cleft graft proved to be better under warmer conditions only.

Temperature: Higher yield was achieved in the environment of warmer propagation house (73 to 97%) as compared to the cooler one (40 to 89%).

The influence of temperature was proved in *Q. pubescens anatolica* and *Q. virgiliana* grafted by splice.

The yield of *Q. frainetto* and *Q. robur* Fastigiata grown at different temperatures was comparable (Table 3b).

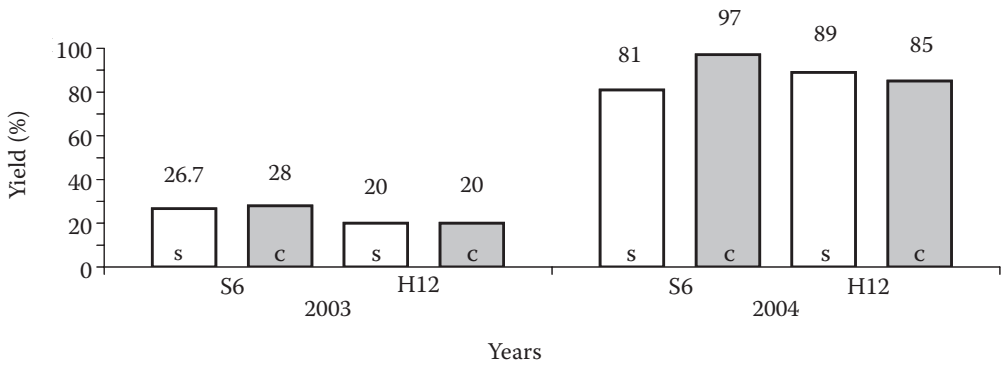

Fig. 2. Yield comparison of 1-year-old oaks *Q. frainetto* X/1/0 splice and cleft grafted grown in propagation houses at different temperatures (2003–2004)

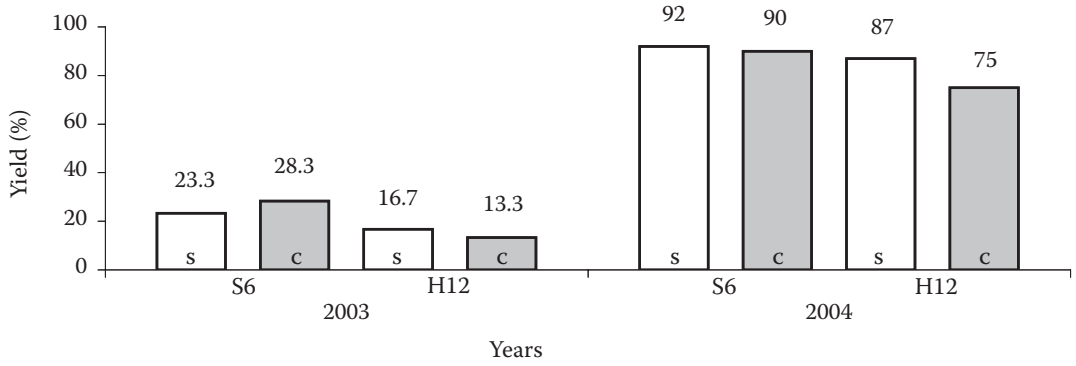

Fig. 3. Yield comparison of 1-year-old oaks *Q. robur* Fastigiata X/1/0 splice and cleft grafted grown in propagation houses at different temperatures (2003–2004)

The environment of the cooler propagation house had a positive effect on the sprout growth and length in *Q. frainetto, Q. pubescens anatolica* and *Q. robur* Fastigiata grafted by splice. Higher number of plants could have been incorporated in height groups 30–50 cm and 50–80 cm (Tables 3b, 4 and 5, Figs. 2 and 3).

Earnings (CZK)

High yield and quality indexes of young grafted oaks in the year 2004 facilitated to fix the selling price of one year old grafts X/1/0 from winter grafting.

