3. Watering heavily and as seldom as possible.
4. Maintaining moderate humidity levels.
5. Locating crops according to growth factor needs, such as high or low light.

Note also that a level or a bench may be "Tented Off" for specialised microclimatic control such as fog propagation.

Another common comment was our light source at the lower level, not exactly overhead. Our experience is again good with most species which we have placed on the lower level, including Kentia palms, *Calathea, Spathiphyllum, Peperomia, Dieffenbachia, Philodendron, Laccospadix, Aglaonema,* etc. Species which do show directional reaction are mainly those which have "spaced internodal trunks" such as *Aralia* and *Schefflera*, and climbing species.

Some benefits not anticipated include slightly spaced internode lengths on *Syngonium* and other "tightly node spaced" species, facilitating my style of cutting supply. This is to take early smallish, main-growth cuttings, resulting in a bushy yet compact young plant for growing on. This spacing makes the taking of cuttings so much easier and therefore quicker, which in turn is more economical.

By this practical illustration of my approach to the aims stated, I hope I have at least suggested to you that alternative approaches to nursery production can be taken. If, in time, an integrated nursery system evolves using standard sizes to facilitate production processes, quality, and systems handling, including despatch, then I believe the nursery industry will be poised to take a great step forward.

Finally, I must stress the versatility of this system which enables the enterprise to discover a market need and quickly adapt the growing or production facility to enable supply of that line, thus the nursery will be better equipped all around to go into the more competitive years ahead.

SOME PROBLEMS IN SEED RAISING

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As propagators, we find at some time we must produce some plants by sexual propagation. The old cry can be heard that seed lines are easy to grow. I often wonder how many good propagators have lost a batch of seed or have failed to germinate them. When this happens a good propagator will look to find out where he has gone wrong. Seed propagation is

easy in most instances if one understands all their requirements and have the facilities to fulfill the various needs of the species intended to be sown.

I have so often been surprised that, within the nursery trade, many failures still occur. If we take a close look at some of the failures encountered most can be traced back to bad management or shoddy workmanship. As a consultant, I am constantly asked to look at problems occurring every day with seed germination, not only from inexperienced people but from people in all branches of horticulture, including seed testing laboratories.

Many of the problems that occur could be overcome very quickly if more care was taken in the practice of seed sowing. A great number of people intending to sow seed treat all species in the same manner and just hope for the best. With the rising cost of seed and the ever growing importance of getting a good quality plant, one cannot or should not be so unprofessional in the way they plan for seed raising.

There are, of course, many problem areas which the grower has no control over, such as length of viability, poor seed quality, and the aftercare that seed are given when first collected.

PURCHASING

Firstly, let's look at purchasing: In many cases when seed is needed it will not be ordered until the last minute. You should always plan well ahead (at least six months) or the seed company may have sold out of the species or cultivar you require; this often happens with new introductions and popular cultivars. Most companies have the policy first in, first served. Lesson one — order early to avoid disappointment. While on the point of purchasing I would like to stress that if you are wanting the best results then make sure you purchase only from reliable seed companies. Price is not the first consideration. Most good seed companies have excellent storage and cleaning facilities to care for seed. If requested, most seed companies will pretreat the seed and dispatch on a date to meet your sowing dates. When ordering for the first time ask the company for a seed count chart and expected germination percentage; often these are found in their catalogues and will help you work out your needs. So often too much seed is ordered; this is both costly and wasteful.

When seed is received make sure that the order is checked; if not available, re-order immediately with another seed company. Seed should be sown as soon as possible or, if needing treatment, they are so treated. Most nursery office

staff are not aware of the importance of these facts; they must be instructed to inform propagators or someone in propagation of the arrival of all seed. Seed in packets can deteriorate very quickly if left lying on a desk. Sun shining through a window for 20 minutes will roast seed within the packet. If the seed are not to be sown on arrival they must be stored under cool conditions or losses may occur.

Any seed obtained from overseas will be subject to inspection. When ordering seed from overseas ask the company to advise you when the order is despatched so you can check with Quarantine when your seed arrives; sometimes seeds can be left in these areas for days.

CONTAINERS

For those that only sow a few seed by hand the most popular container would be the punnet or plastic tray or even the wooden seed trays. Before commencing to fill our trays we must firstly check that all holes in the trays have been pushed out. Often patchy germination is caused by these holes being blocked. The reason for this is air drainage through the medium is impaired and air space is then filled with water. If this happens the temperature in those areas of the tray will drop. Changes in temperature within the area of some kinds of seed will result in uneven germination or even loss; too much water will also reduce the amount of available oxygen, another important factor affecting seed germination.

If wooden trays are to be used care must be taken to ensure that large gaps are not in the bottom or the medium may dry out, again causing losses, or the medium may be washed through at watering, a very common fault.

FILLING TRAYS AND SOWING

Filling of trays can be carried out by hand or machine as long as uniformity is controlled. If by hand, trays should be filled to two thirds and roughly levelled, then screen the medium through a 6 mm mesh sieve. This size is recommended to avoid crusting of the surface. The tray is overfilled and a bar used to remove surplus by running it over the edges of the tray; at this stage the tray should be completely full but not compressed. If the tray is then lifted 3 to 4 cm off the bench and just lightly dropped this will settle the medium in the tray to just under full (make sure that when you drop the tray onto the bench it's kept level or you will find the surface becomes uneven).

At this stage we need a board or blade that will fit inside the tray but has edges that will run on top of the tray (depth of

inside should be 6 mm lower that top edge). This blade is then run over the tray with the medium in it; this removes the upper 6 mm making the surface very uniform. Seed can then be sown onto this surface. Some people think you should at this stage press down the surface on which you are going to sow. If that is done two things happen; firstly, if the medium is a little over-moist the surface becomes smooth and seed that are round will roll. This makes uniform sowing difficult and encourages over-sowing. Secondly, it creates a barrier for penetration of the radicle; when this occurs the radicle will run along the surface till it finds an easy access. Secondary roots will not form until the radicle moves down into the medium. What we then have is a seedling with a heel. Trees such as eucalyptus, acacias, and many others, will often uproot in winds when grown this way as the heel acts as a spring making the tree sway backwards and forwards.

If the medium is not pressed down at this stage, round seed will not roll and overcrowding will not occur. After sowing, the seed are lightly covered; depth of cover will depend on the species being sown. After covering the surface is then lightly pressed down; this keeps a uniform firmness around the seed.

When hand sowing from packets avoid allowing seed to run down the edge folds of packets as the seed will jam up; if then shaken it will cause overcrowding. It is far better to fold the centre of the packet; this allows the seed to run down from both sides. Density of sowing is then much easier to control.

TREATMENT OF SEED

Many seed purchased these days are treated with a fungicide to prevent pathogens that may be carried on the seed coat getting a start. Some diseases such as smuts may not be killed by the use of a fungicidal treatment. What is needed to control such pathogens is a hot water treatment. Seed are firstly placed in a cloth bag which is then tied at the top.

The time and temperature for hot water treatment of seed of various species plant and pathogen species will vary a little but in general smuts (*Ustilaginales*) and leaf spot diseases, such as *Septoria* and *Phoma*, may be treated at a water temperature of 50°C (122°F) for 25 minutes. The bag should only be half full of seed while treating with hot water to ensure good circulation of the water through the seed. The bag with seed in it should be suspended in the hot water on a bar across the container. Since hot water treatment may reduce germination by about five percent, a germination test should be made before and after treatment.

If you have to treat the seed yourself with a fungicide, just a little placed in the packet is all that is needed; fold down the edges of the packet twice after the fungicide has been put in and give the packet a vigorous shake. Care must be taken when dusting seed with a fungicide as most are very fine powders; if the dust is inhaled it may cause some unpleasant side affects.

Many acacia seeds are treated with hot water to promote germination. Problems of sowing the seed after this treatment may occur; for example, seed sticking together. The reason for this is that the seed coat is softened when treated with hot water. When this happens sugars and gelatinous substances are released into the water causing the seeds to stick together. These sugars also encourage the formation of moulds on the young germinating seed. Moulds use á great volume of oxygen when forming. This in turn starves the young embryo of the oxygen that is so vitally needed for germination to take place. If, after soaking, they cannot get oxygen the embryo will die. This, in turn, causes pathogens to attack; once this happens great losses will occur.

