



Reproductive Material No. 16

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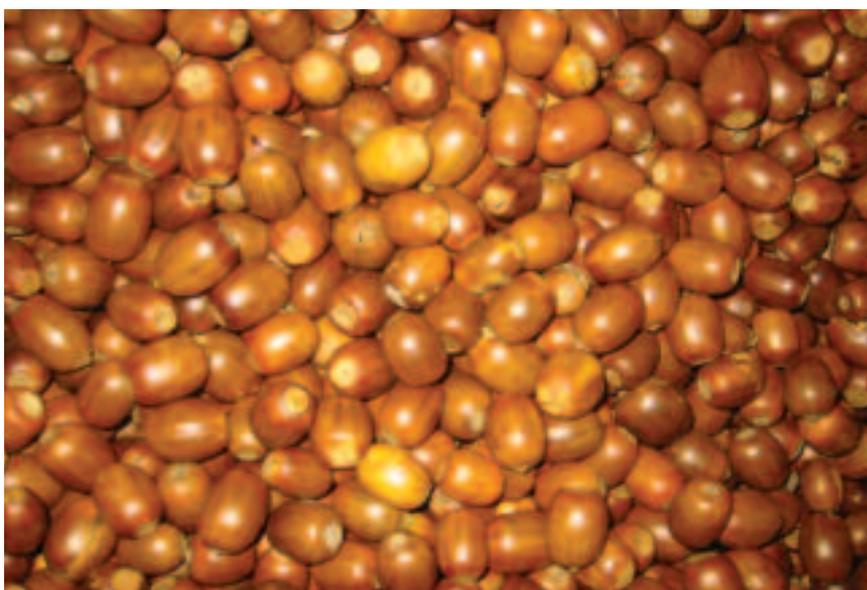
- ▶ Results are presented from two oak provenance trials, one comparing different Irish sources and the other comparing Irish with several European sources.
- ▶ It is important to emphasise that these assessments were undertaken when both trials had been growing on the site for 14 growing seasons and that this is considered to be too early in the rotation to draw any definitive conclusions.
- ▶ Early results from these trials suggest that when Irish seed is not available Dutch and British sources provide suitable alternative sources, producing good growth and stem form.
- ▶ The results from the Clonegal trial suggest that French and German seed sources have not performed well under Irish conditions.
- ▶ All sources produced sufficient potential final crop trees in each plot, although those with poorer form will require a greater degree of silvicultural management.
- ▶ Grey squirrels have destroyed the Clonegal trial and will inevitably ruin the Camolin trial if left unchecked.

## Seed source significantly influences growth, form and silvicultural management of oak

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Oak (*Quercus petraea* and *Q. robur*) accounts for approximately 2.3% of the land covered by forest in Ireland and for 9.6% of the total broadleaf cover (Anon. 2007). Planting of oak has increased dramatically over the last 15 years. Annual seed requirement is currently in the order of 35 tonnes of acorns (Cahalane et al. 2007, Felton et al. 2006). Even in a mast year, the amount of home-collected seed has yet to meet the demand, so it is important to know which other European sources are best adapted and produce good quality timber under Irish conditions. As seed origin, commonly referred to as 'provenance', can play an important role in the growth and stem quality of the resulting crop, questions are repeatedly asked as to which are the 'best' sources of native Irish oak. However, it is perhaps more important to know which sources to avoid planting.

In 1984, a particularly good acorn crop in Ireland prompted the collection of seed from a range of stands believed to be of native Irish origin and the establishment



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of a series of native oak provenance trials. Four trials were established in 1988 at Camolin, Co Wicklow; Durrow, Co Laois; Belturbet, Co Cavan; and Donadea, Co Kildare. A detailed statistical analysis of these trials has been published (Felton et al. 2006).

In 1987, as part of an IUFRO (International Union of Forest Research Organisations) project, acorns from five European countries were collected and exchanged to establish a series of oak provenance trials. One trial was planted in Ireland, comparing Irish with British, French, German and Dutch sources.