Yield and numbers of grafted plants in heights 15–30, 30–50 a 50–80 cm affected the earning at the end of the growing cycle.

In *Q. frainetto* the highest earnings 4,110 CZK were achieved from plants grown at lower temperature. Their yield was 85% (cleft graft) and 89% (splice graft) (Table 4).

In Q. *robur* Fastigiata the highest earnings 4,360 CZK were achieved from plants grown at higher temperature. Their yield was 90% (cleft graft) and 92% (splice graft) (Table 5).

In comparison with beeches and limes, oaks need higher temperatures for scion taking with the rootstock (Mac Donald 1996; Obdržálek, Pinc 1996; Krüssmann 1997). High yield and average height of 1-year-old grafts in the year 2004 was influenced by good quality of rootstocks and ripeness of scions as a result of good weather in summer and autumn 2003,

Table 5. Technical and economical indexes of 1-year-old grafted plants *Quercus robur* Fastigiata grown under glass at different temperatures (2004)

Oak species (grafting technique)	Technological and economical indexes	Temperature t_i	
		20 ± 2°C	15 ± 2°C
Q. robur Fastigiata X/1/0 (splice)	height 15–30 (pcs)	34	32
	30–50	34	25
	50–80	1	8
	average height (cm)	31	34
	yield (pcs/%)	69/92	65/87
	earnings (CZK)	2,430	2,360
Q. robur Fastigiata X/1/0 (cleft)	height 15–30	25	18
	30–50	27	24
	50–80	2	3
	average height (cm)	31	32
	yield (pcs/%)	54/90	45/75
	earnings (CZK)	1,930	1,650
Total earnings (CZK)		4,360	4,010

Height group (cm)	Price (CZK/piece)
15–30	30 CZK (1 € = 31 CZK, Oct. 2004)
30–50	40 CZK
50–80	50 CZK

and also as a consequence of light and temperature conditions in the propagation house. The differences of the two temperatures were eliminated by extreme temperatures during hot sunny days in spring and summer months of 2004. Under those conditions it was impossible to regulate the temperature in the greenhouses.

Low survival rate of oak grafts in the years 2001 to 2003 could have been caused by insufficient rooting and frost damage of rootstocks inaccurate grafting – repeated incorrect growing interventions. Watering of sprouting buds caused their withering and grafts dying. Grafts with well-developed leaves are not damaged when watered on the leaves (Obdržálek, Pinc 1997; Obdržálek et al. 2004).

CONCLUSIONS AND PRACTICAL RECOMMENDATIONS

According to the present experience and achieved results oaks belong among trees propagated vegetatively with the greatest difficulty. Winter oak grafting from January till the end of March is used in specialized nurseries (Howe 1976; Bärtels 1995; Krüssmann 1997). Summer grafting of oaks is used less frequently. In our conditions late summer grafting can be recommended in the cases of saving dendrologically valuable and endangered taxa (Obdržálek et al. 2004). Mac Donald (1996) emphasized the use of mature scions taken in the rest period of endogenous dormancy for grafting terms in September/October and January/February in exogenous dormancy.

In the year 2004 the best results were achieved by splice dormant grafting of *Q. frainetto*, *Q. robur* Fastigiata, *Q. pubescens anatolica* and *Q. virgiliana* in the warmer propagation house with temperature above 20°C (yield 78 to 93%). Higher yield (97%) was achieved only in *Q. frainetto* grafted by cleft under the same conditions. The highest earnings of saleable plants were achieved in splice grafted *Q. frainetto* and *Q. robur* Fastigiata grown at both temperatures.

The research proceeded 5 years. The oaks were grafted on one-year-old rootstocks *Q. robur* 1/0 from direct sowing in Quick Pot units.

Grafted plants growing

The growing cycle of oaks grafted in winter lasts 8 to 9 months.

In September/October they have good saleable grafts X/1/0 in heights 15–30, 30–50 and 50–80 cm, which are prepared for expedition and transplanting.

For obtaining higher and strong plants it is recommended to grow grafts for two seasons (20 to 21 months, i.e. two-year growing period).

