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Year 16 assessment of 2006 oak provenance and progeny trials

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INTRODUCTION

In the late 1990s and early 2000s the establishment of the Millennium Woodlands, together with increased interest in native woodland revealed a significant gap in the availability of suitable native planting stock. This was particularly true of oak, notorious for the unpredictability and infrequency of mast years[1] and the inability to store acorns for more than one year. Acorns for use in commercial hardwood forestry must be sourced from 'Selected' seedstands registered with the Forest Service if they are to be used in the subsequent establishment of grant-aided afforestation. A lower seed source category 'Source Identified' is acceptable for native woodland schemes.

In the period preceding the 1990s almost all of the acorns used in Irish forestry were sourced overseas, mainly from the Netherlands, which is a Forest Service approved region of provenance for oak seed sourcing. To increase potential acorn production a number of oak stands, selected on the basis of overall good tree form, together with their probable native status, were added to the National Seedstand Catalogue in the 'Source Identified' category. Comparison of the growth performance of seed from these stands, together with previously untested seedstands and existing Irish Selected Seedstands, as well as with UK and continental standards, constituted the provenance aspect of the trials.

The trials also include a progeny element. A series of Irish plus oak trees were selected within the Coillte estate under the ECLAIR programme in the early 1990s, based on form, growth rate and other quality criteria. Scions were taken from the plus trees and were grafted, grown on and then planted out in a genebank at Coillte's Tree Improvement Centre at Kilmacurragh, Co. Wicklow. A number of the genebank trees seeded in 2004, and the acorns were collected from each tree and sown. These single parent progeny plants were planted in the Progeny plots as randomised single tree plots. Progeny plots are assessed both as plots and individual trees.

In summary, two aspects of oak tree improvement are being investigated in the provenance/progeny trials:

1. Provenance Trials: to determine the best populations of Irish oak in order to source the best seed.
2. Progeny Trials: to select the best Irish individuals (plus trees) for clonal propagation and clonal seed orchard development.

ESTABLISHMENT

The trials were established in 2006 at three privately-owned properties:

[1] A mast year occurs when oak stands produce a bumper crop of seeds.

Manch Estate, Ballineen, Co. Cork

None-so-Hardy Nurseries, Shillelagh, Co. Wicklow

Tullynally Estate, Co. Westmeath

All of the trials were established using the same methods. Station locations were measured out on a 2 x 2 m square grid and marked with paint.

Planting stations were prepared using a two-man power auger, augured holes being drilled to c.50 cm. Trees were planted by hand into the augured holes, sufficient loose soil having been reamed to pack the plants.

Each plot comprises 25 trees on a 5 x 5 square grid. There are no gaps between plots. Marker stakes with embossed aluminium nametags were placed at the location of tree no.1 in each plot. The trials are enclosed by rabbit and stock-proof fencing.

There are four replications totalling 100 trees of each provenance in each trial.

Shelterbelt trees were planted around the exterior of each trial where appropriate. All shelterbelt trees were Provenance 14 Nuenen (Netherlands).

All of the Irish trees were one 1-year-old container grown, while the imported trees were 2-year-old bareroot stock in the 40 – 60 cm range, the only exception being the German trees from Oster Kustenraum (90 -120 cm).

As all of the sites are on private property, protocol demands that the owners or their agents be informed prior to any visit.

Provenance trials sources

Sources and species, and their distribution across the three trials, as well as seedstand status are shown in Table 1 below.

Table 1 Provenance trial sources. M = Manch, S = Shillelagh and T = Tullynally.

Number	Name	Location	Species	M	S	T	Status
1	Tomnafinnogue	Wicklow	Sess	+	+	+	Registered
2	Glengarriff	Cork	Sess	+	+	+	Reg
3	Coolattin	Wicklow	Sess	+	+	+	Reg
4	Rahin	Offaly	Ped	+	+	+	Reg
5	Cool Mountain	Cork	Sess	+	+	+	Source Id
6	Stradbally	Laois	Ped	+	+	-	Reg
7	Charleville	Offaly	Ped	+	+	+	Reg
8	Ahil	Cork	Sess	+	+	+	Source Id
9	St. John's Wood	Roscommon	Ped	+	+	+	Reg
10	Tullynally Elite	Westmeath	Ped	+	+	+	Reg
11	Tullynally Avenue	Westmeath	Ped	+	-	+	Reg
12	Forest of Dean	UK	Sess	+	+	+	Reg
13	Forest of Dean	UK	Ped	+	+	+	Reg
14	Nuenen	Holland	Ped	+	+	+	Reg
15	Oster Kurstenraum	Germany	Ped	+	+	+	Reg
16	Squire's Walk. Stick	Westmeath	Ped	-	-	+	Reg
17	Tullynally General	Westmeath	Ped	-	-	+	Reg
18	Helmond	Holland	Ped	-	+	-	Reg

Progeny trial sources

All but one (Mount Bellew) of the source progeny plus trees, are located in the Leinster area. This distribution may not be fully representative of the potential genetic pool in Ireland. Not all of the progeny trees have been identified to species to date.

While a new numbering system was used for the trial purposes, the original ÉCLAIR numbers are retained and the progeny can be traced back to individual plus trees, as shown Table 2.

Table 2 Progeny numbers, location and distribution across the trials (M = Manch, S=Shillelagh and T= Tullynally)

Trial No.	ECLAIR No.	Location	County	M	S	T
1	2	New Ross	Wexford	10	6	4
2	10	Bree	Wexford	20	16	20
3	11	Coolgreany	Wexford	10	12	13
4	14	Coolgreany	Wexford	20	18	17
5	26	Mount Bellew	Galway	20	16	15
6	27	Shelton	Wicklow	10	6	4
7	34	Donadea	Kildare	20	11	8
8	39	Knocktopher	Kilkenny	20	18	19
9	44	Allen	Kildare	10	6	4
10	45	Allen	Kildare	20	12	7
11	46	Allen	Kildare	10	6	4
12	52	Callan	Kilkenny	20	12	8
13	85	Portlaoise	Laois	10	9	11
14	86	Portlaoise	Laois	10	6	4
15	88	Portlaoise	Laois	10	12	15
16	89	Portlaoise	Laois	10	11	15
17	90	Dundrum	Tipperary	10	12	16
25	?87	Portlaoise	Laois	10	6	4

METHODS

Diameter breast height (DBH) was measured on all trees in each plot in each trial with a SANDVIK callipers to a precision of one millimetre.

Height measurements were taken on five dominant trees in each of the provenance plots and on each tree in the progeny plots. Measurements were made a 7.5m pole at Manch and with a HOHENMESSER Altimeter at the other two sites, pole measurements being accurate to 10cm and altimeter values to 50cm.

Three aspects of tree form were assessed visually and scored on a 1 (poor) to 4 (good) basis.

Straightness

1 Very crooked
2 Crooked
3 Mainly straight with a few kinks
4 Straight

Trees with straightness values of 3 and 4 have potential as crop trees

Apical Dominance

1 Weak, with multiple growth tips
2 Weak, more than three leading shoots
3 Strong, with several leaders

4 Strong, with one leader

Apical dominance and straightness are closely related and trees with high values for one tend to reflect high values for the other

Forking/Branching

1 Heavy forking and heavy branching
2 Some forking and heavy branching
3 Light forking and light branching
4 No forking and light branching

Forking is usually attributed to damage to soft early season growth caused by late spring frosts, but can also be the result of wind damage or deer grazing. Trees with strong apical dominance are likely to recover over time. Heavy branching is characteristic of young oak and does not reflect a tree's potential value in the long term.

Analysis

While all data sets are available for detailed statistical analysis, a simple Z-score methodology was used throughout. Plots values were compared in terms of standard deviations (StDev) from the trial means. Z scores are particularly useful for comparing disparate data sets.