The objective of this note is to provide a summary of the results to date from the largest of the native Irish trials (Camolin) and to compare them with some European oak sources (Clonegal trial). It is important to note that all of these trials are still young and that an assessment at age 25

(a quarter of the full rotation length) will provide more conclusive results.

## Materials and methods

### *Native Irish oak (Camolin trial)*

Acorns were collected in the autumn of 1984 from 29 oak stands that were believed to be native or semi-natural. The seed was sown in the spring of 1985 and grown for three years. Details of the 27 seed sources included in the Camolin trial are presented in Table 1.

The Camolin trial is the most complete of the four trials, having 27 sources planted in a randomised block design with three replications. Each square plot comprises 15 x 15 individuals (225 trees) spaced at 1.3 x 1.3 m (about 5,500 trees/hectare). The soil type is an acid brown earth,

Table 1: Sources and species of oak used in the Native Irish Provenance trial, locations and species.

Source	Forest name	County	Species
Abbeyleix	Abbeyleix estate	Laois	pedunculate
Ballyvourney	St. Gobnets Wood	Cork	sessile
Cahir	Cahir Park	Tipperary	pedunculate
Charleville Island	Charleville estate	Offaly	pedunculate
Charleville Main	Charleville estate	Offaly	pedunculate
Collooney	Colloney	Sligo	sessile
Cootehill	Dartry	Monaghan	pedunculate
Corrakyle	Cahir nat. reserve	Clare	sessile
Croagh Patrick	Brackloon	Mayo	sessile
Delgany	Glen-of-the-Downs	Wicklow	sessile
Enniskerry	Knocksink	Wicklow	sessile
Foxford	Pontoon	Mayo	sessile
Glendalough	Glendalough	Wicklow	sessile
Glengarriff	Bantry Demesne	Cork	sessile
Glenealy	Deputy s Pass	Wicklow	sessile
Gort	Coole Park	Galway	pedunculate
Kenmare	Uragh	Kerry	sessile
Killarney-Derryicunnihy	Derricunnihy	Kerry	sessile
Killarney-Tommies	Tommies Wood	Kerry	sessile
Knocktopher	Clone	Kilkenny	pedunculate
Letterkenny	Ballyar	Donegal	sessile
Lough Gill	Cullentra	Silgo	sessile
Mulroy	Rathmullen	Donegal	sessile
Rathdrum	Clara Vale	Wicklow	sessile
Shelton	Killeagh	Wicklow	sessile
Waterville	Waterville	Kerry	sessile
Woodford	Pollnaknockaun	Galway	sessile

approximately 10 miles from the Irish sea at 80 m above sea level. The site is level and sheltered, and had previously grown a crop of Norway spruce. Mature beech along one edge of the trial initially provided shelter, but has since started to shade some plots. In addition, self-seeded birch (now removed) had caused some growth restriction and stem deformation in a number of plots.

In the winter of 2001/2002, after 14 growing seasons on the site, the central nine trees in each plot were assessed for a number of characteristics including survival, height and diameter growth. Assessments were also made on the best three individuals in each sample plot, and these results are presented here. Straightness, apical dominance and forking height were evaluated using a 1-4 scale (1=poor to 4=very good); form was measured by summing these values. In addition the plots were assessed for species using leaf characteristics (Potter 1994), A flushing assessment was made in the spring of 2002.

#### *European oak sources (Clonegal trial)*

The site was old woodland with an acid brown earth soil. This trial consists of 23 oak sources from five countries:

Germany (6 sources), France (4), the Netherlands (3) the UK (5) and Ireland (5). The seed was collected in 1987, grown in Ireland, and the trial was planted in 1990. The plots comprise 8 by 8 individuals (64 trees) at a 1.4 x 1.4 m spacing and the layout is a randomized complete block design with three replications. Data were collected in the spring of 2003 (Felton 2003) after 14 growing seasons. The same assessment criteria used in the Camolin trial were used here. Once again some plots were influenced by self-seeded birch and willow.

## Results

It is important to emphasise that these assessments were carried out when both trials had been growing for 14 years on site, and that this is too early in the rotation to draw any definitive conclusions. The general rule of thumb is that sources can most accurately be assessed after a quarter to a third of their full rotation length, which in the case of oak is probably after age 25. This underscores one of the main problems in broadleaf tree improvement programmes: the length of time required for testing. Nevertheless, these findings should provide the first reliable results from these trials.



▲ Camolin trial.

### Native Irish sources

Twenty-one of the 27 sources in the Camolin trial were identified by leaf analysis as sessile oak (*Quercus petraea*) and six as pedunculate oak (*Q. robur*) sources (Table 1). There was little difference between sources in flushing dates. All sources flushed within a period of seven days. Sessile sources from the northwest and southwest flushed four days earlier than those in the southeast sessile and all of the pedunculate stands.

The results of survival, height growth, girth, stem straightness, apical dominance, forking height and overall composite stem form are presented in Table 2.

Survival was good in all sources and ranged from 77.8 to 100% which resulted in well stocked plots. Height growth ranged from 4.7 to 6.6 m and averaged 5.5 m with ten sources being above the trial average. Diameter growth ranged from 4.5 to 8.1 cm and averaged 6.3 cm with 15 sources being above average. Eleven of the 27 sources had above average straightness, 12 had above average apical dominance and 14 had above average forking height. Using a composite 'form' index, 11 sources were above average.

The Glendalough, Glenealy, Waterville and Cootehill sources were found to be above average in all categories. Both Charleville Main and Cahir were above average in all

Table 2: Camolin Native Irish trial after 14 growing seasons – above average values in each category have blue fill, those below average are in grey.

	SURV	HGT	DBH	STR	AD	FK	FF
Abbeyleix	85.6	5.6	8.1	2.5	2.9	2.4	7.9
Ballyvourney	88.9	5.1	6.3	2.3	2.8	2.2	7.3
Charleville Island	100.0	5.2	6.2	2.2	2.7	2.3	7.2
Charleville Main	78.9	5.1	6.5	2.6	3.3	3.2	9.1
Cahir	88.9	5.3	6.4	2.6	3.0	3.0	8.7
Collooney	77.8	5.0	5.9	2.2	3.0	1.6	6.8
Cootehill	92.2	5.7	7.1	2.6	3.0	2.8	8.4
Corrakyle	85.6	6.0	6.6	2.7	2.6	2.6	7.9
Croagh Patrick	92.2	5.4	5.7	2.5	3.0	2.0	7.5
Delgany	85.6	4.7	5.4	2.5	3.4	2.9	9.1
Enniskerry	81.1	6.6	6.7	2.3	2.7	3.2	8.2
Foxford	77.8	6.0	7.6	2.4	3.1	2.8	8.2
Glendalough	90.0	5.5	7.0	3.2	2.9	2.7	8.8
Glenealy	88.9	6.0	6.6	2.8	3.0	3.1	8.9
Glengarriff	100.0	4.8	4.6	2.3	3.3	1.9	7.5
Gort	81.1	5.8	5.6	2.4	2.9	2.4	7.6
Kenmare	96.7	5.4	6.9	2.5	2.9	3.0	8.4
Knocktopher	88.9	5.4	6.9	2.3	2.6	2.2	7.1
Killarney- Dennyconnihy	88.9	5.6	6.9	2.3	2.9	2.8	8.0
Killarney- Tommies	85.6	5.2	5.6	2.4	2.9	2.8	8.0
Lough Gill	92.2	6.4	5.5	2.7	3.1	3.9	9.8
Letterkenny	74.4	5.1	4.5	2.7	3.1	2.7	8.5
Mullroy	92.2	6.2	6.7	2.2	3.2	2.4	7.8
Rathdrum	88.9	6.0	6.5	2.8	2.5	2.6	7.9
Shelton	88.9	5.5	6.1	2.3	2.9	2.8	8.0
Woodford	95.6	5.4	5.0	2.7	2.8	3.0	8.4
Waterville	85.6	5.5	7.3	3.0	2.9	3.6	9.4
mean (m)	87.9	5.5	6.3	2.5	2.9	2.7	8.2
standard deviation (sd)	6.5	0.5	0.9	0.3	0.2	0.5	0.7
		well above average (>m+sd)			below average (m-sd)		
		above average (m+sd)			well below average (<m-sd)		

categories except height growth. Lough Gill was above average in all but stem straightness while Foxford was above average in all except stem straightness and form. Mullroy was above average in all except stem straightness and forking and Rathdrum was above average in all except apical dominance and forking.

The Ballyvourney, Charleville Island, Colooney, Knocktoper and Killarney-Tommies sources were all below average in most categories and thus their ability to produce good quality, productive stands is in some doubt.

Having said this, about these last five sources, a survey of plots showed that even in these poorer sources enough trees were present in each plot to provide sufficient final crop trees, albeit of a lower quality than some of the better sources. Needless to say that these poorer quality sources would require not only a decrease in the standard needed to select final crop trees, but would also require a significantly greater investment in pruning and shaping to produce a crop of reasonable quality. Thus by selecting a good quality seed source selection of final crop trees will be relatively easy and extra pruning and shaping work can be kept to a minimum.

### *European oak sources*

Of the 23 oak sources included in this trial 14 were determined to be sessile, 8 pedunculate and 2 were hybrids between the two species (Table 3).

Data from a flushing assessment carried on these sources assessed after six growing seasons in the field showed some variation. Material from The Netherlands, the UK and Ireland were found to be slightly later flushing than the German and French sources. This later flushing could provide some protection against late spring frost damage.

The results of survival, height growth, DBH, stem straightness, apical dominance, forking height and overall composite stem form are presented in Table 4. Conclusions from these results are more difficult to draw than from the results of the Camolin trial because of the large geographic range of sources covered in this trial.

Nevertheless, from the national averages in Table 4, the UK sources were above average in 4 out of the 6 categories, with the Dutch above average in 3 of the 6, the Irish and the French in 2 out of the 6, the German below average in all categories. In fact, the Schonau source is from the well known ‘Spessart’ region of Germany, which did not perform

Table 3: Sources and species of oak used in the European oak trial.

Source	Location	Country	Species
Glenealy	Deputy s Pass	Ireland	sessile
Coolgreany	Ballyfad	Ireland	hybrid
Delgany	Glen-of-the-Downs	Ireland	sessile
Killarney-D	Derrycunihy	Ireland	sessile
Killarney-M	Muckross	Ireland	pedunculate
Dymock 4008	Dymock, Hereford	UK	sessile
Hurst Hill 4003	New Forest, Hants.	UK	pedunculate
Drummond	Drommond Castle, Perthshire	UK	Pedunculate
Dean 4001	Blankey, Dean, Glos.	UK	sessile
Dean 4007	West Downs, Chiddingfold, Surrey	UK	sessile
Permery	Bourgogne	France	sessile
Le Temple	Champagne- Ardenne	France	sessile
Berce	Pay de Loire	France	Sessile
Orleans	Centre	France	sessile/hybrid
Helvoirt	Noord Brabant	The Netherlands	pedunculate
Waalwijk	Noord Brabant	The Netherlands	pedunculate
NL3	Noord Brabant	The Netherlands	pedunculate
Merzalben	Rhineland Palatinate	Germany	sessile
Weinhausen	Lower Saxony	Germany	pedunculate
Peine	Berkhopen	Germany	sessile
Schonau 862	Bavaria	Germany	sessile
Fallersleben	Lower Saxony	Germany	pedunculate
Lappwald	Lower Saxony	Germany	sessile

Table 4: Clonegal Irish and European Trial after 14 growing seasons – above average values in each category have blue fill, those below average are in grey.