Propagation and technological aspects

Preconditions of good graft results are:

Rootstocks

– One- and two-year-old potted seedlings in good quality from direct sowing in deep Quick Pot units.

Possible risks:

– insufficiently rooted potted rootstocks,
– frost damage of rootstock roots,
– dried roots of lifted seedlings stored improperly.

Scions and grafting technique

– Taking of scions in the period of endogenous or exogenous dormancy.
– Scions from thicker, well mature shoots of one- and two-year old wood with two or three developed buds are most suitable for grafting.
– Disinfection of rootstocks at the place of grafting and disinfection of scions by water solution of ethanol is necessary.
– Apical graftage – splice graft (whip-and-tongue) and cleft graft are more suitable. Graft directly on root collar of the rootstock or close over the collar.
– Use of the graft wax is necessary. Temperature of water bath with wax should be maximally 70 to 75°C.

Possible risks:

– not mature or too thin scions.

Propagation and growing environment

– For oaks grafted in winter (January/February) propagation houses with air temperature 20 ± 2°C and 15 ± 2°C are suitable.
– Covering of grafted plants with UV stabilized plastic (microten) is useful. Do not air the tunnels in the first two weeks and do not water. Do not spray the sprouting buds with water! After buds sprouting an everyday airing of plastic tunnels is necessary.
– Higher temperatures up to 28°C in the propagation environment accelerate graft uniting with the rootstock and its sprouting in spring period.
– Preventive watering of grafted plants by systemic fungicide Previcur 0.15% in the amount of 10 l/2 m^2 just after grafting.
– The biofungicide Supresivit (*Trichoderma harzianum*) in the amount of 2.5 g/10 l water/2 m^2 can also be recommended.
– Spray by Rovral (Iprodion) 0.075% or Euparen (Dichlofluanid) 0.15% against *Botrytis* ssp. before scions sprouting is recommended.

Possible risks:

– wilting of sprouting buds in grafted plants,
– sprinkling of sprouting buds causes their wilting and the scions and the rootstock do not unite,

– bad graft affinity and intensive sprouting of root-stocks.

Overwintering of grafted plants

Grafted oaks overwintere reliably in a cold glasshouse or in frames covered with textile mats (thermofoils) and a plastic tunnel.

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Zimní roubování dubů – *Quercus* L.

ABSTRAKT: V letech 1999 až 2004 jsme výzkumně řešili technologii zimního a letního roubování dubů. V technologických pokusech jsme pracovali s pěti taxony dubů: *Quercus frainetto*, *Q. macranthera*, *Q. pubescens* ssp. *anatolica*, *Q. virgiliana* a *Q. robur* Fastigiata. Tyto vybrané modelové taxony jsou vhodné pro potřeby revitalizace intravilánu sídel a pro různé typy urbanizované krajiny. Předmětem hodnocení byly jednoleté roubovance dubů X/1/0. U mladých rostlin dubů – skupiny listnaté stromy roubované – jsme stanovili ukazatel hodnocení výtěžnosti *y* (%) jako podíl výpěstků schopných prodeje. V roce 2004 u čtyř taxonů dubů ze zimního roubování jsme dosáhli výtěžnosti 75 % až 97 %. Počty mladých roubovanců X/1/0 ve velikostech 15–30, 30–50, 50–80 cm umožnily stanovit ceny a tržby v ověřovaném technologickém postupu. Mladé roubované duby určené k expedici se dodávají školkařským podnikům v České republice. Z dvouletých a tříletých roubovanců (X/1/1 a X/1/2) ve velmi dobré kvalitě byla založena matečnice a klonový archiv na Dendrologické zahradě Výzkumného ústavu Silva Taroucy pro okrasné zahradnictví v Průhonicích.

Klíčová slova: dub – *Quercus*; taxon; technologie množení; zimní roubování; rouby; podnože; kopulace; rozštěp; množárenský skleník; výtěžnost jednoletých roubovanců

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