In a set of numbers, the **mean** (M) is the average of that set of numbers, and the **standard deviation** (StDev) is a measure of the distance each number in the dataset is from the mean. This can be either plus or minus. A Z-score of +1 indicates that the selected number is greater than the series average by up to 1 StDev, while a score of -1 shows that the number is less than the series average by up to 1 StDev.

Any value within the range -1 to +1 StDev is considered average. Values between +1 and +2 and -1 and -2 are considered to be above and below average, while those >+2 or <-2 StDev are considered outliers or very significant.

This method is used to summarise all average measurements and is expressed graphically on all relevant tables throughout the report using the colour coding shown below.

Z score		
Greater than + 2 SD		+3
Between +1 and +2 SD		+2
Between Mean and + 1 SD		+1
Plot Mean/Average		
Between -1 SD and Mean		-1
Between -1 and -2 SD		-2
Below -2 SD		-3

Potential crop tree (PCT) selection and further management

Potential crop trees are stems of above average form and growth that are assessed to be candidate final crop trees in the stand. A minimum of two PCTs have been selected in each plot (with the exception of one Manch plot). These trees have been recorded on maps but have not been marked on the ground to date. PCTs trees will be marked with paint. The intention is to work to these trees and free up their crowns by thinning.

Trial Sites

Manch

This trial is located on the Manch Estate, two miles west of Ballineen on the R586 between Bandon and Dunmanway in Co. Cork. The trial is sited 200m south of the road through wide farm gates across a level arable field. Grid reference of the centre of the trial is 307.527.

Site description

The trial is established on level ground within the floodplain of the river Bandon. The soil is alluvial, sandy and free draining, with low organic matter content. Previously under tillage, the trial is flanked on two sides by contemporaneous broadleaf planting undertaken by INFF (the Irish Natural Forestry Foundation). Soil quality reduces towards the river Bandon and growth and form can be seen to deteriorate.

Post-planting history

During the first winter after planting excessive flooding of the river Bandon brought down the fencing on the southern side of the trial. As a result, hare damage ensued, with 90% of the trees being cut back to ground level, apart from the progeny plots where trees were protected by tree guards. The fence was repaired and all of the trees were protected with tree sleeves. Recovery was remarkable, there were no losses and none of the trees required subsequent stem singling.

In the winter of 2020, an unauthorised thinning and pruning programme was carried out wherein 150 trees were felled and most of the remaining trees were pruned to two metres. Reduction in leaf area resulting from pruning has impacted on growth and slowed canopy formation. All of the cut stumps have produced well established coppice shoots and singling may be of value in the future. All of the felled trees had poor form values as recorded on a previous assessment (2013).

Significant numbers of oak volunteers have seeded into the trial and are competing with the trial trees. The locations of these trees are shown on accompanying Map Manch Year 16. In order to prevent future mix-ups, it is planned that these will be removed.

A large proportion of the plot marker stakes are still extant, although some re-staking and tagging will be necessary.

Shillelagh

This trial is located at Poulbeg, Coolboy, near Shillelagh, immediately west of the None-so-Hardy Forestry offices and cold store. It can be reached from the R748 Aughrim-Carnew road: travelling south from Aughrim turn right at the Kilcavan Gap and follow signs to None-so-Hardy Forestry. National grid reference to the centre of the trial is 020.668.

Site description

The trial is located on a sheltered gentle northwest facing slope. Soil is heavy with a high clay content. Drainage is good in the upper part but somewhat impeded on the lower more level ground.

Post planting history

Deer damage became a problem at the site more or less immediately after planting. The height of the stock fence was therefore increased to 2m with the use of three strands of electrified cord attached to extension batons fastened to the original stock fencing stakes. This proved to be largely successful, though deer continued to access the trial by 'nosing' under and breaking through the rabbit wire. Funding was obtained and stronger sheep wire was erected over the rabbit wire. This has proved wholly successful and the trees are now showing good recovery. The continued browsing by the deer has skewed results to date, but these differences will likely decline over time.

In the second summer after planting many of the trees were severely damaged by accidental herbicide application. In order to fill gaps in the plantation, in the absence of replacement oak, some 150 hornbeam were planted, a small number of which are beginning to compete with the trial oaks.

Differences in soil drainage capacity, particularly on the lower ground has given rise to waterlogging, and together with frost damage and persistent deer browsing growth has been inhibited. Consequently, a number of plots have considerably poorer values than might be expected (See heights and DBH maps).

Significant numbers of marker stakes have deteriorated and stakes and tags will be replaced.

Tullynally

This trial is located within Tullynally Estate some three kilometres west of Castlepollard, in Co. Westmeath on the R395. Access to the site is from the main avenue running up to Tullynally Hall (park just after the cattle grid and walk 200m across the field to the north-northeast. **Caution: electric fencing and cattle**). Grid reference to the centre of the trial is 448.710.

Site description

The trial is located in a well sheltered corner with a gentle slope towards the northeast. Previously in pasture, the soil is heavy with a high clay content and

drainage can be impeded, especially where compacted by heavy cattle. The trial is immediately adjacent to a larger area of oak planting undertaken contemporaneously and also within 100m of a mature elite stand of pedunculate oak.

Post planting history

Rank grass growth in the first year swamped the small oaks and it was necessary to spot spray with glyphosate in the first winter. No subsequent application of herbicide was needed. All trees were protected by tree sleeves at this time. No fertilizer has been applied.

During the destructive February 2014 storm, a large over-mature beech broke and obliterated two of the trial plots.

Numbers of marker stakes will be replaced and remaining tree guards will be removed.

RESULTS

Provenance Trials

MANCH

HEIGHT

Mean plot height values are average heights measured on five co-dominant trees including selected PCTs in each provenance. All progeny trees were measured

Average co-dominant height across the trial is 6.1m. With a mean height of 6.7m, the best values were recorded in the first replication. The tallest plots (#4 Progeny and #12 Tullynally Elite) average 7.8m and 7.7m respectively. With values of 5.9m the poorest plots in the first replication are #6 Osterkustenraum and #5 Cool Mountain.

Over the whole trial both the Progeny plots and Tullynally Elite averages are 6.6m, just above Rahin and Forest of Dean Pedunculate (6.5m). Cool Mountain, at 5.3m and Osterkustenraum at 5.5m, have the lowest values in the trial.

Plot heights consistently drop off towards the southeast with the fourth replication averaging just 5.5m (See Manch Height Map).

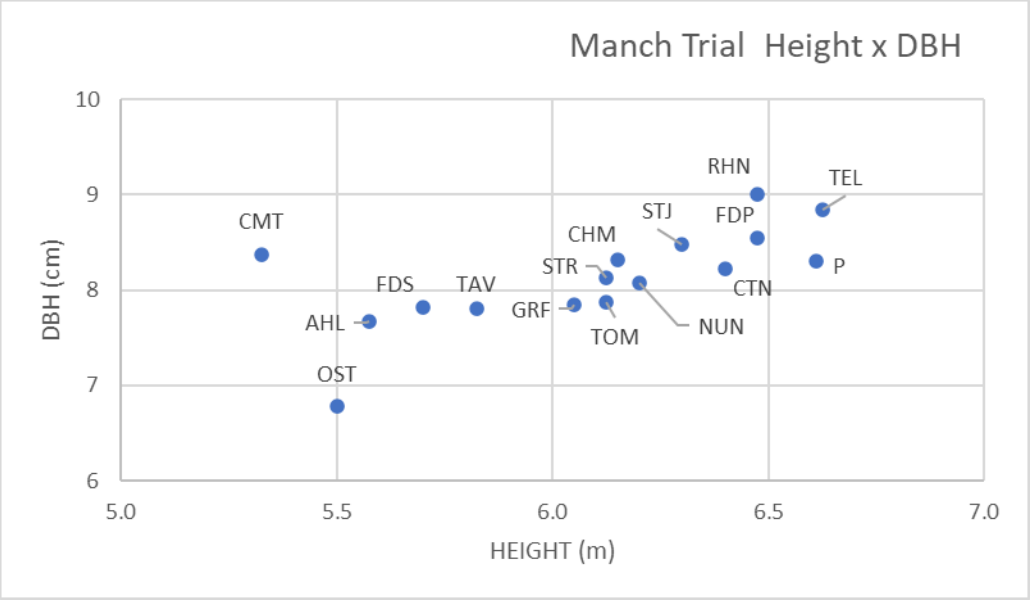
DBH

DBH measurements were taken on every tree in every plot.

