nozzles in the propagation unit should be scrubbed and disinfected. An essential part of the sanitation of the propagation structure is the maintenance of clean ceilings and grooves. Infection can be transmitted by air or by condensation on walls and floors. Footwear can carry infected soil particles. Watering nozzles must be kept off the ground at all times, splashing eliminated, and smoking prohibited with some crops. Immediate isolation and and preferably destruction of infected plants as they appear, should be a daily chore. We must make sure our properly sterilized containers are not put on infected ground or trolleys, or that we do not use a non-sterilized shovel to move the mix, or leave the mix open to airborne spores and seeds or adjacent to surface water. These are essential considerations if we are to be serious about disease prevention.

For advice on the use of pesticides we should look to our Government Departments and when we find a suitable system we should adhere strictly to it to maintain our success rate. The most rewarding and comprehensive books on this subject is, "The U.C. System for Producing Healthy Container-Grown Plants" (1). It should be read and re-read by all who hope for 100% success rate.

Preventative control is the most successful method for containing diseases and pests in propagation. It is essential that all staff understand this and are trained to maintain the standard of hygiene.

LITERATURE CITED

1. Baker, K.F. (ed.) 1957. The U.C. System for Producing Healthy Container-Grown Plants. Berkeley, California, University of California. Division of Agricultural Sciences.

PROPAGATION OF SOME SOUTH AFRICAN PLANT SPECIES

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Most of the nurseries in Southern Africa propagate a range of plants similar to that grown here in Western Australia. The best of the nurseries are probably not as sophisticated as the best in this country mainly because, in general, Southern African labour is not brought up in technological surroundings, and nursery hygiene is a new subject, difficult to get across. But that does not mean that every nursery owner himself is behind the times. On the contrary several nursery owners have done a lot of trial work into crops which have an export potential. Cut

flowers of the family Proteaceae are one example and I would like to outline some of the problems of the enthusiast nurseryman; enthusiast in the sense that he does not just grow bread and butter lines. In relation to proteas I define an enthusiast as one who regards this weird and fascinating family as an ever present challenge. How far any commercially oriented organisation can afford to go along this road of specialised and often expensive trial work is an issue which I would like to touch on later.

There are about 400 species of Proteaceae in Southern Africa. The genera *Protea*, *Leucospermum*, *Leucadendron*, and *Mimetes* are well known. About 12 genera are of commercial importance. There are three essential requirements common to all these twelve genera:-

1. Water must be fresh, very low in salts.
2. Soil must be low in nutrients.
3. Warm humid conditions must be avoided. Cold humidity is all right and a breezy exposed site is ideal.

But it is not as simple as that — the genus *Protea* required costly research before the nurserymen of South Africa could exploit its potential. Some species grow in dry conditions, a few in very wet soils but *only where the water is clean*. Most grow best on acid soils, for instance, *Protea cynaroides*, the king protea, grows in a pH as low as 3.6. Others like *P. neriifolia* can take an alkaline soil of pH 7.3. Some are tender, others, like *P. grandiceps*, grow in nature high up in a winter snow belt. The three I have mentioned are three of the twelve important species. One of them, the king protea, has three important geographical variants. Another, *P. neriifolia* has five geographical variants, at least two of which are exceptions to the low nutrients requirement: they can take salts in solution at 400 ppm. Indeed the cultivation of the proteas is hardly straightforward.

As might be expected, the propagation of other members of Proteaceae is not very straightforward either. The pincushion, *Leucosperum cordifolium*, is a very popular species which is related to the proteas and it is fairly easy to propagate from cuttings. Hence several clones have become established in the trade. Members of the genus *Protea* are not easy to root nor are they satisfactory even when rooted. For instance, a cutting of the king protea usually ends up as a stumpy plant with 30 cm of stem growth and fails to develop further. So seed propagation is the only practical means. Each nurseryman has his own tricks; some are freely communicative but a few are not. I am indebted to Prof. Van Staden of Natal University, Pietermaritzburg for much of the factual information.

Proteas which have wide, shallow, cup-shaped flowers (using the term "flower" loosely) ripen their seeds in 6 to 7 months. The deeper cupped forms take up to one year and, if the flower heads are removed sooner, then any viable seeds can germinate immediately but, if not sown, would have a poor shelf life. If a flower head is removed later there are likely to be more viable seeds but germination might take longer, and there is a great risk of insect damage on the plant. As long as the flower head remains on the plant variations in temperature and humidity can also be detrimental, so it is difficult to know what to do. In nature pollination is generally poor and good seed can comprise less than 3% of the total. Most *Protea* seeds are partly covered with soft bristles. An experienced seed sorter can distinguish good seed from shrivelled seed and from lignified empty seed by the feel of it. (Botanically, the seed is a nut). To control the pests (and there are about 200 known pests of protea shoots and leaves), some nurserymen inject developing seed heads with 5% carbaryl dusting powder; young plants can be sprayed with a systemic insecticide to protect them from most insect damage. To accurately determine the time to harvest it is preferable to mark flower heads when flowering with a coloured strip of plastic. After harvesting, seed heads are stored and the seed falls out of its own accord. Where harvesting cannot be done every 3 to 4 weeks, the seed head is enclosed in a muslin bag to collect seeds as they are shed naturally. Seed can be stored in sealed bags for quite long periods in a refrigerator or in a freezer down to about -5°C.

