virus-free" understocks on which a promising seedling may be budded. To test out a possible hanging basket or groundcover cultivar I usually bud at 24 to 36 in. For others, 8 to 12 in. is adequate. This gives a good idea of the shape, flowering and growing habit of a new selection, and can supply more propagating wood in a short time.

A variation on the above is to use rooted *Rosa multiflora* cuttings grown from clean virus-free material. I like to have a plant that is grown from a de-eyed cutting (leave 1 or 2 eyes at top) which heads out about 6 or 8 in. above the soil line (in pots). From this numerous shoots will grow. I select the strongest, removing all buds possible up to the height at which I wish to bud. This fast growing cane is easily budded and the "take" is usually excellent.

Other ideas: roses can be grown by grafted cuttings in which a short cutting (*R. multiflora* or any easily-rooted stock) about 4 or 5 in. long is made, leaving 1 or 2 leaves at top. All other buds are removed. Then a deep slanting cut downward is made in the understock (about 1 in. from base) into which a wedge-shaped scion is placed. This scion may have only one bud and leaf. We wrap with Parafilm, as the graft then heals much better.

SUCCESSFULLY GROWING PROTEACEAE

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This paper will cover growing of Proteaceae transplants, propagation by both seedlings and cuttings, transplanting, and cultural aspects, including soils, fertilization, and disease control.

PROPAGATION

Seedling Propagation. Our experience began with seeds of members of the Proteaceae family purchased from Australia and South Africa. We attempted germination in seed flats, and encountered the first problems with seedling propagation—seed dormancy. Many dormancy factors are built into different kinds and/or populations of Proteaceae seeds. Most Proteaceae plants are native to Mediterranean climates and seeds tend to germinate best in the cooler rainy seasons when ample water is available to the young seedling.

Seed scarification in Proteaceae plants (6) has been found to improve germination rates. Stratification (5) of seeds at 5°C for 30 to 60 days prior to planting improved germination rates. Oxygenation

(2) by soaking the seeds in 1% solution of hydrogen peroxide for 12 to 24 hours improved germination. We found seed freshness to be of utmost importance in obtaining high germination percentages.

Seed germination rates vary widely among cultivars of the same species and certainly among different species and genera. The root growth that we found on seedlings was surprising. At the time of cotyledons only, with no true leaves expanded, we had as much as six inches of tap root growth and by the time the first true leaves had expanded well over a foot of tap root growth had occurred.

One problem that seeds bring with them are diseases. Seed-borne diseases have been introduced into California. Luckily California's dry environment is not supportive of many of the diseases, although the moist nursery environment can be.

A seed treatment has been recommended to minimize many of the seed-borne diseases, which include *Dreschlera* spp. and *Colletotrichum gloeosporioides*. The treatment is as follows: A hot water soak at 50°C for 30 min. followed by dusting with a fungicidal powder.

Cutting Propagation. The rooting medium should be free-draining, in acid in reaction, and sterile. Semi-hardwood material is the preferred type for cuttings. This usually develops in shoots that are 4 to 9 months old on the mother plant. Some wood as old as 18 months can be rooted by the use of higher rates of hormonal treatment. IBA is the best rooting hormone, and both powders and liquids have been effective in concentrations from 2,000 ppm to 8,000 ppm. Fungicides have not appeared to be detrimental when mixed in with powdered IBA. Some *Protea* species were sensitive to NAA as a rooting hormone (3), and we have limited its use to experimental treatments.

Bottom heat can initiate callus and roots quickly in some species (1). Many of the hard-to-root cultivars are kept on bottom heat for rooting; in some cultivars i.e. *P. repens* bottom heat is detrimental (3). Although it is not recommended, most *Protea* we grow is rooted on bottom heat. The frequency and duration of misting is quite variable among the many cultivars. Some do best if moistened once a day, with the rooting medium remaining dry; others require both regular misting and a moist rooting medium.

A general rule we use is an average of once per hour misting for 5 to 10 sec. at 19°C, with 70% humidity. Some indication can be obtained by the geography of the origin of various populations and how hot or moist their native environment is as to how much misting the cuttings require.

Transplanting. As with most crops, the handling of the transplants is very important. Our primary failures during transplanting were minimized by using a "plug" system. The roots remain undamaged or minimally damaged during transplant. The soil medium we use has always been a quick-draining acid mix. Over-

potting has been less successful than a plant "sized" to a container.

We selected deep "sleeves" that give air pruning. The plants in the "sleeves" are kept up off the ground to allow for air to prune the roots. They do not become rootbound. We try to transplant once a year.

Proteas that become rootbound have extreme difficulty adapting to other soils, even more so than other ornamental plants. We have found shade to be valuable in minimizing the shock at transplant. Transplants are held in shade for approximately 4 to 6 months or until adequate root system is developed in the new container medium and then they are moved into a full sun position.

Fertilization. Fertilizer is incorporated into the water and applied to each plant at every watering. Fertilizer concentrations are generally at a half rate compared to other ornamentals and no phosphate or potassium is used. Phosphate toxicity symptoms can develop rather quickly. We withhold nitrogen fertilizer from most of our plants during the late fall into early winter to avoid the tender growth that can be damaged by frost.

Pests and Diseases. Luckily most insect problems on our Proteaceae were left in the southern Hemisphere, although aphid, worm, scale, and thrip damage can be found among Proteaceae. Most of the disease problems that we do have in California are directly related to soils or lack of air circulation. The soil medium should be quick-draining as this tends to minimize the amount of *Phytophthora* and other soil pathogens. Good air circulation is very important for control of foliar fungi. Our nursery is primarily under shade cloth and allows for good air movement. Watering is generally done by a time clock in the early morning. Good air movement dries the leaves and we have a minimum of foliar fungi, although those listed below can occur.

1. *Colletotrichum gloeosporioides* infects, but is not limited to the genus *Protea*. It is favored by warm (25° to 28°C.) temperatures and leaf wetness during infection and can be identified by canker and lesions with red halos (4).
2. *Batcheloromyces proteae* is found on ecotypes of *Protea cynaroides* and little is known about its control and life cycle. The red spots are very evident on the plants' dark green leaves (4).
3. *Dreschlera* spp. are active in *Leucospermum* spp. plants and are most active at 20° to 22°C. during a period of leaf wetness. Red halos appear around sunken necrotic tissue on leaves (4).
4. *Elsinoe* spp. are also active on *Leucospermum* spp. plants. They are scab infections and are similar in appearance to citrus scab; infection again occurs during moist conditions. The corky tissue appears on both leaf and stem (4).

Good hygiene is certainly a contributor to success. Plants that do have foliar problems or seem unhealthy are removed from the nursery and destroyed.

CULTURAL APPLICATIONS

Many cultural applicatons have been discussed previously but the following reiterates some of the most important:

We moisten the media completely and thoroughly, allow the media to drain of all free water prior to the next irrigation. We water in the morning, minimizing overhead application. The plants are adapted to full sun by exposing them from the shade cloth area into full sun during periods of less intense solar conditions.

A site selection for Protea operation should incorporate good wind movement, a minimum of frost below 3°C., and soils that are free draining. Water quality should be good, low in lime and salts.

Many cultivars grow in coastal areas, while others grow inland and may consistently have summer temperatures above 30°C. Coastal cultivars generally do not do well inland and vice versa, though a few adaptable species will survive in both situations. Certain species may have populations in inland areas as well as coastal, upon mountains, and at low altitudes; the propagation and cultural success of species is governed greatly by which population the seed or cutting was selected from.

The selection criteria for propagation is similar to most floral and ornamental crops, although special attention should be paid for the general adaptation of the plant to various conditions; example, "normal garden watering," and higher phosphate soils. New protea cultivars that can tolerate a wide variety of conditions are certainly in demand within the floral and horticultural trades.

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