



Growing native trees from seed



A Practical Guide to Tree Nursery Production



Nursery Production - Local Provenance Trees

There are two basic methods of tree nursery production:

- Container production - growing in pots/plug trays/root-trainer cells.
- Bare-root production – growing in beds in the soil.

It is important to decide which method (or mixture of methods) suits your individual situations (site, business objectives, and time and investment level).

Advantages and disadvantages:

Container production

- Produces plants that are suitable for planting over a longer period than bare-root grown stock. Plants can therefore command a small price premium.
- Enables growers to have greater control of the growing environment and extend the growing season (using polytunnels, etc).
- Requires less capital investment in machinery.
- Requires more capital investment in infrastructure (polytunnel, irrigation, etc) and has higher production costs (composts, containers, etc).
- Watering and ventilation requirements are more labour/capital intensive in summer.
- Can produce saleable plants in 1 growing season.

Bare-root production

- Produces plants suited to planting out only in main/dormant season (October to February).
- Is subject to more environmental limitations (weather/soils, etc) to the growing/working season.
- Require less capital investment in infrastructure and has lower production costs.
- Requires more capital investment in machinery.
- Has a larger land requirement, (e.g. when *lining out* trees from nursery beds).
- Has higher production costs for weeding, needing to employ labour and/or chemicals.
- Watering can be somewhat less labour/capital intensive.
- To produce saleable plants, it is usually, at least a 2-year growing/sales cycle.

The Nursery Site

Site selection

Each production method is more or less particular about site characteristics they prefer (e.g. bare-root production is more particular about soil drainage). However there are some general, basic considerations for a suitable tree nursery site:

Soils – Obviously this is critical for bare-root production. General fertility is important but soils can be improved. Winter drainage and summer water retention are also important.

Elevation – Together with aspect/exposure this impacts on the length of growing season.

Aspect – Aim to maximise sunlight for growth, but protect from intense early morning sun.

Exposure/Shelter – Consider protection against wind/frost, but also shading from large trees, structures, etc.

Slope – An important consideration in respect of drainage, use of machinery; ease of constructing of polytunnels or flat hardening-off areas, etc.

Access – for supplies delivery and order collections/despatch.

Protection – squirrels, rabbits, deer, livestock, public/vandals.

Essential requirements for nursery production

The relative importance of any of these site factors will obviously be affected by both your individual situations and the production method chosen. However, four common, *essential* requirements are:

1. Land

- As a growing area (for nursery beds, lining-out beds; polytunnel/shadetunnel; plus an equal-sized, hardening off area). Obviously the area required depends very much on the scale of operations. A rough guide to growing areas (excluding ancillary facilities/buildings, etc) might be:
 - Container production - 130-170 plants per square metre.
 - Bare-root production - 40-100 plants per square metre.
- For buildings/facilities (seed storage/treatment, sowing, grading/sorting, packing, tools, equipment, etc).

The area and level of production used need to be selected carefully to suit your time/resource constraints and wider aims!

2. Water supply

- Access to a reliable water supply throughout the growing season is critical, both economically and environmentally! A range of irrigation options exists (hand-hosepipe, pumped, sprinkler, drip-lines, or more automated systems). Generally, more initial thought and investment will yield reduced labour costs throughout the year. Environmentally, with the adoption of Sustainable Extraction Licenses, it is wise to consult with Environment Agency at an early stage. A rough guide to water requirements might be:

Early season (March-May) - 600-700 litres / m² of growing area.

Mid-season (June to September) - 1500-2500 litres / m².

Late season (October-November) - 300-500 litres / m².

3. Access.

- For delivery of supplies. For cost effectiveness, many nursery supplies (containers, compost, machinery, feed, etc) need to be ordered in bulk and will be delivered by articulated lorry.
- For collection/despatch of tree orders. Trees are bulky and relatively fragile, increasing the transport costs. Also a nursery site which may be ideal in all other respects may be inaccessible, especially during winter!

4. Time.

As with most nursery businesses, efficient production of trees from seed has seasonal, peak labour commitments, particularly:

- Seed collecting – autumn
- Seed sowing – spring
- Weeding – spring/summer periods

For further details of please refer to Fig 1, tree nursery operations and activities through the year.

In addition to these general requirements there are other important infrastructural needs, specific to each method of nursery production and for the different nursery operations throughout the year.

Nursery production throughout the year – what is involved and what is needed.

Firstly it is necessary to look at the timing of these various operations and decide if they fit in with/can be accommodated within your existing time/business constraints (see figure 1).

Seed collecting

Legislation

No farmer or grower enjoys paperwork and this is not something to dwell on too deeply but obviously it is necessary to operate within the law and to show best practice. In fact, adhering to legislation governing traceability of plants will assist growers in selling their stock, as increasingly grant scheme bodies require documentary proof of tree provenance.

Seeds and cuttings are covered by Forest Reproductive Materials legislation (FRM). It is compulsory for anyone marketing or supplying FRM to Register with the Forestry Commission as a supplier. The Forestry Commission maintains a Register of Suppliers.

- Always register with the Forestry Commission as a supplier before beginning a collection - use form FRM6.
- When collection seed follow the steps outlined below.

Step	Stage
1	Get permission from the owner of the collection site, or their agent, before starting the work.
2	Use the Land Information Search (http://www.forestry.gov.uk/forestry/infid-5ygfel) to find out if there are any designations or other sensitivities that might need to be taken into account.
3	Give the following information to the local Forestry Commission office in whose area the collection site lies at least 14 days before collecting starts: <ul style="list-style-type: none">• Collector's name, address and contact details• Place of collection• Species• Grid reference of collection site• Basic material reference in the National Register, or for source identified (SI) material, region of provenance or seed zone (see figure 2)• Proposed date and duration of collection
4	Apply for a Master Certificate for the seeds or cuttings. This must be done within nine months of collection or before marketing the FRM, whichever is earlier.

If collecting seed where no marketing/sale is involved (e.g. for growing into trees for your own use) FRM legislation does not apply, but it is now possible to apply for Certificates of Local Provenance and operate via a Voluntary Identification Code (see Forest Practice Note 8). It is advisable to inform the Forestry Commission and obtain certification (either a Master Certificate or Certificate of Local Provenance) as this will assist you greatly with traceability/quality assurance in satisfying grant-awarding bodies (F.C., C.C.W., etc).

If you are a landowner with a source of good quality seed you may apply to become a registered stand/source, with additional financial benefits if you are selling the seed.

Seed collection considerations

- Careful selection of parent trees is necessary, preferably collecting from ancient or semi-natural woodland. Obviously, collect only from healthy parent trees.
- Check seed sources regularly for seed ripening, pest attack, etc (see figure 3).
- Don't collect seed too early as the seed may not be mature. A good indicator of maturity is a change in colour of seed/fruit; but for more accurate results samples may be taken for dissection and testing.
- Don't leave collection too late as fruited seed will be eaten and germination can be inhibited. Also the earlier seed enters stratification/treatment the earlier germination can occur next spring.

Equipment and requirements

Labels	Give each collection a batch number, cross referencing these to records on: location/conditions of the tree and site, date, quantity, quality, etc.
Containers	Open weave sacks (polythene or hessian) are ideal for larger seeds/nuts. Polythene sacks (co-extruded) are useful for berries/wings. Paper bags can be used for smaller seeds (birch/alder).
Gloves	To hold thorny blackthorn, hawthorn branches, etc.
Stepladder	Preferred to pruners as hand picking minimises destructive seed collection.
Pruners	"Snip and grip" type are especially useful.
Rakes/shovels	For raking up larger quantities of seeds (beech mast, acorns, etc).
Tarpaulins/nets	For large scale collection from taller trees. A worthwhile investment particularly at productive seed sites, saving a great deal of time and backache.
Lunch +first aid	They help to ensure a safe and enjoyable days' work.

Seed processing, storage and treatment

Processing

Before storage most seed needs cleaning, removing the fruit (depulping) and separating off twigs, pods (dehusking) and other impurities. This will help prevent fungus/mould spoiling seed and also aid germination.

Equipment and requirements:

Labels	Warm, moist storage conditions necessitate weatherproof labelling.
Mesh sieves	Different gauges to allow seeds to pass through/sieve out rubbish.
Buckets	To clean off seeds and float off residue/unviable seeds (remember not all floating seeds will be unviable! So separate them, but retain).
Pestle	Blunt ended implement (3" x 3" timber, potato masher) for depulping.
Hose	A high-pressure nozzle assists separation of pulp and seed.

Larger scale extraction for fruit-seeds is accomplished more efficiently using a food mixer, food processor, or even cement mixer.

Seed treatments

- The main purpose is to improve the seed germination rate, giving more even germination and to overcome *dormancy* of some seeds.
- The aim is to provide controlled periods of warmth and cold (see figure 4).
- This is to preserve the quality of the seeds throughout their storage/treatment period, by maintaining a balance between humidity/aeration, whilst preventing overheating and spread of fungi/bacteria, etc.
- This is achieved by either storing seeds dry or *stratifying* in a medium (sand/compost/leaf mould mix) in a plastic bucket or bag with an open neck.

Stratification

- Stratification involves mixing a quantity of seeds with a similar quantity of sharp sand - compost mix, and storing at normal, outside temperatures in a sheltered area (to minimise the worst effects of frost, direct sunlight, drying out and water logging).
- These mixes will need to be checked regularly for moisture (they need only be damp enough to squeeze a few drops of moisture from a handful of mixture).
- More precise controls of temperature and humidity may be desirable using artificial heaters/coolers.

Equipment and requirements:

A sheltered area outside.

Fridge, which can be regulated 1-5°C.

A warm cupboard/room, which can be regulated to around 20°C.

Plastic bags loosely tied at the neck or buckets/tubs with holes for drainage/aeration.

Sieves, hose and buckets to separate chitting seed from medium

Seeds can be divided into roughly four storage/treatment groups:

Not dormant / sow immediately

Aspen	Wych Elm
Oak	Willow
Sweet chestnut	

Store naked or dry / pre-treat in spring

Alder	Gorse
Birch	Pine
Broom	

Stratify / pre-treat in a medium and sow in the first spring after collection

Blackthorn	Crabapple	Rowan
Bird cherry	Elder	Hazel
Wild cherry		
Guelder Rose (germinate in 1 st spring but doesn't grow above ground until 2 nd spring)		

Stratify/pre-treat in medium and sow in 2nd spring after collection

Hawthorn	Holly	Dog Rose
Ash (Brown)	Yew	Spindle

Seed sowing

- There are two main seed sowing periods: in autumn (acorns, sweet chestnut, etc); and in spring (most other seeds).
- For propagating from cuttings, the main planting periods are autumn (willow, hazel) and early spring (hazel, aspen, black poplar, honeysuckle, elder)
- Basic rules:
 - ✓ Sow seeds at a depth of roughly twice their size/thickness.
 - ✓ Sow 2 seeds or more per hole/cell depending on their size/viability.
 - ✓ Smaller seeds (birch, alder) are easier to broadcast in beds, or seed trays and transplanted/pricked out later.
 - ✓ For best quality, containers should be raised off the ground, allowing an air gap underneath, to “air prune” roots, concentrating root growth in the containers.

Equipment and requirements:

Bare root production – in cultivated soil beds, with irrigation system.

Cultivation hand tools (spade, fork, rakes, dibbers/multi-dibbers, lines, etc).

Rotovator for larger scale production.

Roller.

Windbreaks if exposed locations.

Rabbit fencing perimeter and protective net cloches to deter birds, squirrels, etc.

Labels/signs to keep track of individual provenances.

Sand/grit to cover lighter seeds.

Fertiliser (muck, leaf/mould/bracken) – pre incorporated into cultivated beds or as mulch in older/transplanted trees.

Container grown production – usually in polytunnels, shade tunnels, also requiring hardening-off area, all with irrigation system.

Potting shed/area – not too warm, not direct sunlight, bench for pot-filling/sowing.

Benches/staging to raise trays/cells off the ground for “air pruning” of roots.

Root-trainer-cells/plug trays/pots/cardboard milk cartons.

Compost – whether homemade or bought in it needs to be suitable for a wide range of seeds sizes. You can make your own mixes incorporating sand, vermiculite, lime, fertilisers, etc.

Trolley/barrow for moving trays between potting shed, polytunnel and hardening-off areas.

Labels/signs.

The Growing Season

Irrigation

- A critical activity to maximising plant growth, nutrition and reduce disease incidence.
- Very important in the early stages of seedling growth, especially birch, alder.
- Both too much and too little water restrict plant growth and cause disease and plant losses.
- Without some level of automation it can be very time consuming. Always a major cost.

Equipment and requirements:

Water supply and /or water storage.

Hose pipe with coarse and fine spray heads.

Standpipe sprinkler(s) connected to hose pipes for irrigating larger areas. Used together with timer valve(s) for time-saving and watering in your absence.

Automatic Irrigation systems, including storage will still need manual checks and top up irrigation.

Drip lines/trickle irrigation – useful for small-scale bare root production/bed irrigation.

Soak trays for emergency rehydration of dried out trays/cells.

Flood benches/floors involves a significant investment but reduces annual costs and environmental impact.

Weeding

- After irrigation, this is probably the next priority in terms of maximising growth potential for plants.
- Critical to keep beds/pots weed-free in plants' early growth period.
- Very time consuming if weeded manually, but better to invest time in weeding at earlier stages before weeds become difficult to uproot and begin to stunt plants.
- Weeding of container grown stock easier, especially if trays/cells are grown on benches. Avoids considerable effort and backache.
- Manual weeding of bare-root beds possible, but arduous. Possible to employ weed-suppressing mulch in older/wider-planted plants. Otherwise, specialist machinery or chemicals may need to be employed.

Feeding

- Much of the fertility for the first few months of plant growth will be contained/incorporated into the growing medium (soil beds or compost in cells).
- To maintain and increase growth in mid-late summer, some supplementary feed may be required.
- A practical method for container grown stock is liquid/dissolved feed added to irrigation water (fertigation). Liquid feed can be bought in or home-made (comfrey, nettles, bracken, etc).
- For bare root production fertigation also useful. Mulching (with leaf-mould/manure, etc) of older, lined-out transplants is possible or granular, slow release or top dressing fertilisers could be used.

Equipment and requirements:

Comfrey beds + plastic barrels for DIY feed production.

Watering cans – for use on a very small scale

Knapsack sprayer – for selective feeding of foliar feeds/mineral/trace elements.
(Also useful for pest and disease control).

Diluter/injector for automatically adding liquid feed directly into irrigation water.

A mixing tank provides an alternative to the above, for diluting concentrated feeds and applying as fertigation every 4-6 weeks.

Pest and disease management

Significant pests include:

- Seed sowing/early growth period Birds, mice and squirrels digging up seed.
- Main growth period Rabbits/livestock chewing off green tips and moles attacking stems at ground level.

Significant diseases include:

- Damping off in young seedlings due to over-watering. This is probably the most significant in terms of the number of seedling deaths/wasted seeds, etc. It is best prevented by matching irrigation carefully with day-to-day environmental conditions. Cheshunt compound may further reduce losses.
- Black fly infestations of wild/bird cherry in May/June – employ soft soap or insecticide.
- Powdery mildew on oak, hawthorn, in mid/late summer – treat with sulphur, bordeaux mixture, or other fungicide.
- Rusts on birch in late summer/early autumn

Treatments

- Maintaining good sanitary regimes (pot cleaning) and good regimes for watering, feeding and ventilation should be the main preventative treatment to avoid disease.
- Preventative spraying of anti-fungal agents (e.g. equisetum, garlic spray), plant tonics and mineral supplements can reduce incidence.
- Otherwise, careful monitoring of growing crop is necessary, identifying disease incidence and treating early to prevent spreading.

Equipment and requirements:

Secure fencing is essential to exclude livestock and rabbits
Net cloches for covering growing beds outside.
Warning/scaring devices and traps
Mouse/small mammal guards on benches
Knapsack sprayer for applying pesticides/fungicides.