On the basis of plot averages the mean across the whole trial is 8.1cm. As in the case of the height figures, DBH values drop off dramatically towards the southeast. Anomalously the greatest DBH is found in the fourth replication with an average of 10.5cm in Plot 70 (Rahin). Over the four replications Rahin maintains the greatest DBH (mean 9.0cm), followed closely by Tullynally Elite (8.9cm). Other above average DBHs include Forest of Dean Pedunculate (8.6cm), St. John's Wood (8.5cm) and Cool Mountain (8.4cm). At 8.4cm average across the ten plots the Progeny material is above average but not significantly so.

Consistently and significantly low values were recorded for Osterekustenraum across the four replications averaging 6.8cm, being well below those of the next lowest provenance: Ahil at 7.,7cm.

Height by DBH is shown in the figure below.



FORM

All trees were visually assessed on a scale of 1 to 4 for straightness, apical dominance and forking/ branching.

STRAIGHTNESS

Across all of the plots the trial average is 2.1. There is little variation between replications although the third rep has higher scores (2.3). Scoring 3.0 Tomnafinogue (Plot #57) has the straightest trees, closely followed by the Tomnafinogue plot (#46) in rep 3 and Forest of Dean Pedunculate (rep 2) both with values of 2.8. Consistently high scoring provenances include Coolattin and Charleville averaging 2.5 and 2.3 across the four reps respectively. Eight of the ten progeny plots score above or well above the trial average (mean Progeny score 2.3).

The poorest score for an individual plot is 1.5 recorded by Osterkustenraum in the first rep (Plot #6). Averaged across the four reps the least straight provenances are Forest of Dean Sessile (1.8) and Cool Mountain, Stradbally and St. John's Wood (1.9).

APICAL DOMINANCE (AD)

Averaged across the trial the mean plot apical dominance (AD) score is 2.5. At 3.1 the first Progeny plot (#4), Glengarriff (#18), Forest of Dean Pedunculate (#32) and Osterkustenraum (#55) score highest. In contrast, the poorest scoring plots Forest of Dean Sessile (#67) and Nuenen (#65) both score 1.9 in the fourth rep.

Averaged across the four reps Coolattin (2.9), Tomnafinnogue (2.8) and Forest of Dean Pedunculate (2.8) have the highest scores. The averages for the Progeny plots and Rahin are 2.7

Lowest values were recorded for Forest of Dean Sessile (2.2) and Ahil (2.3).

FORKING and BRANCHINESS

Trial average score is 1.9. With a score of 2.3 six plots Coolattin (# 4), St. John's Wood (# 2), Forest of Dean Sessile (#1) Forest of Dean Pedunculate (# 32), Tomnafinnogue (# 46) and Osterkustenraum (# 55) have the best FB values. Lowest scoring plots are Rahin (# 70) at 1.4 and Nuenen (# 23) at 1.5.

The best aggregated provenance scores are 2.2 Coolattin and 2.1 Tomnafinnogue. Combined Progeny plot scores at 1.9 are equal to the trial average.

Stradbally (1.6) and Cool Mountain (1.7) have the lowest scores.

MANCH FORM — PLOT VALUES AND Z SCORES

		STRAIGHTNESS						APICAL DOMINANCE						FORKING/BRANCHING					
		Replications						Replications						Replications					
		1	2	3	4	Av.	Z	1	2	3	4	Av.	Z	1	2	3	4	Av.	Z
1	TOM	1.9	2.5	2.8	3.0	2.6	6	2.4	2.9	2.9	2.9	2.8	5	1.8	2.1	2.3	2.0	2.1	3
2	GRF	2.1	2.1	2.3	1.8	2.1	-3	2.7	2.6	3.1	2.0	2.6	0	1.8	1.8	2.0	1.8	1.9	-2
3	CTN	2.6	2.4	2.7	2.4	2.5	6	3.0	2.9	2.8	3.0	2.9	7	2.3	2.1	2.2	2.2	2.2	7
4	RHN	1.7	2.1	2.5	2.4	2.2	-1	2.4	2.9	2.5	2.8	2.7	1	1.8	1.8	2.1	1.4	1.8	-4
5	CMT	1.8	2.2	2.0	1.6	1.9	-6	2.6	2.4	2.4	2.2	2.4	-4	1.6	1.8	1.8	1.6	1.7	-4
6	STR	1.7	2.0	1.8	2.1	1.9	-6	2.5	2.8	2.2	2.1	2.4	-4	1.6	1.6	1.7	1.6	1.6	-4
7	CHV	2.3	2.2	2.6	2.2	2.3	4	2.5	2.6	2.7	2.3	2.5	-1	1.7	1.8	2.0	1.7	1.8	-2
8	AHL	1.7	1.7	2.4	2.0	2.0	-4	2.0	2.6	2.5	2.2	2.3	-6	1.6	1.8	1.8	1.8	1.8	-4
9	STJ	2.0	1.9	1.8	1.9	1.9	-5	2.5	2.2	2.7	2.2	2.4	-4	2.3	1.8	2.1	1.6	2.0	0
10	TYE	2.7	1.9	2.5	2.1	2.3	1	3.0	2.3	2.6	2.5	2.6	-1	2.0	1.9	1.9	1.8	1.9	-3
11	TAV	2.2	2.2	2.1	1.9	2.1	-2	2.3	2.6	2.9	2.3	2.5	0	1.8	2.1	1.8	1.8	1.9	-2
12	FDS	1.9	1.8	1.9	1.6	1.8	-7	2.3	2.5	2.1	1.9	2.2	-7	2.3	1.6	2.0	1.6	1.9	-2
13	FDP	2.2	2.8	2.1	2.4	2.4	3	2.8	3.1	2.4	2.7	2.8	3	1.9	2.3	1.7	1.8	1.9	0
14	NUN	2.2	2.2	2.4	1.8	2.2	-1	2.7	2.4	2.6	1.9	2.4	-3	1.9	1.5	2.0	1.8	1.8	-2
15	OSK	1.5	2.0	2.2	2.1	2.0	-5	2.3	2.4	3.1	2.4	2.6	-1	1.7	1.7	2.3	1.9	1.9	0
16	SQW																		
17	TYG																		
18	HEL																		
P	P	2.3	2.2	2.5	2.0	2.3		3.1	2.5	2.9	2.4	2.7		1.9	1.7	2.1	1.8	1.9	
P	P	2.2	2.3	2.2				2.5	2.8	2.9				1.8	1.7	2.1			
P	P	2.4	2.0	2.4				2.9	2.4	2.8				1.8	2.0	2.0			
Rep mean		2.1	2.1	2.3	2.1			2.6	2.5	2.6	2.6								
		Trial Mean			2.2			Trial Mean			2.6			Trial Mean			1.9		
			StDev		0.3				StDev		0.3				StDev		0.2		
				>2.7						>3.1						>2.3			
				2.6 - 2.7						2.9 - 3.1						2.2 - 2.3			
				2.3 - 2.5						2.7 - 2.8						2.0 - 2.1			
				2.2						2.6						1.9			
				1.9 - 2.1						2.3- 2.5						1.6 - 1.8			
				1.7 - 1.8						2.1 - 2.2						1.3– 1.5			
				<1.7						<2.1						<1.3			

SHILLELAGH

HEIGHT

Mean plot height across the trial is 8.6m. There is notable variability between replications with Rep1 (9.6m) and Rep2 (8.7m) being substantially greater than Rep3 (7.8m) and Rep4 (8.2m).

Individual plots with the highest values are #10 Forest of Dean Pedunculate (12.1m), #8 Progeny (11.6m). Additional high scoring plots are #18 Progeny, #24 Helmond, #35 Coolattin and #40 Tomnafinogue, all averaging 10.5m. Plots with the lowest trees are #47 Forest of Dean Sessile (4.8m) and #48 Coolattin (5.4m)

Averaged across the four reps the provenances with the tallest trees are Forest of Dean Pedunculate (9.7m), Tomnafinnogue (9.4m), Osterkustenraum (9.3m) and Helmond (9.3m). Consistantly poor performers include Forest of Dean Sessile (7.3m) and Rahin (7.7m). While a number of progeny plots score well overall value are just above the trial average.

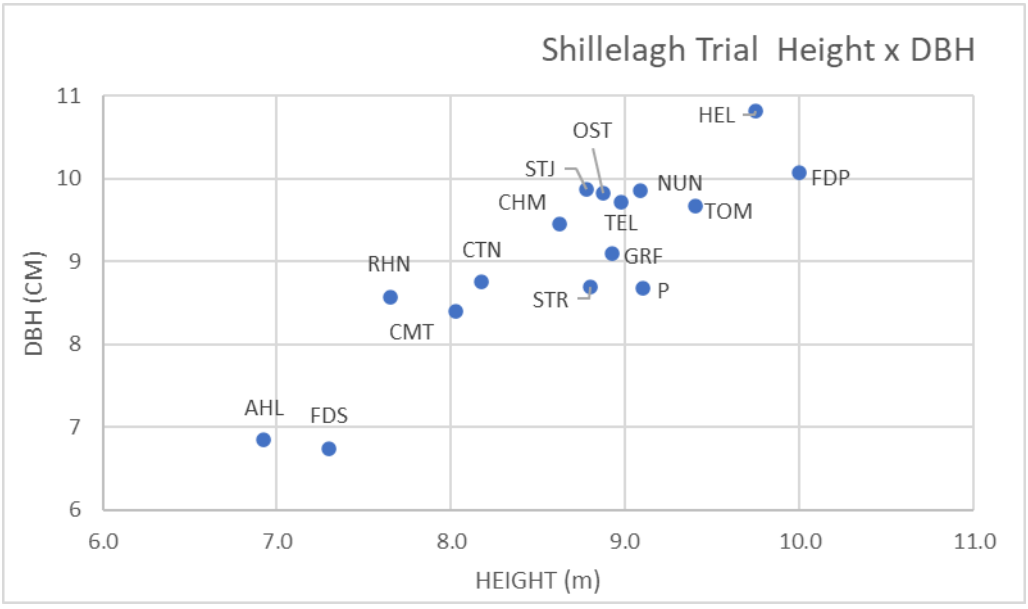
DBH

Average DBH across the trial is 9.1cm. with distribution of larger values reflecting those for Height. The highest values were recorded in Rep1 (9.8cm). Reps 2 and 4 average 9.2cm and Rep3 is significantly lower at 7.9cm.

Two Forest of Dean Pedunculate plots #10 (12.1cm) and #22 (12.2) have the greatest DBH values. Plot #47 (Forest of Dean Sessile) has the lowest DBH values (4.3cm) and two other plots, #30 (5.6cm) and #42(6.1cm), both Ahil, have values lower than two standard deviation below the trial mean.

Provenance averages range from 6.8cm (Forest of Dean Sessile) up to 10.8cm (Helmond). High DBH provenances include Forest of Dean Pedunculate (10.1cm), St. John's Wood (9.9cm) and Nuenen (9.9cm). Low values were recorded for Ahil (6.9cm), Cool Mountain (8.4cm) and Rahin (8.6cm). The Progeny plots have average DBH of 8.7cm, below the trial average (9.1cm).

Height by DBH characteristics for this trial are shown on diagram below



FORM

All trees were visually assessed for straightness, apical dominance and forking/branching on a scale of 1 (poor) to 4 (excellent).

STRAIGHTNESS

Across this trial, the average plot score is 2.2, with minor variation between reps. Two Tomnafinogue plots (#2 and #59) are exceptionally straight, scoring 2.9 and 2.8 respectively. Together with Helmond (#24), these plots have values in excess of two standard deviations from the trial mean. The least straight plot is # 6 St. John's Wood which scored just 1.6.

Averaged across the four reps Tomnafinogue (2.7) and Helmond (2.6) are the highest scoring provenances. At 2.4 both Coolattin and Forest of Dean Pedunculate have above average values. The lowest scoring provenances are St. John's Wood (1.8) and Stradbally (1.9). The Progeny plots average 2.3, just above the trial average.

APICAL DOMINANCE

Across the trial average plot score is 2.6, with minor variation between reps. Two exceptionally strong plots are Tullynally Elite (# 4) and Forest of Dean Pedunculate (# 10) with values of 3.2. Seven plots have low scores of 2.2, five of which are in the second rep.

The best scoring provenance are Tomnafinnogue (2.9), Helmond (2.8) and Coolattin and Osterkustenraum at 2.7. Four provenances which score 2.4 are grouped at the bottom: Stradbally, Charleville Forest, St. John's Wood and Nuenen.

With an average score of 2.7 the progeny plots exhibit above average apical dominance.

FORKING and BRANCHING

In this trial the average score is 1.8, with plot values ranging from a low of 1.3 (Tullynally Elite plot # 64) up to 2.3 Tomnafinnogue (# 25) and Coolattin (# 48). There is little variation between reps.

The best scoring provenances are Tomnafinnogue (2.1) and Coolattin (2.0), while the poorest values were recorded for Stradbally (1.5), and Charleville Forest, Tullynally Elite and Helmond (all 1.6).

At 1.7 the Progeny plots aggregate just below the trial average.

SHILLELAGH FORM — PLOT VALUES AND Z SCORES

								APIC						FORKI						
		Replications						Replications						Replications						
		1	2	3	4			1	2	3	4			1	2	3	4	Av.		
1	TOM	2.9	2.6	2.6	2.8			2.7	3.0	3.0	3.0			2.1	2.3	2.0	2.1	2.1		
2	GRF	2.0	2.2	2.3	2.2			2.4	2.5	2.7	2.9			1.7	1.9	1.8	1.6	1.8		
3	CTN	2.4	2.3	2.5	2.3			2.5	2.4	3.0	2.8			1.9	1.9	2.3	1.8	2.0		
4	RHN	1.9	2.0	2.2	1.8			2.6	2.2	2.7	2.4			2.0	1.4	2.0	1.5	1.7		
5	CMT	2.3	2.0	2.0	2.1			2.5	2.2	2.3	2.7			2.0	1.8	1.8	1.8	1.9		
6	STR	1.9	2.0	1.9	1.8			2.2	2.5	2.4	2.4			1.5	1.7	1.4	1.5	1.5		
7	CHV	2.2	2.0	2.1	2.2			2.4	2.2	2.3	2.5			1.8	1.7	1.5	1.5	1.6		
8	AHL	2.0	2.1	2.2	2.4			2.3	2.2	2.6	2.7			1.7	1.7	1.9	1.7	1.8		
9	STJ	1.5	1.9	2.0	1.8			2.4	2.5	2.3	2.3			1.6	1.9	1.7	1.5	1.7		
10	TYE	2.5	2.3	2.4	1.9			3.2	2.7	2.3	2.3			1.7	1.5	1.9	1.3	1.6		
11	TAV																			
12	FDS	2.3	2.3	1.9	2.0			2.5	2.6	2.2	2.3			1.8	1.8	1.9	1.8	1.8		
13	FDP	2.4	2.4	2.3	2.4			3.2	2.4	2.9	2.8			2.0	1.5	2.0	1.8	1.8		
14	NUN	2.4	2.1	2.2	2.4			2.4	2.2	2.4	2.5			1.8	1.7	1.6	1.5	1.7		
15	OSK	2.1	2.2	2.0	2.2			2.8	2.9	2.3	2.6			2.1	1.8	1.7	1.5	1.8		
16	SQW																			
17	TYG																			
18	HEL	2.4	2.8	2.6	2.4	2.6	7	2.8	2.8	3.1	2.6	2.8	4	1.7	1.6	1.5	1.6	1.6	-4	
P	P	2.6	2.3	2.1	2.2	2.2	4	3.0	2.8	2.5	2.5	2.7	3	1.8	2.0	1.9	1.9	1.7	0	
P	P	2.4	2.3					2.7	2.7					1.7	1.8					
P	P	2.3	2.1					2.8	2.4					1.8	1.6					
Rep mean		2.3	2.2	2.2	2.2			2.6	2.5	2.6	2.6									
		Trial Me			2.2			Trial Mean			2.6			Trial Mea			1.8			
			StDev		0.3				StDev		0.3				StDev		0.2			
				>2.7						>3.1						>2.3				
				2.6 - 2.7						3.0 - 3.1						2.1 - 2.3				
				2.3 - 2.5						2.7 - 2.9						1.9 - 2.0				
				2.2						2.6						1.8				
				1.9 - 2.1						2.3- 2.5						1.5 - 1.7				
				1.7 - 1.8						2.1 - 2.2						1.2– 1.4				
				<1.7						<2.2						<1.2				

TULLYNALLY

HEIGHT

All of the trees in the progeny plots and five selected co-dominant trees in the provenance plots were measured using a handheld hypsometer. Precision is ± 50 cm.

Average plot height across the trial is 9.0m, ranging from a low of 6.2m Charleville Forest (# 49) up to 10.9m Rahin (# 23). With an average of 8.6m, plots in the first rep are well below the trial mean, while the other reps better reflect overall results.

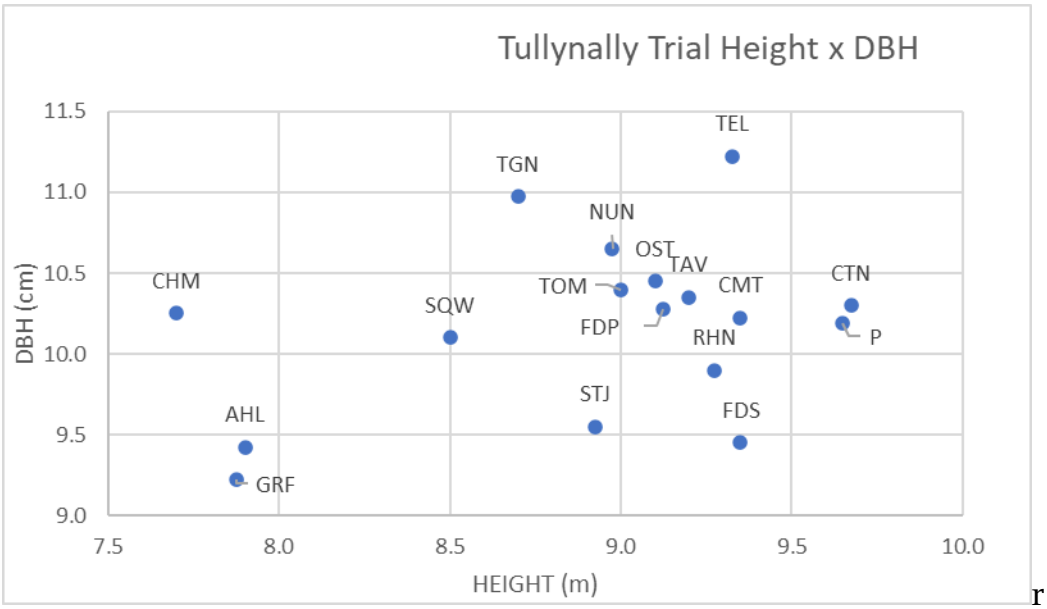
Provenance averages ranged from 7.7m (Charleville Forest) to 9.7m (Coolattin and the Progeny plots). Other provenances with significantly above average height values include Cool Mountain and Forest of Dean Sessile (9.4m), and Rahin and Tullynally Elite (9.3m). While the values for Tullynally Avenue were also above average (9.2m), the other Tullynally groups were below average: Tullynally General 8.7m and Squire's Walking Stick 8.5m.

DBH

Average DBH for this trial is 10.2cm, with values ranging from 6.8cm (St. John's Wood #1) up to 12.4cm (Progeny Plot #52) and increasing from the first to the third and fourth reps. The best provenance plots are Tullynally Elite #40 (12.1cm), Tullynally General #7 (11.7cm) and Tullynally Elite #12 (11.5cm). While St. John's Wood has the lowest values in the first rep, values are above average in all of the other reps.

Averaged across the whole trial the provenance values range from 9.2cm Glengarriff to 11.2cm Tullynally Elite. DBH values of 11.0cm Tullynally General and 10.7cm Nuenen are significantly higher than the trial mean. Two southwestern provenances, Glengarriff (9.2cm) and Ahil (9.4cm), have the lowest overall values.

While the eight Progeny plots include the largest DBH (#52), only two others are above the trial mean, the remainder being below, to well below average.



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FORM

All trees were visually assessed for straightness, apical dominance and forking/branching on a scale of 1 (poor) to 4 (excellent).

STRAIGHTNESS

On a scale of 1 – 4, the average straightness score across the trial is 2.1, values dropping across the four reps.

Scoring 2.7 plot #3 Cool Mountain has the highest values. Scoring 2.7 other high value plots include Forest of Dean Sessile (#2), Progeny (#4) and Tomnafinnogue (#27). With an abysmal score of 1.4 Glengarriff plot #15 is the most crooked plot. Two Nuenen plots (#37 and #67) have only slightly higher scores of 1.6.

Tomnafinnogue, with values of 2.4 across the four reps, is the overall straightest provenance. Forest of Dean Sessile (2.3) and Coolattin, Charleville Forest and the Progeny plots (all 2.2) are all above average. The lowest scoring provenance is Nuenen (1.7), closely followed by Glengarriff and Rahin (1.8).

Three of the eight Progeny plots have well above average straightness values and a Progeny mean of 2.2 is just above the trial average.

APICAL DOMINANCE

The trial average is 2.5 and there is little variation between replications.

Individual plot scores range from 1.8 Glengarriff (#15) up to 3.0 St. John's Wood (#68). Other high scoring plots are Tomnafinnogue (#27), Charleville Forest (#36 and #66) with values of 2.9. With a score of 1.9 plot #55 Osterkustenraum has poor apical dominance.

Grouped provenance scores range from 2.1 Glengarriff to 2.7: Tomnafinnogue, Tullynally Elite and Nuenen.

The Progeny plots combined average just above the trial mean.

FORKING and BRANCHING

The mean trial score is 1.7. Values in the fourth rep are significantly lower than the other three.

Individual plot values range from 1.2 (Progeny plot #71) to 2.3 (Cool Mountain #3). Above average scoring plots include #32 (Forest of Dean Pedunculate 2.2) and three of the eight Progeny plots (#4, #11 and #45). With values of 1.3 other low scoring plots are #6 Rahin, #14 Forest of Dean Pedunculate and #49 Charleville Forest.

Grouped provenance scores range from 1.5 to 1.9, with Coolattin, Cool Mountain, Forest of Dean Sessile and the aggregated Progeny plots topping the table. The most branchy provenances are Charleville Forest and Nuenen.

All but one (#71) of the Progeny plots score above to well above average.