Protea seeds are notoriously erratic in germination. Apparently they do not contain substances which will inhibit germination, although there are substances which inhibit seed germination in other Proteaceae genera. *Protea does respond to* growth promoters and these can be induced to form within the seed by getting oxygen through the hard pericarp. Oxygen is the limiting factor. The embryo can obtain oxygen if the seed is scarified. A file will do this or a small grindstone but the embryo should not be exposed, cut or damaged in any way because of the risk of fungal infection.

The seed is then sown *scarified side upwards*. If this side is placed downwards there is a marked reduction in germination. Most nurserymen sow their seeds virtually on the surface of a very sandy mix (70% sand at least) and the seed is barely covered. Some nurserymen add sawdust purposefully to reduce available nutrients, especially nitrogen. Some place the seed individually into containers using stiff card tubes and cover these with moistened absorbent paper. Some pre-germinate the seed between two layers of damp hessian (burlap) then pot up the seed singly. I have not been to any nurseries where germination

is initiated in flasks of oxygen, but this method works well in the laboratory. The earlier system of germinating was to sow protea seed in seedbeds about 5 cm apart, but percentage germination was very low and was spread over three years or more.

If the young seedlings are required for stock they are planted out while still very small just as the first pair of true leaves are appearing. They are set very low to avoid damage to the tender young stem by sun or blowing sand. They are watered frequently, as much as every day at first with clear water, preferably rain water or mountain stream water and, of course, the site must be very well drained and low in nutrients. Most seed is sown in March and April and seedlings are ready for planting in late winter/early spring.

Whichever way you look at it, growing young protea plants for sale is not very lucrative. This brings me to the point of whether the profit motive should control the whole thinking of a nurseryman. I would say not. A nurseryman has to keep going, of course, but I think the serious nurseryman, once established, has an obligation to his community. He should serve his public as well as profit from it. Merely bringing new plants to the notice of the public and having smart promotions is not necessarily serving; to my mind such plants should always be genuine improvements on the older ones, or should be reliable additions. They should have as wide an application as possible.

I think it is time for the nurseryman to look less at the catch-penny lines or what is in fashion at the moment, and look instead at plants when they are not in flower. Foliage is usually there for twelve months — flowers rarely for more than two months. So foliage is more important than flowers in the structure of a garden. Foliage can be dense and screening, or it can be wispy. It can have interesting colours; it can be shiny or dull. Here we are getting into aspects of design, but it is important for the nurseryman to think along these lines too. We should be the ones to offer to the garden architect new material which is reliable and interestingly different and to tell him what he should be planting. Gardens are not going to get any larger: in fact they are more likely to be smaller, so the garden owner has to be more critical in the choice of the few he has room for and make sure that all his plants work successfully and perform more than just one function. By that I mean that a fruit tree can at the time serve as a shade tree and a screening tree or a shrub; besides having flowers it can have interesting foliage which might last well when cut for the house.

So the nurseryman, besides looking at the profit margin of his lines, should also consider the texture and habit of the

plants and whether that they are truly adapted to a local environment.

That's all very well, you will say — but you have not got the time to play around like this — or the capital — and why should you do all the donkey work anyway? — That is where the Protea story comes in: — From about 400 species, only 12 were selected. There were problems: sorting out these problems was not a one-sided affair. The nursery trade did not progress very far on its own until it had help and cooperation from research bodies and from universities.

I am sure that there is a great future for the native flora of this country. The potential of some genera is enormous. But no nursery concern can afford the trials — or has sufficient expertise — to develop what is on our doorstep. So I suggest that the nursery trade take a look at this: a long creative look without quibbling; get together, put up a combined front; in fact, formulate a policy and then approach government and research organisations for support.

EFFECTS OF WATER QUALITY IN RELATION TO PROPAGATION

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During the last 20 years the propagation of a general range of shrubs and trees has been undertaken using poor quality irrigation water. Some practical observations and methods we have developed over this period of time under these conditions are as follows:

The quality of underground water we use is approximately 800 ppm of total soluble solids; the majority of the salts being sodium chloride 350 ppm; iron 0.3 ppm; calcium 34 ppm; zinc 0.10 ppm. The pH is approximately 7.5.

While cuttings of most species can be struck successfully, the overall percentage is poorer than if superior quality water is used. A fairly wide range of species are propagated, including both natives and exotics. Some susceptible species, such as soft-leaved deciduous shrubs and trees and azaleas are no longer attempted as the results are too poor to warrant the perserverance.

The damage to plant tissue from poor water quality seems to follow a fixed pattern, namely: