Ash in a changing climate

by Jo Clark

We have heard a lot about climate change and carbon emissions over the last few years. The climate is undoubtedly warming at an unprecedented rate, largely due to anthropogenic carbon dioxide emissions. Climate matching analysis uses current and predicted levels of carbon dioxide to match our climate to those likely to arise in the future. If we mitigate our carbon emissions, by 2050 the climate of southern England is likely to be that of the Loire valley in France today. By 2080, our climate is more likely to be that of Bordeaux in the south of France. This raises the question, how will trees growing in southern England cope with this changing climate, and will they be able to adapt?

To help address this question, I started studying part time for a PhD in 2006. The first step was to identify native populations of Ash *(Fraxinus excelsior L.)*. Five sites were selected along a latitudinal gradient ranging from Cawdor in the north of Scotland to Monein in the foothills of the Pyrenees *(Table 1)*. Leaf samples were collected from each population during the summer of 2007 and DNA analysis carried out to ensure that each was native. Microsatellites genetic markers were used to detect differences in the chloroplast genotype and identify the colonisation history of the different populations.

Armed with generous funding from the Forestry Commission, a map and trusty colleague Ben Philipps (complete with shotgun!), we collected enough seed and a ton of soil from each location to raise 6,000 seedlings. To minimise nursery carry over effects, seedlings were raised in rootliners, in the soil from the site where they were to be planted. Due to Ash being deeply dormant, seed required a prolonged period of stratification and so were only sown in May 2008. Multiple seed were sown per cell, as germination was sporadic due to different chilling requirements of the various seed lots.

The research trials were established in December 2008 and are termed a reciprocal transplant experiment (RTE) as each population is planted at each site. This enables investigation as to how British material will grow in a warmer climate, and also to determine the effect of moving more southerly material north.

Ben Philipps shooting seed at Monein.

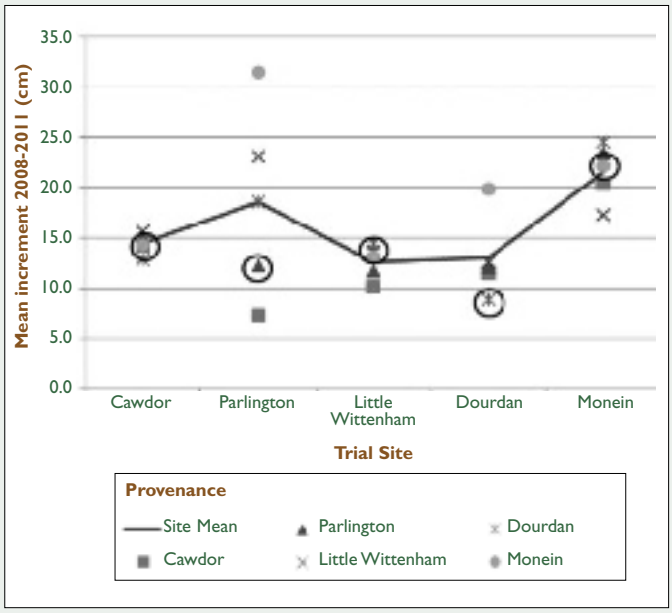
Trees were on average only 4 cm tall at the time of planting due to only six months in the nursery and competing seedlings in the cells. Because they were so small, each tree was protected with a mulch mat. This led to problems with data collection later on, as the UK trials were all badly damaged by voles. This was not a problem in France, although many seedlings were buried by moles at each French site. Timing of budburst is a useful parameter to assess, as it can show how individual provenances perform on different sites and so indicates likely adaptive potential. It was not therefore possible to protect the

Table 1. Details of trial sites used in the reciprocal transplant experiment

Trial Site	Latitude	Longitude	Elevation (m.a.s.l.)	Stand Type	Trial Site
Cawdor	57.52	-3.61	150	Scattered roadside trees	Ex arable
Parlington	53.81	-1.36	65	Ash and Sycamore woodland	Restock
Little Wittenham	51.63	-1.17	50	Ash dominated woodland	Ex arable
Dourdan	48.51	1.96	125	Registered Ash seed stand	Arable in Oak forest
Monein	43.33	-0.54	138	Registered Ash seed stand	Restock

trees with vole guards as this would have created a microclimate around the tree which would influence the timing of budburst.

Trees were assessed several times each year; budburst was scored on three occasions each spring from 2008 to 2010, and heights and root collar diameters were recorded each winter (2008-2011). Due to the long term nature of this research, and the expense in setting out the trials, funding supplied from the Forestry Commission was exhausted by 2010. As the trees get bigger, differences between sites and provenances become more noticeable. Here, *Woodland Heritage* stepped in and awarded me their Travel Bursary to enable me to assess the trials again during November 2011. Simple results are shown in the graph below.



The graph shows incremental height growth for the three years 2008 to 2011 at the five trial sites, which have been ordered from north (Cawdor) to south (Monein). The solid line indicates the site average for all provenances at a site. It is shown as a solid line for ease of clarity although each site is distinct from other sites. Ranged around this site average are the provenance averages at each site, indicating their difference (better or worse) from the site average. The local provenance at each site (e.g. Little Wittenham seedlings growing at Little Wittenham) has been circled.

Although trees were only 4 cm tall on average when planted, growth in three years has been disappointing, especially at Little Wittenham and Cawdor. Both these sites were previously arable fields and are exposed. The trials at Monein and Parlington are located on restock sites, and the Dourdan site is located within the Forêt Domaniale de Dourdan, surrounded by impressive Oaks. Most trees hardly grew at all in the first two years as the trees put on root growth. The spring of 2009 was particularly

Measuring root collar diameter with digital callipers at Monein, 2010.

harsh with several late spring frosts over several weeks. New growth was badly frost damaged twice at all sites which impacted growth significantly that year.

British forest policy has for a long time promoted the use of local material for reforestation, as being most suited to the local conditions. This graph shows clearly that at this age the local provenance is never the best performing provenance, and indeed sometimes performs below the site average, as can be seen at Dourdan and Parlington. Material from the south of France performs well at all sites, but the material from Scotland (Cawdor) does not do so well further south, and is usually the poorest performer. Looking only at tree growth, it is difficult to see in only three growing seasons any evidence of adaptation. Factors such as chilling requirement to break dormancy of seed and bud are better indicators for adaptation.

Whilst the view that 'local is best' may be pertinent for short lived annual species, trees are long lived organisms and genes travel great distances via pollen to bring new genetic diversity to a population. When considering what to plant for forests for the future, it is maybe a good idea to use some local material, but to also include material from the near continent. Maintaining a broad genetic base that gives our trees the potential to adapt is the best insurance policy for climate change.

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