TULLYNALLY FORM		PLOT VALUES AND Z SCORES																	
		STRAIGHTNESS						APICAL DOMINANCE						FORKING/BRANCHING					
		Replications						Replications						Replications					
		1	2	3	4	Av.	Z	1	2	3	4	Av.	Z	1	2	3	4	Av.	Z
1	TOM	2.3	2.6		2.3	2.4	5	2.6	2.9		2.6	2.7	4	1.8	1.6	1.5	1.7	1.7	1
2	GRF	1.4	2.0	2.0	1.9	1.8	-6	1.8	2.4	2.0	2.3	2.1	-8	1.4	1.6	1.6	1.6	1.6	-4
3	CTN	2.5	2.1	2.2	1.8	2.2	2	2.7	2.6	2.7	2.4	2.6	2	2.0	2.0	2.0	1.6	1.9	0
4	RHN	1.7	2.1	1.7	1.7	1.8	-6	2.2	2.5	2.2	2.0	2.2	-5	1.3	2.0	1.6	2.0	1.7	0
5	CMT	2.7	1.9	1.9	2.1	2.1	0	2.8	2.5	2.3	2.8	2.6	3	2.3	2.0	1.7	1.6	1.9	2
6	STR																		
7	CHV	2.1	2.3	2.2	2.3	2.2	3	2.2	2.9	2.2	2.9	2.6	0	1.6	1.7	1.3	1.4	1.5	-3
8	AHL	2.5	2.0	2.1	1.5	2.0	-1	2.8	2.4		2.7	2.6	2	2.0	1.7	1.4	1.4	1.6	-1
9	STJ	2.2	1.9	1.8	2.0	2.0	-2	2.6	2.2	2.5	3.0	2.6	2	2.0	1.8	1.6	1.5	1.7	0
10	TYE	2.4	2.0	1.8	2.2	2.1	0	2.6	2.6	2.7	2.8	2.7	5	1.7	1.6	2.0	1.8	1.8	1
11	TAV	2.1	2.2	2.0	2.0	2.1	-1	2.7	2.4	2.3	2.6	2.5	0	1.6	1.8	1.4	1.5	1.6	-2
12	FDS	2.6	1.8	2.4	2.2	2.3	3	2.7	2.6	2.5	2.2	2.5	0	2.0	1.9	1.9	1.6	1.9	2
13	FDP	2.2	2.2	1.9	2.0	2.1	0	2.3	2.7	2.3	2.5	2.5	-1	1.3	2.2		1.5	1.7	0
14	NUN	1.8	2.0	1.5	1.5	1.7	-6	2.5	2.6	2.8	2.7	2.7	4	1.6	1.7	1.4	1.3	1.5	-3
15	OSK	2.1	2.2	1.9	2.0	2.1	-1	2.3	2.5	2.5	1.9	2.3	-4	1.7	1.8	1.8	1.3	1.7	1
16	SQW	2.0	2.1	2.0	1.8	2.0	-3	2.4	2.5	2.4	2.6	2.5	-1	1.5	1.7		1.8	1.7	0
17	TYG	1.9	1.8	2.3	1.8	2.0	-2	2.5	2.3	2.6	2.6	2.5	1	1.6	1.8	1.5	1.3	1.6	-2
18	HEL																		
	P	2.6	2.1	1.8	2.5	2.2		2.8	2.8	2.4	2.5	2.6		2.1	2.0	2.1	1.7	1.9	
	P	2.3	2.4	1.9	2.1			2.6	2.7	2.5	2.3			2.1	2.0	1.8	1.2		
Rep mean		2.2	2.3	2.4	1.9			2.5	2.6	2.4	2.5								
		Trial Mean			2.1			Trial Mean			2.5			Trial Mean			1.7		
		StDev			0.3			StDev			0.2			StDev			0.3		
			>2.7						>2.9						>2.4				
			2.5 - 2.7						2.8 - 29						2.2 – 2.4				
			2.2 - 2.4						2.6 - 2.7						1.8 – 2.1				
			2.1						2.5						1.7				
			1.8 - 2.0						2.3 - 2.4						1.3 – 1.6				
			1.5 - 1.7						2.1 - 2.2						1.0 – 1.2				
			<1.5						<2.1						<1.0				

PROVENANCE TRIALS SUMMARY and RECOMMENDATIONS

While the Tullynally trial is relatively uniform, biotic, edaphic and hydrological influences have clearly affected growth in both the Manch and Shillelagh trials So generalisations regarding the performance of the various provenances have limitations. This being said, some provenances perform consistently well across all three trials and other uniformly badly (see Table 3 below).

With the exception of the Forest of Dean pedunculate oak, the overseas provenances are not superior to the Irish material.

The most outstanding characteristics are the consistently high form scores for Tomnafinnogue and Coolattin across all the trials. These two, likely remnants of the Shillelagh oak woods are only five kilometres apart. Their dbh and height growth are also above average for each trial, though rarely among the best. Tullynally Elite has good volume with above average form scores. The Progeny plots have good height scores and, although DBH and Form scores are above the trial averages, they are not exceptional at this stage.

Of the consistently poor Irish sources Ahil (Source Identified) and Stradbally (Selected) stand out. Cool Mountain (Source Identified) and Glengarriff (Selected) are also poor. It is recommended that both Ahil and Cool Mountain be removed from the National Seed Register and that Stradbally and Glengarriff be downgraded from Selected to Source Identified seed stands.

Table 3. Summary of best and worst performing oak provenances in the 2006 trials.

	MANCH		SHILLELAGH		TULLYNALLY	
	BEST	WORST	BEST	WORST	BEST	WORST
HEIGHT	Tullynally Elite Progeny Rahin For. of Dean P	Cool Mt. Osterkurst. Ahil	For. of Dean P Helmond Tomnafinnogue	Ahil For. of Dean S	Coolattin Progeny Tul .Elite	Charleville Ahil Glengarriff
DBH	Rahin Tullynally Elite St. John's For. of Dean P	Cool Mt. Osterkurst Ahil	Helmond For. of Dean P St. John's Osterkurst.	Ahil For. of Dean S	Tul. Elite Tul. General Nuenen	Glengarriff Ahil St. John's For. of Dean S
STRAIGHTNESS	Tomnafinnogue Coolattin Charleville	For. of Dean S Cool Mt. Stradbally St. John's	Tomnafinnogue Coolattin For. of Dean P	St. John's Stradbally Rahin	Tomnafinnogue Charleville For. of Dean S Coolattin	Glengarriff Nuenen Rahin
APICAL DOM.	Coolattin Tomnafinnogue For. of Dean P	For.of Dean S Ahil	Tomnafinnogue Tullynally Elite Coolattin	Stradbally Charleville Nuenen	Tomnafinnogue Nuenen Cool Mt.	Glengarriff Rahin Osterkurst.
FORKING	Coolattin Tomnafinnogue	Rahin Cool Mt. Stradbally Ahil	Tomnafinnogue Coolattin	Stradbally Charleville Nuenen	Cool Mt. For. of Dean S Tomnafinnogue	Glengarriff Charleville Nuenen

PROGENY TREES

The progeny trial was designed to assess single parent half-siblings derived from clonally propagated plus-trees selected within the Coillte estate during the early 1990s under the ECLAIR programme. These clones have been outplanted at two oak

genebanks located at Kilmacurragh and Newtownmountkennedy forest. All of the material in these trials came from Kilmacurragh.

Two clonal oak seed orchards are in the process of being established by FGRT with material collected from both of the genebanks, as well as from standing plus trees and UK material. However, not all of the genebank material is present in the trials.

The performance of these progeny in the provenance/progeny trials provides some guidance in determining potential genetic gain (or loss) to be expected from the seed orchards, and whether phenotypic selection alone is an adequate determinant of potential genetic gain. In the context of oak improvement more generally, the accepted way to judge the performance of seed orchard material is through formal progeny trials comparing the growth and form of seedlings derived from all or most of the material in the orchard compared with oak controls.

The trials provide guidance in relation to the following questions:

Across the three trials, how do the progeny plots compare to the provenance plots?

Across the three trials, how do the progeny trees compare to each other?

Progeny v Provenance

The Ballineen are half-siblings, meaning they are derived from a single maternal parent, fertilised by an unknown source, either within the genebank or, from outside, oak being wind pollinated. The provenance trees represent a population rather than single trees.

HEIGHT

MANCH

With a trial mean of 6.1m, the Progeny plots average of 6.5m is significantly above average and only beaten by Tullynally Elite provenance. Progeny plot #4 is the tallest in this trial.

