

Oak Breeding Seedling Orchards

Research Report 2007

Jo Clark Northmoor Trust



Acknowledgements

BIHIP would like to express their thanks to all landowners for their continued support of this research and in allowing access to sites by research staff and associated students. To the Trustees of the Northmoor Trust for their continued support for management of this project. To Forest Research for data entry and verification of all data collected by Northmoor Trust. Also, to all donors who support the work of BIHIP, particularly Forest Research, Coford and Woodland Heritage who provide unrestricted funds.

Introduction

Eight breeding seedling orchards for oak were established by BIHIP in 2003, containing both *Quercus robur*, *Q. petraea* and their hybrids. Site and establishments details can be found in the oak reports to BIHIP for 2003 and 2004. Sixty two plus trees (families) are being tested across eight orchards with 21 families common to all sites. Trees are as single tree plots.

Each orchard was visited and 5 year data collected in 2007 by staff from Northmoor Trust with the exception of the orchard at Bwlchgwynant, Carmarthenshire which was assessed by staff from Forest Research, and the trial in County Cork which was assessed by staff from Coford. Height was recorded to the nearest centimetre with a telescoping measuring pole. Apical dominance was scored on a 1-3 scale, with 1 being a clear leader (20 cm above the next highest shoot), 2 being a discernable leader and 3 being no apical dominance.

Form was assessed in a separate visit to four sites only (Dalkeith, Sotterley, Northmoor Trust and Shakenhurst) by Nick Evans, an MSc student from Imperial College, Wye. He compared subjective and objective form assessments and concluded that a subjective assessment of form was as useful as an objective one, and infinitely quicker.

Research was also carried out by Jennifer Peters, an MSc student for the University of York, looking at the effect of exotic oak phenotypes on an associated community of herbivourous insects. Flushing was recorded in 2008 by CEH at the Northmoor Trust site only. These data are not included in this report.



Figure 1. Location map of the eight trials, represented here as red dots, and the selected plus trees represented in the trials, represented as oak trees.

Orchard updates

Belmont, Kent

Originally, this trial was 70 reps of 34 = 2380 trees of 34 families.

Belmont did a survival and beat up in 2006 and beat up 580 trees. Beat up data was passed on to Northmoor Trust. However, four reps (43, 44, 57, 58) had no beat up data and therefore are excluded from analysis (136 trees). Twenty trees were dead in 2006, but not beaten up. Of these twenty, five have resprouted from the base.

In 2007, an additional 204 that were alive in 2006 had died, leaving a total of 1445 test trees alive in this trial for statistical analysis.

In general, the site looked good, although the grass sward was dense. For reference, there is no guard row on the south side (nearest the entrance gate) and only a partial guard row to the east.

Dalkeith, East Lothian

Originally, this trial was 85 reps of 31 = 2635 trees of 31 families.

Seventeen trees were dead in 2004 and an additional 420 dead in 2007. There are no fillers on this site leaving 2198 trees for analysis.

This site was the only restock site within the trial series. Doing very well in 2004, growth and particularly form was disappointing in 2007, possibly due to the trial being sited on top of a hill and being quite exposed. Many trees were growing in more horizontal fashion, rather than vertical.



The other issue was that many trees are stag headed with several leaders as shown here.

Figure 2. Dwarf (above) and stag headed (right) oak at Dalkeith BSO.



Northmoor Trust, Oxfordshire

This trial consists of 39 reps of 56 = 2184 trees of 56 families.

One hundred and twenty nine trees were dead in 2004, and an additional 108 dead in 2007, 34 of these eaten by voles. There was one resurrection from 2004, leaving 1948 trees for analysis.

This trial is in good condition, although the site was badly waterlogged for a month during the winter 2007/08. Ditches have been cleared which will hopefully alleviated this problem. A demonstration line is present at this site so that individual families can be looked at outside of the single tree plots. Family differences are beginning to be apparent to the observer.

Newton Rigg, Cumbria

Originally 63 reps of 40 trees = 2520, of 40 families. This trial was badly damaged by voles in 2003/2004 and consolidated in 2005/06 to 45 reps of 42 with 52 fillers = 1838 test trees. A further 372 trees were dead in 2007, partly due to vole damage leaving 1446 test trials for analysis. Many trees were pruned in 2007 just before the visit from researchers.



Figure 3. Newton Rigg BSO, after consolidation of reps. The tree in the foreground has been pruned, as had any that showed apical dominance.

Despite high mortality, the trial is in good order. However, a heavy grass sward is still providing excellent vole habitat which is the cause of such high mortality on this site despite vole guards which were fitted in 2006.

Sotterley, Suffolk

This site comprises 50 reps of 61 = 3050 trees and contains all but one family within the trial series (62 families being tested). In 2007, there were two fillers and 690 dead leaving 2358 trees for analysis.

The site is still very weedy, although weed control is now being carried out. Many of the worst performing trees had been stumped in spring 2006 and unfortunately, no record made of this. Nick Evans looked at this as part of his MSc in thesis in 2008 and assessed 2217 trees (the remainder were small, at under 80cm).

Shakenhurst, Worcestershire

100 reps of 21 = 2100 trees representing 21 families.

There were 14 fillers in 2007 with 107 dead, leaving 1979 trees for analysis. This site was excellent with very low mortality. Vigour here was much the greatest across all orchards, and this reflects the rankings from 2004. However, given it's superiority in 2004, this site had not performed as well as may be expected. The site has a few mature oak in the hedges to the north and the east. The site slopes to the west. Here the trees had grown very poorly, whereas higher up the slope growth was very impressive. There is a pronounced site effect for this orchard.

Ireland, County Cork

This trial comprises 48 reps of 46 trees = 2208 trees across 46 families. In 2007, three trees are fillers, 41 were dead in 2004, and planted up with fillers and removed from the analysis. An additional 58 were dead in 2007, leaving 2106 test trees for analysis. This site was not seen by the author.

Wales, Carmarthenshire

This trial comprises 52 reps of 44 = 2288 trees across 44 families. The site was beaten up 2003 with correct family. Those 20 yellow spots on the beat up map are those that could not be beaten up with correct family and are now fillers. Two hundred and seventy four trees were dead in 2004, beaten up in 2005 with unknown material and therefore excluded from analysis. An additional 19 trees were dead in 2007, leaving 1975 trees for analysis. This site was also not seen by the author.

Results

<u>Survival</u>

Survival had decreased at all sites since last measured in 2004 although remains at over 70% throughout except at Newton Rigg. Here survival is 58% of the original trial. However, if survival is looked at after consolidation, survival is 79% suggesting that the vole problem is being brought under control (Table 1).

Table 1. Mean data for growth and apical dominance score by orchard at year 2 and year 5. Apical dominance is reflected as a three point score where 1 is good apical dominance, 2 acceptable and 3, no apical dominance expressed.

BSO	Trees planted	Survival 2004 (%)	Survival 2007 (%)	Ht 04 (cm)	Ht 07 (cm)	Inc 04 – 07 (cm)	Apical dominance 07
Belmont	2446	76	73	42	115	73	1.48
Sotterley	3050	80	77	25	98	73	1.81
Little Wittenham	2184	95	89	54	121	67	1.59
Shakenhurst	2100	97	94	101	184	83	2.1
Newton Rigg	2520	71	58	41	98	57	1.94
(consolidated)	(1839)		(79)				(pruned)
Dalkeith	2635	94	83	45	151	106	2.54
Wales	2288	88	87	70	121	51	2.2
Ireland	2304	98	97	34	121	87	2.2

NB. Survival reflects total number of original test trees and beat ups of know family, and is not necessarily an indication of how many trees are currently in each trial.

Belmont and Wales had carried out a second beating up phase after the initial beat up with known family material, and so these sites are stocked more highly than the survival data would suggest. Shakenhurst and Ireland have shown excellent survival at 94 and 97 % respectively.

Apical Dominance

Mean orchard apical dominance scores range from 1.48 (Belmont) to 2.59 (Dalkeith) (Table 1). The form at Dalkeith was particularly poor, many of the trees growing along the ground. This was not a problem in 2004 and the orchard was growing well. Many of these trees will never recover from this, and it becomes necessary to address this issue.

Newton Rigg scored 1.94, but many of the trees had been pruned to a single leader, thus rendering this score meaningless.

