An Outline of a Nursery System to Produce Quality Sitka Spruce Transplants

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The nursery site is situated at Tilford, Farnham, Surrey and consists of 250 acres of soil derived from sands of the Folkestone Beds with a natural pH value of 3.5 raised for nursery purposes to between 4.5 to 6.0.

An annual rainfall of 30 inches can be expected.

Advantages of the Site

1. 250 acres of production at one location is probably unique.
2. Free drainage ensures a soil that is workable all the year round.
3. Situated in the South of England a long growing season can be expected.
4. The nature of the soil gives no frost lift enabling lining-out to be carried out during any month of the year.

Disadvantages of the Site

1. High risk of late and early frosts.
2. Both rabbit and roe deer are present creating a need for fencing.
3. A short dormant period means high pressure of work during the lifting period.
4. Water is needed for both frost protection and irrigation.

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Production

The production programme is for 15 million Sitka spruce transplants per annum. This species represents 85% of the total of transplant production in the nursery.

Seed

The necessity to have ample stock of good quality seed is paramount. Any shortage in a year could mean disaster to a crop representing 85% of the transplants grown in the nursery. One year's supply of seed is kept in hand by using a normal household deep freeze.

To consistently have a good and even germination of seed, pre-treatment of the seed in essential.

The seed (in known quantities by weight) is placed in polythene bags and soaked in water for 48 hours. The neck of the bag is then loosely tied so that when inverted the water will drain. The pre-treatment is completed by hanging these bags in a cold store for a period of 6 weeks at a temperature of 2°C.

Before sowing the seed must be spread out to allow it to dry sufficiently so that it will run freely through the seed drill.

Ground Preparation for Sowing

The vast majority of seed is sown on sterilised ground with a small percentage on unsterilised ground. The reason for using some unsterilised ground will be given later.

Sterilisation is by spreading Basimid onto the area by means of a Sissis Loadspread. The distributed powder is mixed into the soil by a rotovator. The area is then thrown up into seed beds and finally covered with polythene sheeting. Gas is released by the action of the powder coming into contact with the moisture in the soil and the gas is contained by the polythene. This operation is carried out in the autumn whilst soil temperatures are still warm. Six weeks is needed for the sterilising to take place.

In late March and April after minimal cultivation to allow any excess gas to escape, samples of soil from the area are tested by sowing cress seed onto the samples contained in screw topped jars. Any gas in the soil will be evident by its effect on the cress seedlings.

Four tractors, a Sissis drill, a rotovator, a bed maker together with a poly layer can sterilise up to 4.5 acres per day.

Sowing and Production of Seedlings

Sowing of seed is carried out by a specially adapted Sissis drill with its distribution limited to the width of a seed bed. The machine

is geared, enabling broadcast sowing to be carried out with great accuracy once the machine has been calibrated.

When calibrating the machine in order that the intended seedling density is achieved, it is necessary to take into account not only the quantity of seed but also the germination percentage.

Lime-free grit or coarse sand of a light colour is used to cover the seed. This is spread using a tractor-mounted distributor.

The advantages of grit or sand over a soil covering are:

1. It is quick to apply.

2. It does not cake, and thus avoids impeding emergence of the germinating seedlings.

3. It conserves moisture at this critical time.

4. Heat is reflected.

Conserving moisture and reflecting heat are important in protecting the germinating seed from dry winds and or undue heat in warm weather, both of which could adversely effect germination.

Protection against birds is needed until the seed caps have fallen from the emerged seedlings. This is provided by netting supported by hoops over each individual bed.

During the critical germination period to guarantee good germination irrigation may be necessary in the absence of sufficient precipitation.

Seed sown in March/April will produce good balanced 1+0 seedlings ready for lining-out from September onwards.

During the growing season to help produce a root system of controlled length and to encourage fibrous growth the seedlings are undercut.

Controlling the length of the root system also helps to ensure that when the seedlings are lined out, the root is correctly planted.