SHILLELAGH

The trial mean is 8.7m. At 9.1m the progeny plots are significantly above average. Taller provenances include Tomnafinnogue (9.4m), Helmond (9.8m) and Forest of Dean Pedunculate (10m). The two tallest plots are Forest of Dean Pedunculate (#10) 12.1m and Progeny plot #8 11.6m

TULLYNALLY

The trial mean is 9.0m. At 9.7m the Progeny plots share the top position, with Coolattin, and while no plots are outstanding, all are above to well above the trial average.

HEIGHT SUMMARY

In each of the trials the Progeny Plots are significantly above average in height.

DBH

MANCH

Mean trial DBH is 8.1cm and at 8.3cm the Progeny plots are above average' but not significantly so.

SHILLELAGH

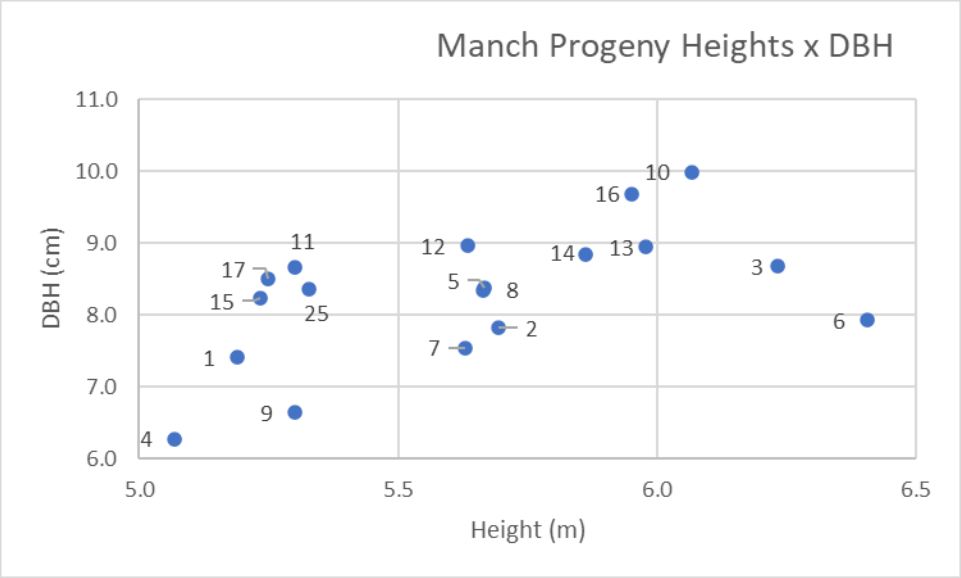
Mean trial DBH is 9.1cm and at 9.0cm the Progeny plots are insignificantly below average.

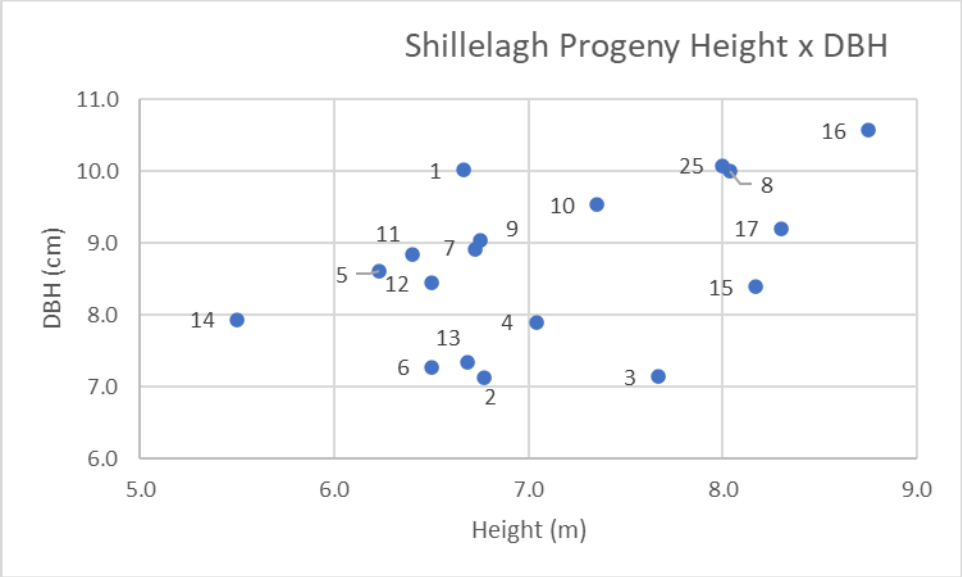
TULLYNALLY

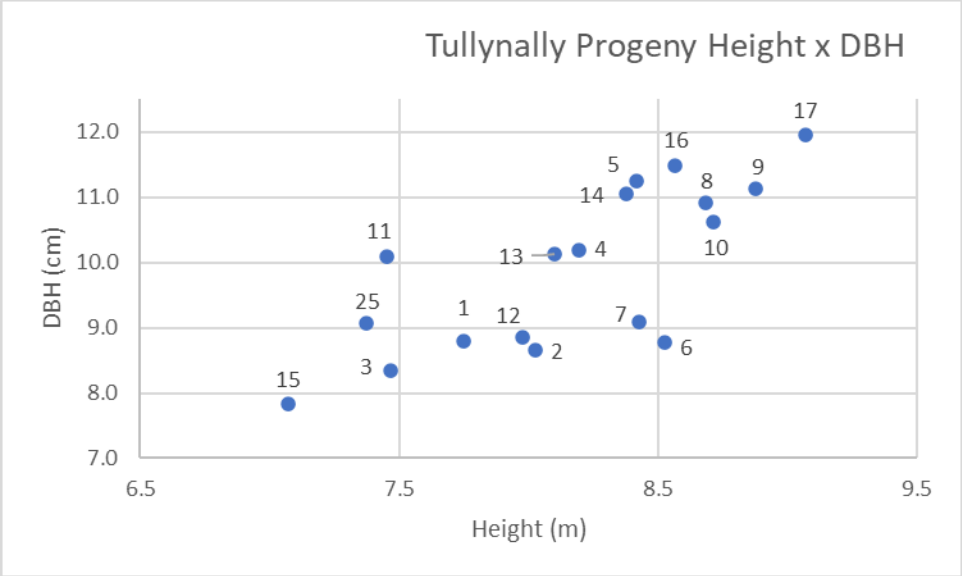
Mean trial DBH is 10.2 and at 10.2cm the Progeny plots are equivalent to the trial average.

DBH SUMMARY

In each trial the Progeny plot DBH values closely reflect the trial averages.







FORM

STRAIGHTNESS

MANCH

Mean trial Straightness score is 2.1. At 2.3 the Progeny plots are above average.

SHILLELAGH

Mean trial score is 2.2. At 2.3 the Progeny plots are just above average.

TULLYNALLY

Mean trial score is 2.1. At 2.2 the Progeny plots are just above average.

STRAIGHTNESS SUMMARY

The Progeny plots exhibit just above average straightness.

APICAL DOMINANCE

MANCH

Mean trial score is 2.5. At 2.7 the Progeny average is significantly greater than the trial average, outclassed only by Tomnafinnogue (2.8) and Coolattin (2.9).

SHILLELAGH

Trial mean score is 2.6. At 2.8 the Progeny average is significantly above the trial average and only bested by Tomnafinnogue (2.9).

TULLYNALLY

Trial mean is 2.5 equivalent to the Progeny plot mean.

APICAL DOMINANCE SUMMARY

Progeny plots show well above average apical dominance in two of the three trials.

FORKING and BRANCHINESS

MANCH

Mean trial score 1.9, Progeny plot average 1.9.

SHILLELAGH

Mean trial score is 1.8, and Progeny plot score 1.7 just below average.

TULLYNALLY

Mean plot score is 1.7, mean Progeny plot score is 1.9, bested only by Coolattin (2.0)

FORKING and BRANCHINESS SUMMARY

Well above average at Tullynally, forking scores in the other trials are insignificantly different from the trial averages.