To avoid this happening, after soaking the seed, remove the sugar substances from the seed before sowing them. We can do this by gently running clean water into the container with the soaked seed in it. Running a tap slowly into one side of the container will cause the seed to suspend about half way up the container. This movement will clean all the gelatinous substances off the seed. If we then strain off all the water and add a little sand or sawdust to the seed they will no longer stick together; the sand and seed together may be sown. If you use sawdust for this be careful that it's not toxic to the seed.

An after-sowing problem that is often encountered is when trays are placed onto the benches. It is important that the trays are level; if not, water will move to the lower side; when this happens germination is poor. This also leads to overwatering or drying out of young seedlings.

WATERING

Many seedlings are lost each year by thoughtless watering; by this I mean the rose spray used to water is too coarse and the pressure too high. Large droplets of water cause much physical damage to young seedlings. When watering seedlings a very fine rose should be used and while watering it must be kept on the move while over the trays. The pressure should be turned up just enough to stop drips from forming at the end of the rose; at no time should the rose be held over the tray because if the water pressure suddenly drops large droplets of

water will occur causing a great deal of damage to the seedlings.

Always remember that all watering equipment must be kept off the ground at all times to avoid pathogen contamination.

One problem that one often encounters is under-filled trays; when this happens germinating seedlings are too low to obtain good air circulation over the surface. If in low light, *Botrytis* infection may occur; once in the glasshouse it is difficult to eradicate.

Germination may also slow down if the depth of the medium in trays is too great. When sowing seed that will be pricked off, 5 cm of medium is all that is needed; if more than this amount is used the physical properties change and movement of air and water in the medium will change. These small changes do affect germination, particularly in autumn and winter. However, there are many kinds of seed that produce very long radicles and need a deeper container in which to germinate. Many such seed are sown direct, or chitted and then planted; palms and other trees are among this group.

MACHINE SOWING

We have now come to the age of seed sowing machines for nurseries. Many of these machines require the seed to be chitted and it is here that problems seem to occur; knowing your seeds reaction to chitting is of great importance.

When we chit seed for machine sowing we must soak the seed in water up to or within a few days of the radicle emerging; seed of different species require varying periods of time in water for this to take place. Let us take a look at two genera which have different periods of time for chitting. In *Apium graveolens* (celery), the seed is small and takes about 21 days to germinate and is usually chitted for 15 days. At this stage the radicle can be seen just breaking the seed coat; if sown by a machine at this stage very little if any damage will occur. If we wait until 18 days passed the radicle will be well developed and when picked up by the pins on the machine and sown a great number are damaged. Considering cabbage (*Brassica oleraceae)*, if we chit this seed the period of radicle emerging is eight to ten days but we find that when chitting, four hours of soaking has lifted the seed coat off the young embryo. If we allow this to happen when we place them in the machine one pin picks up the embryo, the other its seedcoat. We all know that seed coats do not produce plants and when working to a given number of plants per sq. metre of nursery

space we can't afford to only have half the units filled with plants.

When soaking the seed in water they should be placed in a fine cloth bag and only half filled to allow for movement of water through the bag and around the seed. The bag must be tied at the top and suspended in the water. A very vital point when chitting in water is that after seed have been in water for 24 hours they need oxygen, the same as they would when sown in a medium so make sure that water is oxygenated from the start of chitting.

MEDIA FOR MACHINE SOWING

Most machines being used in Australia for seed sowing are those that use pins to suck up the seed from a container and eject the seed into the trays of the medium. Problems will occur at this stage if the medium used has too many abrasive materials in it; for. instance scoria or coarse sand should be avoided. Most people using these machines use peat and vermiculite, 50/50. This medium seems to cause no physical damage but one must be very careful of overwatering. With houses being filled by machine sowing care must be used in rotating the batches of different genera and species through the house.

RECORDS

There has been one problem which everyone I have consulted for has had and that is the lack of records on all aspects of propagation. There are very few people who can remember changes in weather; these conditions should be recorded because they play a great part in propagation success. Sowing dates, time of germination under your conditions, media used, treatments and pathogen control are all part of recording and become an important part of better management.

SUMMER GRAFTING OF ACER PALMATUM CULTIVARS

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Seedling *Acer palmatum* are field-grown for one year, then dug and potted into 200 mm buckets in mid-winter (July). A few are large enough by early summer (December) for budding, but most are carried over into the following year, trimmed to make standards up to one metre high for weeping