	SURV	HGT	DBH	STR	AD	FK	FF
<b>Ireland</b>							
Coolgreany	96.7	5.6	6.1	2.9	2.9	3.0	8.8
Delgany	74.4	5.0	4.0	2.3	2.9	2.6	7.8
Glenealy	77.8	5.0	4.9	2.6	3.1	2.4	8.1
Killarney - Derrycunihy	94.4	5.6	5.5	2.5	2.8	3.5	8.8
Kilarney - pedunculate	96.7	5.6	7.1	2.4	2.6	2.6	7.6
mean	88.0	5.4	5.5	2.5	2.9	2.8	8.2
<b>United Kingdom</b>							
Dean 4001	74.4	6.4	6.0	2.3	3.3	3.7	9.3
Dean 4007	92.2	6.3	6.3	2.6	3.1	3.1	8.8
Drummond	96.7	5.1	4.1	2.3	2.6	2.0	6.9
Dymock	100.0	5.6	6.2	2.8	2.6	2.8	8.1
New forest	96.7	6.0	5.3	2.3	2.7	2.9	7.9
mean	92.0	5.9	5.6	2.5	2.8	2.9	8.2
<b>France</b>							
Berce	88.9	5.6	6.1	2.8	3.0	3.2	9.0
Le Temple	88.9	5.0	3.9	2.2	2.4	2.6	7.2
Orleans	92.2	5.4	5.0	2.4	2.9	3.1	8.4
Permery	63.3	5.1	5.6	2.7	2.4	3.1	8.2
mean	80.0	5.3	5.1	2.5	2.7	3.0	8.2
<b>Holland</b>							
Helvoirt	100.0	6.3	6.4	2.9	2.8	2.8	8.4
NL3	96.7	5.7	5.3	2.8	2.8	2.3	7.9
Waalwijk	96.7	6.1	7.0	3.0	2.8	3.0	8.8
mean	97.8	6.0	6.3	2.9	2.8	2.7	8.4
<b>Germany</b>							
Fallersleben	92.2	5.6	6.1	2.8	2.7	2.7	8.1
Lappwald	66.7	4.7	3.3	2.0	3.7	2.3	8.0
Merzalben	66.7	4.7	4.7	2.0	1.8	2.2	6.0
Peine	88.9	5.3	6.1	2.8	2.7	2.8	8.2
Schonau 862	33.3	4.7	4.6	2.8	3.4	2.9	9.2
Weinhausen	100.0	5.4	4.8	2.4	2.6	2.9	7.9
mean	74.6	5.1	4.9	2.5	2.8	2.6	7.9
trial mean	85.8	5.5	5.4	2.6	2.8	2.8	8.1
		well above average (>m+sd)			below average (m-sd)		
		above average (m+sd)			well below average (<m-sd)		

particularly well in this trial. However, these figures merely reflect the performance of the individual sources that make up the national averages. For example, Coolgreany, Dean 4007 and Berce are above average in all categories, indicating that good sources can be found almost everywhere.

The composite ‘form’ category is useful here because 75%

of the French sources, 66% of the Dutch sources, 40% of both the Irish and British while only 33% of the German sources were above average. It is, however, important to note that the height growth of both the French and the German sources is less than the other sources.

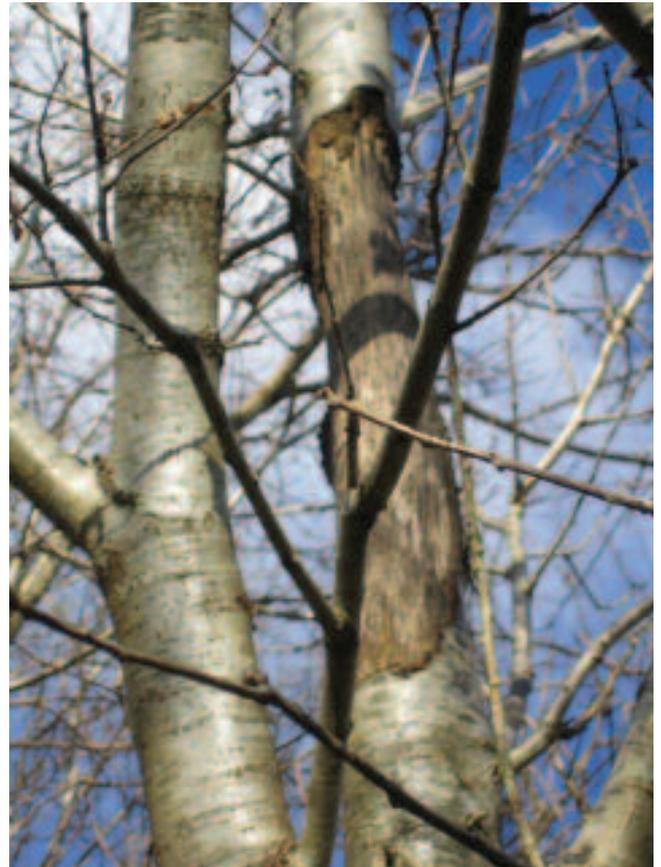
Three Irish sources present in both trials were Delgany, Killarney-Derrycunihy and Glenealy. The Delgany source

has performed poorly in both trials, while both Killarney-Derrycunihy and Glenealy have performed well.

## Conclusions

To date the Camolin trial, having been purged of competing 'weed' trees, remains in good condition and can continue to be reassessed further into the rotation to compare with the results presented here. The Clonegal trial, on the other hand, has subsequently been severely damaged by grey squirrel activity, the squirrels having stripped and ring barked the most vigorous individuals in the plots, rendering any further data from this trial suspect. Whether the Camolin trial will suffer the same fate remains to be seen. One tree in the Camolin trial shows past 'sampling' by grey squirrels and they have been seen in the area.

Perhaps the most important lesson from the Camolin trial is that while in every plot in the trial it is possible to identify the necessary number of potential final crop trees, the degree of difficulty in finding these trees varies with the source. In some plots potential final crop trees are easy to identify, while in others it is more difficult and in some cases the standard applied to select the potential final crop tree must be lowered. This highlights the fact that while



▲ Grey squirrel damage of oak at the Clonegal trial.



▲ Lough Gill (left) and Knocktopher (right).

there may not be one or several sources that stand out above the others, there are certainly some sources that will require much less pruning and shaping in order to produce good quality final crop trees.

It is also interesting to note that all of the better sources in this trial do not originate from one part of the country but are scattered around (discontinuous variation). Indeed in many cases those sources closest to the best sources are often the poorest (compare Killarney-Tomies to Killarney-Derrycunihy and Colooney to Lough Gill).

The quality of the trees in the plots in these trials in many cases does not reflect the quality of the stands whence the seed was collected. Indeed from the appearance of some of the original seed sources it could be questioned why they were included in the trial in the first place. However, this poor appearance (phenotype) probably results from past management practices wherein the better quality trees had been selectively harvested, suggesting that the same good genes are still present in the population. Thus, phenotypical selection of stands can be deceiving.

The results from the Clonegal trial suggest that French and German seed sources have not done well under Irish conditions. This observation has been supported by a survey of commercial oak stands where the seed source can be traced (Neilan unpublished). It is interesting to note that the Dutch seed sources have done very well in this trial and combine good growth rates together with late flushing, which may be more important than good growth rate alone.

## Recommendations

Even based on 14 year results, large differences in the growth and stem form of different oak sources can clearly be seen. While it is not possible to conclusively identify the 'best' seed sources at this age, it is clear that the origin of the seed will play an important role in the degree of silvicultural management that will be necessary to produce good quality final crop trees.

Because the demand for acorns outstrips the supply in most years, importation of seed will continue to be necessary. The results of the Clonegal trial show that when Irish sources are not available, Dutch and British sources are good options. Although very little British oak seed comes onto the market, there is usually a good supply of Dutch acorns available most years.

While the Clonegal trial may have to be abandoned, the Camolin trial, and the other three trials in this series (Durrow, Donadea and Belturbet) are now in their twenty-first growing season on these sites. Some of the better plots have mean heights in excess of 9 m and are competing for crown space. It is time now to undertake a thorough reassessment and to develop and execute a silvicultural management programme. It would be very worthwhile to manage these trials as demonstration stands utilising various appropriate management techniques.

## Latest information

A recent inspection (July 2008) of the Camolin trial has revealed a considerable degree of recent grey squirrel damage, which will, if left unchecked, destroy this trial. Two sister trials (Durrow and Belturbet) have been inspected since; however, neither show any grey squirrel damage to date.

## Acknowledgements

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