At Sotterley, many of the trees had been stumped in spring 2006. Nick Evans assessed this when he looked at form. Of the 2217 trees he assessed, 1232 were not stumped, 660 were definitely stumped, and 325 were probably stumped, but was difficult to be completely certain. The mean apical dominance score for those 1232 trees NOT stumped was 1.79 and for the 985 trees stumped was 1.82. Mean height for stumped trees was 68cm (in 2 years) and for those not stumped was 125cm (in 5 years). As apical dominance was not scored in 2004, it is not possible to say that stumping has improved the form on this site. However, it is quite possible that the mean apical dominance would be higher (poorer) without the stumping treatment.

Belmont scored the highest for apical dominance at 1.48. It is difficult to suggest why this may be so high, as the site is quite exposed. Northmoor also scored quite high at 1.59 and is again an exposed site. All data are shown in Table 2.

When looked at on a family by family basis, families HRF008, NHP006, NHP008, SHP005 and GLS012 rank the five highest, and Alice Holt (Hampshire), GLS025, HAM013, HAM014 and NHP009 rank the five lowest. Only one family, NHP008 ranks amongst the top five families for apical dominance and height. No family ranks in the bottom five for both these factors (Table 2).

Table 2. Mean height (cm) and apical dominance (AD) score by family across all orchards, with region of provenance (UK) and country, sorted by country, and then by AD. The five lowest (best) AD scores are in green and the worst in red. The five tallest families are in green and shortest in red.

Country	Family	AD 07	Ht 07
10	D&G003	1.86	120
10	BOR001	2.04	121
10	BOR002	2.09	121
20	NMB001	1.71	152
20	ELT005	1.95	130
20	ELT004	1.99	117
30	CUM001	1.71	122
40	HRF008	1.52	84
40	NHP008	1.53	147
40	NHP006	1.66	111
40	GLS012	1.66	118
40	HRF004	1.70	122
40	SUF003	1.70	102
40	HAM012	1.74	106
40	LNC001	1.78	111
40	HAM006	1.78	116
40	SUF001	1.78	117
40	HRF013	1.79	99
40	GLS014	1.79	113
40	HGH001	1.80	93
40	NOR007	1.87	105
40	SOM003	1.88	114
40	GLS022	1.89	134
40	HRF017	1.89	132
40	HAM007	1.94	103
40	WOR003	1.95	93
40	SOM002	1.98	108
40	HRF006	1.99	128
40	NHP002	1.99	109
40	HAM011	2.00	126
40	HAM004	2.05	124

Country	Family	AD 07	Ht 07
40	LEI001	2.06	124
40	GLS016	2.08	133
40	SUF004	2.08	114
40	NOR005	2.09	126
40	WOR007	2.09	123
40	Alice Holt	2.10	111
40	GLS025	2.14	116
40	HAM014	2.17	114
40	HAM013	2.17	130
40	NHP009	2.27	115
Dutch	ZE64 -1	1.68	125
Dutch	ZE142-1	1.81	138
Dutch	ZE80 -1	1.82	120
Dutch	ZE82-1	1.84	134
Dutch	ZE34-1	1.85	110
Dutch	ZE58-2	1.85	103
Dutch	ZE47-2	1.86	155
Dutch	ZE15 -1	1.88	89
Dutch	ZE46-1	1.93	131
Dutch	ZE11-1	1.93	121
Dutch	ZE23-2	2.08	126
Fr	SHP005	1.51	68
Fr	Fontainebleau	1.75	75
Fr	BRC002	1.91	125
Fr	REN001	1.94	120
Fr	REN003	2.00	135
Fr	SEN002	2.07	115
Fr	OFL002	2.09	125
Fr	BRC001	2.09	101
Ire	WIK003	1.74	90
Ire	LND003	1.83	97

<u>Height</u>

Table 3 shows mean family height at each site for those 21 families that are common to each. It also shows which four families performed best and worst at each site. Of particular note, is that two of the Dutch families (ZE142-1 and ZE47-2) are in the top four families at four or more sites, as is family REN003 (French). There is no family from the UK that falls in the top four families at four sites. REN001, SEN002 (both French) and SOM002 (UK) are in the four worst performing families at at least four sites.