The provenance v progeny comparisons are summarised in Table 4.

Table 4 Overall trial and progeny averages

	MANCH		SHILLELAGH		TULLYNALLY	
	Trial Mean	Progeny Mean	Trial Mean	Progeny Mean	Trial Mean	Progeny Mean
HEIGHT	6.1m	6.5m	8.7m	9.1m	9.0m	9.7m
DBH	8.1cm	8.3cm	9.1cm	9.0cm	10.2cm	10.2cm
Straight	2.1	2.3	2.2	2.3	2.1	2.2
Ap Dom	2.5	2.7	2.6	2.8	2.5	2.5
Forking	1.9	1.9	1.8	1.7	1.7	1.9

BETWEEN PROGENY COMPARISONS

There is considerable variation in performances of the individual progeny trees across the three trials. Z scores were used to compare across variables across trials. The best progeny source from all aspects is #8 Knocktopher (ÉCLAIR #39) with exceptional average scores for all variable across all trials. Two other progeny trees also score well above average: #9 (ÉCLAIR Allen 45) and #17 ÉCLAIR 90 Dundrum). The following trees are also above average: #5 (ÉCLAIR 26 Mt. Bellew), #6 (ÉCLAIR 27 Shelton), #7 (ÉCLAIR 34 Donadea), #16 (ÉCLAIR 89 Portlaoise) and #25 (ÉCLAIR ?87 Portlaoise).

Two progeny trees #11 (ÉCLAIR 46 Allen) and #15 (ÉCLAIR 88 Portlaoise) show consistently poor results over the three trials. The remaining trees score below average, but not significantly so.

Values and Z scores are shown in the three tables below:

MANCH												
Trial #	ÉCLAIR	Source	Reps	PCTs	Dead	Fell	Hgt	DBH	Str	AD	Fk	Z
1	2	New Ross	10	3	0	1	5.2	7.4	2.0	2.9	2.0	-1
2	10	Bree	20	0	0	2	5.7	7.8	1.9	2.5	1.8	-4
3	11	Coolgreany	10	2	3	0	6.2	8.7	2.3	2.8	2.0	5
4	14	Coolgreany	20	2	2	0	5.1	6.3	2.3	2.3	2.1	-8
5	26	Mt. Bellew	20	5	1	3	5.7	8.4	2.3	2.4	1.9	1
6	27	Shelton	10	0	2	0	6.4	7.9	2.2	2.4	1.9	-1
7	34	Donadea	20	3	1	1	5.6	7.5	2.2	3.1	2.0	1
8	39	Knocktopher	20	1	1	1	5.7	8.4	2.3	2.6	2.0	2
9	44	Allen	10	0	2	1	5.3	6.6	2.1	2.3	2.0	-5
10	45	Allen	20	5	1	0	6.1	10.0	2.3	2.9	1.7	4
11	46	Allen	10	1	1	1	5.3	8.7	2.0	2.9	1.9	0
12	52	Callan	20	1	3	0	5.6	9.0	2.6	2.8	1.9	4
13	85	Portlaoise	10	5	1	0	6.0	8.9	2.7	3.1	1.8	5
14	86	Portlaoise	10	0	1	0	5.9	8.8	1.9	2.9	2.0	3
15	88	Portlaoise	10	1	0	1	5.2	8.2	2.1	2.8	1.4	-5
16	89	Portlaoise	10	2	1	1	6.0	9.7	2.6	3.0	2.0	8
17	90	Dundrum	10	2	1	1	5.3	8.5	2.3	2.5	2.0	0
25	?87	Portlaoise	10	0	1	1	5.3	8.4	2.4	2.6	2.0	1

SHILLELAGH												
Trial #	ÉCLAIR	Source	Reps	PCTs	Dead	Fell	Hgt	DBH	Str	AD	Fk	Z
1	2	New Ross	1	6	1	0	6.7	10.0	2.7	2.7	2.0	5
2	10	Bree	2	16	1	2	6.8	7.1	1.6	2.4	1.8	-6
3	11	Coolgreany	3	12	1	6	7.7	7.2	2.0	2.0	1.7	-4
4	14	Coolgreany	4	18	1	2	7.0	7.9	2.4	2.4	2.1	-1
5	26	Mt. Bellew	5	16	2	3	6.2	8.6	2.1	2.6	2.0	-3
6	27	Shelton	6	6	0	1	6.5	7.3	2.2	2.2	2.0	-3
7	34	Donadea	7	11	1	2	6.7	8.9	2.3	2.7	2.0	3
8	39	Knocktopher	8	18	5	1	8.0	10.0	2.6	2.9	2.2	10
9	44	Allen	9	6	0	0	6.8	9.0	2.0	3.0	1.7	0
10	45	Allen	10	12	4	2	7.4	9.5	2.5	3.1	1.8	5
11	46	Allen	11	6	0	1	6.4	8.8	1.8	2.6	1.4	-4
12	52	Callan	12	12	0	2	6.5	8.5	2.7	2.8	1.7	0
13	85	Portlaoise	13	9	1	0	6.7	7.4	2.2	2.3	1.3	-6
14	86	Portlaoise	14	6	0	1	5.5	7.9	1.8	2.2	1.0	-9
15	88	Portlaoise	15	12	3	2	8.2	8.4	2.2	2.8	2.1	3
16	89	Portlaoise	16	11	2	0	8.8	10.6	2.0	2.7	1.6	3
17	90	Dundrum	17	12	3	0	8.3	9.2	2.6	2.9	1.6	6
25	?87	Portlaoise	25	6	1	0	8.0	10.1	2.7	2.7	1.7	6

TULLYNALLY												
Trial #	ÉCLAIR	Source	Reps	PCTs	Dead	Fell	Hgt	DBH	Str	AD	Fk	Z
1	2	New Ross	4	0	0	0	7.8	8.8	2.3	2.3	2.0	-2
2	10	Bree	20	2	1	0	8.0	8.7	2.3	2.5	2.2	-1
3	11	Coolgreany	13	2	4	0	7.5	8.3	1.9	2.4	1.7	-7
4	14	Coolgreaney	17	1	2	0	8.2	10.2	2.5	3.1	2.3	6
5	26	Mt. Bellew	15	0	3	0	8.4	11.3	1.9	2.5	1.8	1
6	27	Shelton	4	0	0	0	8.5	8.8	2.8	2.0	2.3	2
7	34	Donadea	8	1	1	0	8.4	9.1	2.9	2.9	1.4	2
8	39	Knocktopher	19	4	1	0	8.7	10.9	2.4	3.2	2.2	8
9	44	Allen	4	1	0	0	8.9	11.1	2.5	2.8	1.8	6
10	45	Allen	7	2	0	0	8.7	10.6	2.3	2.7	1.9	5
11	46	Allen	4	0	0	0	7.5	10.1	1.3	2.5	1.0	-8
12	52	Callan	8	0	0	0	8.0	8.9	2.8	3.0	2.1	3
13	85	Portlaoise	11	1	1	0	8.1	10.1	2.7	2.6	1.7	1
14	86	Portlaoise	4	0	0	0	8.4	11.1	2.3	2.3	1.8	2
15	88	Portlaoise	15	1	1	0	7.1	7.8	1.8	2.2	1.7	-9
16	89	Portlaoise	15	1	1	0	8.6	11.5	2.1	2.5	1.7	0
17	90	Dundrum	16	2	3	0	9.1	12.0	2.5	2.8	1.8	6
25	?87	Portlaoise	4	0	0	0	7.4	9.1	2.5	2.3	1.8	-3

PROGENY CONCLUSION

Compared to the provenance trees the progeny material is characteristically above average, particularly with respect to height and to a lesser extent DBH and Form. Across the three trials individual Progeny trees show significant differences in quality. It is recommended that a reduced number of the poorer performers

(ÉCLAIR 46 and 88) and an increased number of better performers (ÉCLAIR 39, 45 and 90) be selected for proposed seed orchards.