Transplanting, potting on and pricking out

For container stock: pricking out of seed trays/small cells into larger cells
Potting on last seasons' stock from cells/pots to larger pots

Equipment

Pots, compost and a shaded workbench.
Pencil/Dibber or multi-dibber to do a whole tray at a time.

For bare root stock: transplanting after one year to another bed (1 + 1)
Allows root pruning, thinning out and lining out for better spacing.
Alternatively you can undercut seedlings and thin out. (1 u 1)

Equipment

Cultivation hand tools (forks, spade, secateurs, dibbers, lines)
Undercutting machinery for larger scale production

Hardening off

- This applies largely to container grown stock, grown in polytunnels.
- To ensure good quality plants for sale, trees must be acclimatised to a harsher, unsheltered environment.
- Usually takes place in late August/September depending on space/time.
- Continue feeding (with more potassium based mixes) to improve lignification (hardening of stem bark) and good bud formation.
- Need to set aside significant area of land equivalent to polytunnel area.
- Plants/trays can be supported on pallets or other support systems to raise them a few inches off the ground – allowing “air pruning” (roots refuse to grow out of the bottom of cells and continue to grow in the cells).

Equipment and requirements:

Hardening off area, with ground cover to suppress weeds.

Trolley/barrow for moving trays.

Pallets/supports for cell tray to allow air pruning.

Labels, signs and area plans to assist in quick identification/collation of orders, etc.

Grading/Sorting

- A very time consuming activity but essential to ensure uniform quality to customers.
- May need to hire in casual, seasonal labour.
- Grading is usually through height, **but height isn't everything**. Priority is for:
 - ✓ A well proportioned, healthy plant with good root/height ratio,
 - ✓ Good root collar thickness and bud development.
 - ✓ A few years after planting smaller plants will have caught up slightly taller plants.
 - ✓ Smaller plants are cheaper to buy and easier to plant.
 - ✓ Smaller plants are less liable to lodging/breaking in strong winds or damage from vandals, etc.

Marketing/Sales

- In many ways this needs to be the starting point not the finish as you need to know what to grow before planning, seed collection or planting.
- If meeting single order from a number of sources, need to ensure uniform, good quality and similarity for ease of planting.
- Need to be accessible by vehicles for collection of orders.
- If not being collected by customer or delivered by you will incur significant costs for despatch and secure packaging.
- Need to pack trees to protect them during transit, especially to prevent roots drying out.

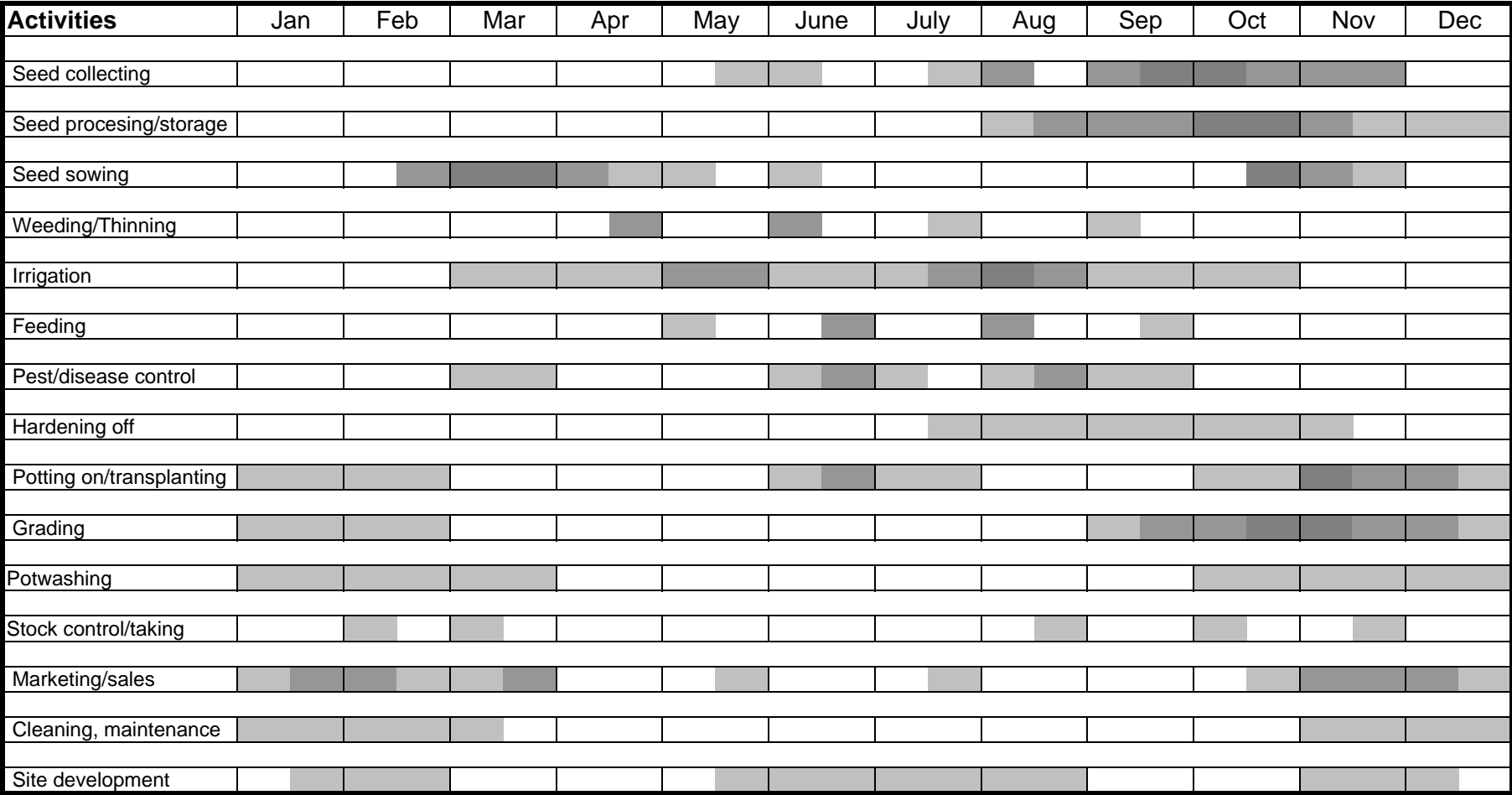
Equipment

Despatch/packaging supplies, such as polythene bags, polypots, cling film and wrapping equipment.

Labels, with tree species, provenance and master certificate details.

Trailer and towing vehicle – for larger scale production and if you wish to deliver/plant for others.

Figure 1 - Tree nursery production operations and activities through the year



■ Periods when normal level of this activity/operation
 ■■ Periods when heightened level of this operation/activity

Figure 2 - UK Regions of Provenance Map
 Showing designated zones for tree seed collection

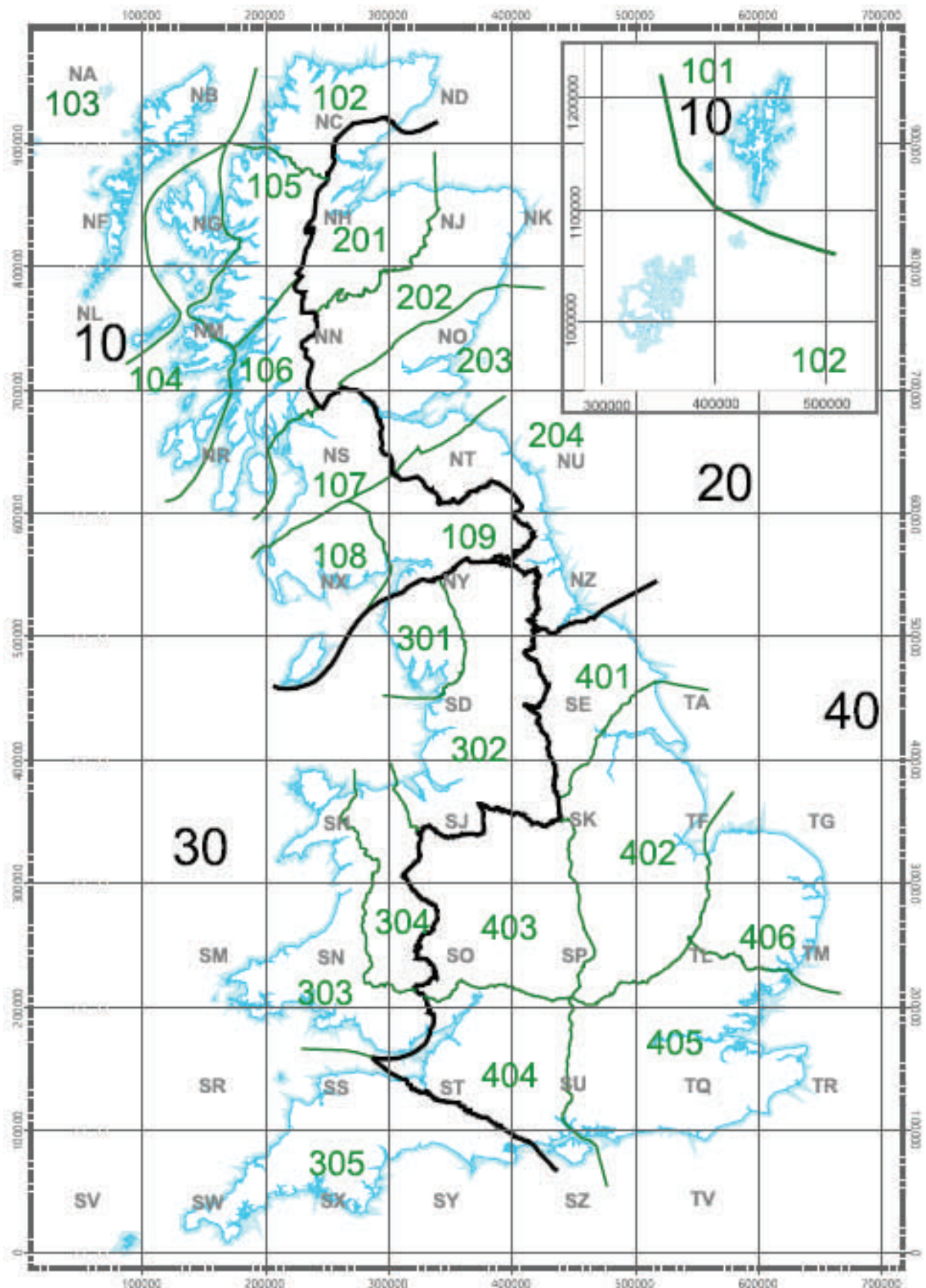


Figure 3 - Seed collection times for tree and shrub species commonly found in the U.K



Figure 4 - Seed treatment times for the major broadleaved tree species, native to the U.K.

	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Alder			4 weeks Naked									
Ash (Green)		Sand or sand-compost								Sow immediately or Natural stratification		
Ash (Brown)			8-12 weeks				Summer following collection satisfies warm period Sow following spring (2nd spring after collection)				8-12 weeks	
Beech										4-20 weeks Naked in cool store		
Birch			4 weeks Naked									
Blackthorn		18 weeks									2 wks	
Broom					Soak in boiling water, cool and sow immediately.					Naked in cool store		
Crabapple										2 wks	16 weeks	
Cherry, Bird										2-4 weeks	18 weeks	
Cherry, Wild										2 wks	18 weeks	
Chestnut, Sweet											Sow immediately or store naked in cool	
Elder		12 weeks								10 weeks		
Hawthorn		12-16 weeks					Summer following collection satisfies warm period Sow following spring (2nd spring after collection)			4-8 weeks		
Hazel										Sow immediately or Natural stratify in sand-compost		
Holly		40 weeks					Sow in 2nd spring after collection.				24 weeks	
Maple, Field										4 weeks	12-24 weeks	
Oak, Sessile										Sow immediately or cool store in moist medium		
Rose, Dog		8-12 weeks								8 weeks		
Rowan										2 wks	14-16 weeks	
Walnut											Sow immediately or 12-20 weeks	