On this very condensed data set, many families rank in both the top and bottom four. However, when the entire dataset is looked at (Appendix 1), only families NHP002, REN001, SOM003, BRC002 and REN003 rank in the top AND bottom four. Thus, some families always perform well regardless of site (ZE47-1, HAM011, NHP008, NMB001, GLS022,), some always perform poorly (WIK003, SHP005, HRF008) and others vary their performance depending on site.

Table 3. Height in cm of the 21 families, common to each orchard. Green shading indicates the top four families at each site in terms of vigour, and red shading indicates the four poorest performing families at each site.

Family	Belmont	Dalkeith	NMT	N Rigg	Sotterley	Shakenhurst	Ireland	Wales
HAM014	108.8	114.2	110.2	104.2	85.2	151.7	111.4	123.8
SOM002	106.8	126.3	104.2	75.4	101.5	152.5	104.5	92.0
NHP009	118.2	105.5	124.7	100.5	98.5	153.1	103.4	113.9
SEN002	99.4	139.4	111.8	74.0	96.0	162.7	134.7	100.9
ZE11 -1	124.8	132.5	122.8	97.4	105.4	166.7	111.4	105.6
REN001	129.5	167.6	108.3	78.3	93.4	172.8	102.4	105.2
WOR007	114.8	150.5	111.5	96.0	101.8	174.0	108.5	123.7
NOR005	125.2	123.9	127.0	110.3	98.0	176.6	126.8	117.7
OFL002	118.4	130.6	127.7	92.9	102.7	178.4	124.7	123.0
D&G003	126.7	164.6	107.4	80.4	82.6	178.9	113.3	106.9
ZE23 -2	127.0	141.7	122.0	97.8	100.4	183.5	106.2	130.0
HAM004	108.0	173.0	109.1	100.5	78.7	185.3	113.2	126.2
BOR002	105.9	172.2	112.6	81.8	81.3	185.7	112.3	117.8
ZE82 -1	118.7	155.6	132.4	109.5	104.3	186.5	126.1	136.2
ELT005	122.6	175.8	115.8	91.8	93.3	189.7	128.9	118.8
HAM013	110.7	141.2	121.7	92.3	105.7	189.9	134.2	140.3
ZE46-1	119.2	152.6	129.2	109.0	99.2	194.9	111.1	135.9
BRC002	129.7	156.4	98.8	77.4	98.1	201.4	126.3	111.8
REN003	128.5	196.2	116.9	81.0	112.7	205.7	140.1	100.8
ZE142-1	135.1	143.4	132.6	104.7	111.4	215.7	133.1	125.9
ZE47-2	121.9	183.0	147.5	133.7	124.7	233.7	144.7	154.3

This data is also shown graphically in Figure 4. Clearly, Shakenhurst and Dalkeith are the best sites in terms of height although there is much variation of family performance across sites.

Mean data for all families at each site is shown in the appendix 1 and as mean family height across all sites in appendix 2.



Figure 4. Mean family height (cm) at each site, for those 21 families common to all sites.

Appendix 1.

Mean 5 year height for all families across all sites, sorted by Sotterley as the orchard with the most families represented.