Earlier I said that some seed would be sown on unsterilised ground. This is usually ground sterilised the previous year from which a crop of seedlings has already been taken. The new seed will get some benefit from the year old sterilisation but will need a pre-emergent herbicide application of Diphenamid. These seedlings will tend to grow slower than those on sterilised ground and are grown on to make 1½+0 seedlings.

When required the seedlings are lifted by hand after using a *Magnefique* lifter mounted on a tractor. The lifter blade with vibrating fingers is passed under the seed bed loosening the seedlings enabling them to be lifted on piece work into plastic boxes with the seedlings standing upright.

The 1+0 seedlings are lifted from September through until March and can either go straight out to be lined out or to be stored in the cold stores until needed.

Alternatively the 1½+0 are left to grow on until June or July of the second year then being lifted and lined-out straight from the seedbeds.

Lining-Out

Due to the light nature of the soil hand lining-out is favoured over machine lining. Both systems have been tried in the past but hand lining-out has many advantages over machine lining on this site.

Each person is responsible for lining out his own area of beds and works on a piece work basis and this fixes the cost of the operation. Checking the quality of work is simplified too as you know who is responsible for a particular area.

Individual working enables the worker to work at his own speed; no one else is relying on him; no machine is held up should he fail to turn up for work and lastly the speed of the operation is not governed by the slowest member of the team.

The work force is employed on a permanent rather than a seasonal basis.

Lining-out is carried out from September to December stopping then to allow lifting and despatching of transplants and recommences in April continuing through until June. The seedlings for the later period are drawn from the cold stores. During July and August the 1½+0 seedlings are lifted from the beds after irrigation and lined-out the same day or they may spend one night on a trailer under cover after watering. Immediately after being lined-out irrigation is applied.

As well as providing continuous employment this system produces transplants of varying size depending on how long they have been growing. This means that if the transplants are lifted for orders in roughly the same order as they were planted any transplants not sold are the most suitable to be carried forward to the next season.

Weed control is by the application of Simazine immediately after planting, giving excellent results in most cases. Atrazine is used as a backup if necessary.

Irrigation and Frost Protection

Both irrigation and frost protection are essential on these light sandy soils if satisfactory plants are to be produced.

Water for these operations has for many years been pumped from the adjacent River Wey under licence from the local water authority. The restrictions imposed by the licence means that most of the water can only be abstracted during the winter period. To ensure that water is available when it is most needed it has to be stored and two reservoirs each capable of holding five million gallons have been constructed.

When water is needed it is pumped from the reservoirs into a system of underground mains which support hydrants strategically situated throughout the nursery. From these a portagrid system of overland pipes and sprinklers is used to distribute water for irrigation or frost protection.

Up to six inches of irrigation water may be needed by a crop during a dry summer.

Frost protection uses the same equipment as irrigation but it has to be on site throughout the threatened periods. These usually extend from April to June and from September to November. During these periods new growth has to be protected in the spring whilst in the autumn late growth is vulnerable until it has hardened off.

This system of water protection was devised for the protection of fruit blossom and the principle of protection is as follows.

The plant cell sap has a slightly lower freezing point than that of water and also as water freezes, it releases latent heat, until all the water is frozen.

So if one can apply water over the whole surface of the plant under freezing conditions, making sure that it is applied so that the base layer of ice is kept continuously wet, the latent heat released will maintain the ice layer at a temperature sufficiently high to prevent the plant cell freezing.

Lifting and Grading

The same *Magnefique* used to lift seedlings is employed in lifting transplants.

By careful adjustment the plants can be loosened but still left with a covering of soil over roots. this is important as it means any plants not removed by the men that day will not suffer from their roots drying out or from overnight frost.

Lifting is done on piece work, one man being responsible for lifting his own number of beds whilst grading up to two saleable grades and discarding any with imperfections.

Lifting and bundling is followed by heeling-in, the time between depending on the weather. The drier or windier the less time the plants must be left before heeling-in. Tractors and trailers transfer the plants from the heel to the cold stores.

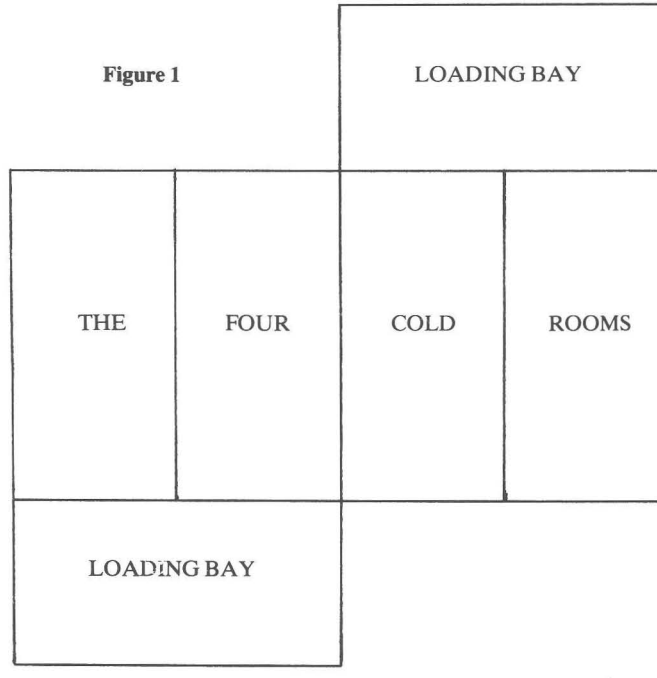
STORAGE

All lifted transplants eventually arrive at the cold stores whether they are intended for long storage or not. The stores are used as a centre for building up orders large or small to await collection or despatch.

The coldstores are of a direct humidified system. This enables plants to be stored bare-rooted without the danger of the root systems deteriorating.

The coldstore buildings consist of four rooms side by side. Each of these rooms has access to one of the two loading bays situated at either end of the building (See Figure 1). Each cold room has a potential for storing two to two and a half million transplants depending on size.

Figure 1



Access is so arranged that it is possible for a fork-lift truck to travel from any one room to another without leaving the building.

Each loading bay is large enough to accommodate a 60 foot long vehicle still leaving ample room for loading from either side. Closing the large double doors at both ends of the bay helps to control the environment whilst loading plants from the adjoining cold rooms. Plants entering the store from the nursery are either transferred to awaiting transport for despatch or crated for storage.

Crates are constructed of slatted timber at the back, bottom and front, with the sides being of one piece plywood. A chicken coop type front enables it to be removed. The specification of the crate is such that it is usable both in the cold store or on our own lorries.

Transplants are packed horizontally into the crates with roots to the two solid sides and the leaders to the middle. Each crate will hold from 1,500 to 5,000 plants depending on the size of the plants. In each cold room crates can be stacked to the side walls six high and three deep leaving a central alleyway for access. All movements of crates is by fork-lift trucks.

There are two humidified refrigeration plants in each room. Large powerful fans force cold air down ducting along the walls, in turn drawing the air through the crates and returning it via the central aisle to be cooled, humidified and then recycled.

Trees entering the store will be cooled to 2°C at which temperature they will stabilise within 24 hours regardless of their incoming temperature.

Transport and Loading

For transport and the loading of the transport we have to cope with not just our own vehicles but also those of our customers.

Customers lorries vary from open backed vehicles requiring sheeting, to enclosed containers which may or may not be insulated, down to pick-up trucks.

Trees are brought out of the cold stores into the loading bays by fork-lift trucks carrying up to three crates at a time. At this point the trees can be loaded in crates onto our own lorries or be taken from the crates and loaded by means of an elevator either bare-rooted or after being bagged in polythene sacks depending on the customers' requirements.

Our own vehicles consist of side loading six-wheeler-lorries towing trailers with insulated temperature controlled bodies.

Fork-lift trucks present three crates vertically stacked, which is the maximum height in the lorry, onto the bed of the lorry with

the removable sides of the crates outward facing. A further 3 crates loaded from the other side completes the load width. This continues until the vehicles are fully loaded. Loading can take as little time as three-quarters of an hour.

Once the side doors are closed the vehicle is insulated.

Remembering that the trees have been stored at high humidity at 2°C it is important to control any rise in temperature using the minimum chilling whilst in transit as excessive use of direct refrigeration reduces humidity. Many loads in the cooler months require no chilling. However, as in most years planting continues well into June, chilling can be essential. It can also be useful in case of a vehicle being delayed through a breakdown enroute.

The lorry and trailer configuration is used rather than an articulated lorry as it tends to be more manoeuvrable on narrow roads, negotiating gateways, etc., thus enabling plants to be delivered as close as possible to the planting site. Unloading is by removing the fronts of the crates thus enabling plants to be discharged without the crates being taken from the vehicle.

It has long been Tilhill's policy that to produce good plants is not enough. Good plants have to be carefully handled from the time they are lifted until handed over to our customers.

Our own branch managers regularly report back planting takes of 90% plus. If for any reason they experienced trouble with any batch of plants they very soon let the nursery know! This type of constructive criticism is welcomed as it is only by knowing what happens to the plants after they leave our control that lessons can be learned and improvements made.

New and Future Developments in Bare-Rooted Planting Stock Production

Most foresters consider that planting stock should be transplanted at least once in the nursery if a balanced root is to be of a standard to perform well when planted on into forest conditions.

An alternative system of precision sowing and undercutting has for some years proved satisfactory in North America and New Zealand.

Undercut seedlings have had a bad name in the past due to seedlings being sown too densely and the inability of undercutting machines to do the job correctly.

Precision drilling places the seed in rows and individually places them within the row. Instead of lifting and transplanting in the conventional fashion an undercutter and lateral pruner is used to restrict the downward and sideways growth of the root system. This in turn promotes a fibrous system.

Difficulties in undercutting have been solved by using a tractor-mounted machine with a reciprocating blade the depth of which is controlled hydraulically ensuring clean cutting of the roots at an accurate depth.

Lateral pruning is by a tractor-mounted frame with sufficient vertical discs capable of severing seedling roots either side of each row.

Wrenching is the operation of heaving the plants whilst *in situ*. A larger blade than the undercutter is mounted on the same frame and set at an angle to run through the soil under the root systems. The disturbance causes the root system to re-establish itself at the same time restricting top growth. This is a further tool to control the growth of the plant.

Both root pruning and wrenching can only be done if adequate irrigation is available immediately after the operation.

To meet the added need for extra water Tilhill is installing a new system. It is known as "Well Pointing". A similar system has been used in the construction industry to evacuate water from a wet site when footings or foundations are to be installed.

On the nursery site a line of 50 bore holes to accommodate 3" suction pipes have been bored at three foot intervals down to a depth of 30ft. The tops of the pipes are connected to a common manifold pipe which in turn links up to a vacuum pump. When in operation the pump is capable of delivering up to 1,000 gallons of water per minute being drawn from the water suspended in the sand beds which the nursery is situated on. Thus the reservoirs can be topped up as necessary. Needless to say the local water authority had to grant us a licence before this kind of operation could be started.

With this adequate supply of water satisfactory trials are on-going at Tilhill and it is anticipated that precision drilling production will take on an ever increasing proportion of our future production.

In our continual search for improvement in the quality of our products we are now engaged in looking for the ideal lifting machine for our nursery. To provide the best transplants we seek a machine that will allow us to lift under ideal conditions only. Thus we need one capable of lifting a whole bed at a time which would then allow the plants to be graded under cover before storage.

Conclusion

As indicated by the title, to meet time and space constraints, this has provided an outline only. However, hopefully it shows the continued search for methods of improving the quality of nursery produce.