Family	Belmont	Dalkeith	NMT	N Rigg	Sotterley	Shakenhurst	Ireland	Wales
HGH001	*	*	109.2	79.4	56.2	*	110.3	109.2
WIK003	*	*	98.3	*	65.4	*	105.4	92.1
SHP005	*	*	*	*	68.2	*	*	*
HRF008	*	*	93.4	*	74.3	*	*	*
Fontainebleau	*	*	*	*	75.2	*	*	*
ZE58 -2	*	*	119.0	102.5	77.9	*	98.0	116.2
HAM004	108.0	173.0	109.1	100.5	78.7	185.3	113.2	126.2
HRF013	106.3	154.3	93.5	60.7	78.8	*	110.4	91.3
ZE34-1	104.6	141.4	118.8	83.1	79.1	*	122.3	118.2
NHP002	113.2	103.8	137.9	86.0	79.6	*	135.1	104.0
BOR002	105.9	172.2	112.6	81.8	81.3	185.7	112.3	117.8
D&G003	126.7	164.6	107.4	80.4	82.6	178.9	113.3	106.9
HAM012	114.0	*	111.1	98.4	84.0	*	110.4	119.0
SUF003	112.0	*	110.3	83.3	84.7	*	115.3	104.8
HAM014	108.8	114.2	110.2	104.2	85.2	151.7	111.4	123.8
BRC001	*	*	111.8	81.8	86.8	*	117.9	107.0
NOR007	*	*	120.5	*	88.6	*	*	*
ZE15 -1	*	*	*	*	89.3	*	*	*
GLS025	104.1	170.0	117.5	87.6	89.6	*	114.4	127.4
WOR003	*	*	*	*	92.9	*	*	*
ELT005	122.6	175.8	115.8	91.8	93.3	189.7	128.9	118.8
REN001	129.5	167.6	108.3	78.3	93.4	172.8	102.4	105.2
LEI001	113.2	152.1	135.2	128.9	94.5	*	115.2	131.8
ZE64 -1	*	*	137.4	*	95.4	*	131.7	136.5
SEN002	99.4	139.4	111.8	74.0	96.0	162.7	134.7	100.9
GLS014	*	*	128.9	*	96.6	*	*	*
LND003	*	*	*	*	97.1	*	*	*
SOM003	102.8	177.7	104.5	77.5	97.3	*	109.3	126.0
HAM007	*	*	108.0	*	97.5	*	*	*
LNC001	*	*	123.8	*	97.6	*	*	*
NOR005	125.2	123.9	127.0	110.3	98.0	176.6	126.8	117.7
BRC002	129.7	156.4	98.8	77.4	98.1	201.4	126.3	111.8
NHP009	118.2	105.5	124.7	100.5	98.5	153.1	103.4	113.9
Alice Holt	112.8	116.2	115.5	95.2	98.6	*	108.7	130.2
NHP006	*	*	123.2	*	99.0	*	*	*
ZE46-1	119.2	152.6	129.2	109.0	99.2	194.9	111.1	135.9
SUF001	127.4	*	128.9	96.0	99.2	*	130.7	118.0

Family	Belmont	Dalkeith	NMT	N Rigg	Sotterley	Shakenhurst	Ireland	Wales
ELT004	117.1	164.6	120.7	92.9	99.5	*	116.2	110.1
GLS012	*	*	120.2	*	99.5	*	135.2	*
ZE23 -2	127.0	141.7	122.0	97.8	100.4	183.5	106.2	130.0
HRF017	121.1	209.8	115.3	103.9	101.5	*	131.8	140.0
SOM002	106.8	126.3	104.2	75.4	101.5	152.5	104.5	92.0
WOR007	114.8	150.5	111.5	96.0	101.8	174.0	108.5	123.7
OFL002	118.4	130.6	127.7	92.9	102.7	178.4	124.7	123.0
ZE80 -1	*	*	137.2	*	102.7	*	*	*
ZE82 -1	118.7	155.6	132.4	109.5	104.3	186.5	126.1	136.2
HAM006	*	*	126.4	*	104.6	*	*	*
ZE11 -1	124.8	132.5	122.8	97.4	105.4	166.7	111.4	105.6
HAM013	110.7	141.2	121.7	92.3	105.7	189.9	134.2	140.3
GLS016	*	*	135.3	*	108.3	*	146.5	140.8
CUM001	*	*	129.1	112.4	108.6	*	125.0	135.3
SUF004	124.1	113.8	118.0	101.8	109.6	*	116.4	110.8
ZE142-1	135.1	143.4	132.6	104.7	111.4	215.7	133.1	125.9
REN003	128.5	196.2	116.9	81.0	112.7	205.7	140.1	100.8
HRF004	*	*	129.0	*	114.7	*	*	*
BOR001	*	*	124.1	115.4	116.5	*	120.9	126.9
HRF006	*	*	129.8	*	117.3	*	139.7	123.2
ZE47-2	121.9	183.0	147.5	133.7	124.7	233.7	144.7	154.3
HAM011	*	*	*	*	126.3	*	*	*
GLS022	*	*	128.3	119.4	126.6	*	145.5	149.6
NMB001	*	*	163.0	*	132.7	*	159.0	*
NHP008	*	*	146.8	*	*	*	*	*

160.0 140.0 120.0 100.0 80.0 60.0 40.0 20.0 100.0

Appendix 2. Mean family height at year 5 across all sites.