Protea Nursery Production Trial

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Seedling variation is commonly observed in commercial protea plantings throughout California. To select desirable characteristics and improve field stock, propagation by cuttings is becoming a necessity. This trial was established to facilitate the production of healthy nursery stock from cuttings for field transplanting. Death of container stock in the nursery has been a frequent problem, and growers are frustrated by the loss of young plants in the field. Loss of plants can usually be traced to three main problems: poor container media, pathogens (poor sanitation), and managerial problems related to irrigation and fertilization.

The first purpose of this trial was to evaluate selected container media with a range of physical properties. A fine-textured soil mix was used as an example of a poor-draining, low-air-porosity mix. Other mixes were suitable commercial preparations with varying water-holding capacities. The effect of pH was also tested with the use of two peat/perlite mixes adjusted to pH 5.5 and 7.5.

Second, two fungicide compounds were evaluated for prevention of the pathogen *Phytophthora cinnamomi.* This root-rot fungus has been isolated from field-planted specimens in San Diego County, and it is possible that cuttings taken near ground level could be contaminated. The extent of damage caused by this pathogen on proteas is as yet unknown; however, *P. cinnamomi* is widespread in the avocado-growing areas of the county, which are also favored for protea production.

This trial also evaluated container depths. California native plants, which require well-drained soils, are often grown in tall sleeves during nursery production. In South America, protea nursery plants are produced in sleeves and allowed to grow to 8 to 12 inches before being transplanted in the field. The benefits from improved container drainage and irrigation management were worth investigating for protea production.

TABLE 1. Physical Properties of Soil Mixes*

Components	pH	Water-holding capacity (P_V)	Air-filled porosity (E_a)	Total porosity (E)
		% by volume		
1. 50% sand, 25% fine peat, 25% RW sawdust	5.7	48.0	5.8	53.8
2. 25% RW shavings, 25% soil, 25% peat, 25% sand	6.4	54.0	16.4	70.4
3. 33% perlite, 33% sand, 33% RW shavings	6.0	37.0	17.5	54.5
4. 25% peat, 50% RW compost, 25% sand	6.3	60.0	16.8	76.8
5. 50% peat, 50% perlite	5.5	57.0	13.0	70.0
6. 50% peat, 50% perlite	7.3	57.0	13.0	70.0

*All measurements were taken on mixes following irrigation and drainage in 5-inch plastic pots. The water-holding capacity represents maximum water storage.

TABLE 2. Evaluation of Six Container Soil Mixes by Growth, Visual Ranking, and Survival at Two Growth Stages

Container mix	Pots 12 wk	Pots 20 wk	Tubes 12 wk	Tubes 20 wk
	GROWTH			
	cm	cm	cm	cm
1	0	0 d*	0	0 d*
2	2.9	4.9 ab	3.6	6.2 a
3	.2	0 d	3.2	4.8 ab
4	1.0	2.8 bc	1.3	1.3 cd
5	2.0	5.9 a	2.4	5.6 a
6	1.0	2.3 bcd	0.8	2.7 bcd
	VISUAL RANKING†			
1	0		0	
2	6.6		7.6	
3	0.1		4.7	
4	3.5		1.5	
5	7.9		7.3	
6	2.9		3.9	
	SURVIVAL			
	%	%	%	%
1	67	0	56	11
2	100	100	100	100
3	44	11	100	67
4	78	67	67	33
5	100	100	100	100
6	100	100	100	100

*Mean separation within columns at 20 weeks' growth by Duncan's multiple range test, 5% level.
† Visual ranking on scale of 0 to 10: 0 is low; 10 is high.

Materials and methods

One hundred fifty 15- to 20-cm (6- to 8-inch) cuttings of *Leucospermum cordifolium* (pincushion protea) were collected in late October 1977 from mature plants. Lateral breaks occurring after flower harvest are most commonly used for cuttings of proteas. All cuttings were dipped for 10 seconds in 4,000 ppm IBA and were placed in a rooting medium of 50-50 peat/perlite under mist with bottom heat. At 6 weeks, 98 percent of the cuttings had rooted and were ready for transplanting. Six soil mixes (table 1) were used in this experiment. Mixes 2, 3, and 4 were prepared and donated by local nurserymen. All mixes were sterilized, except

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Leaf Scorch of Narcissus
Progress Report

Arthur H. McCain, Lyle E. Pyeatt, and Louise Pierce

Leaf scorch caused by the fungus *Stagonospora curtisii* attacks *Amaryllis* and *Narcissus* species and some related genera. Early symptoms of the disease — blighted leaf tips — resemble frost or herbicide injury. Under wet conditions, the infection extends down the leaf, producing reddish brown elongated areas. Tissues around these areas turn yellow and wither, and the plants appear scorched. The fungus produces minute fruiting structures (pycnidia), which appear as small brown specks in the lesions. Spores exude from the pycnidia when water is present and are spread by splashing or by contact with equipment or workers. The infection may extend into the bulb, and in this manner it is introduced into new areas.

Treatment of bulbs with fungicidal dips is helpful. The disease can cause appreciable damage in plantings that remain in place for several years, as is done in cut flower cropping of Chinese sacred lily (*Narcissus tazetta*). In this situation, fungicidal sprays may aid in control of the disease. A trial to determine which fungicides are most effective was established with a grower of field-grown *N. tazetta*. The planting had been in place for three years, and the disease had been severe in the previous two years.

The fungicides were applied to runoff at two-week intervals using an air-pressurized garden sprayer. Applications were made from November 8, 1979 until March 20, 1980. Disease ratings were made periodically. Differences in the plots were not evident until February, probably because the disease is not active in cold weather. A final evaluation was made in March. Materials used and results are presented in the table.

Anilazine provided the best control followed closely by captan and mancozeb; however, none is registered for use for controlling the disease. Several copper-containing fungicides are registered, but in this trial the copper-containing fungicide was not nearly as effective as the first mentioned materials.

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Control of Narcissus Scorch with Fungicides

Product (active ingredient)	Concentration	Disease rating*
	lb/100 gal	
Dyrene (50% anilazine)	2.0	1.0
Captan (50% captan)	2.0	1.3
Fore (80% mancozeb)	1.5	1.5
Chipco 26019 (50% iprodione)	1.0	2.0
Daconil 2787 (75% chlorothalonil)	1.5	2.0
Tribasic (53% Cu, tribasic copper sulfate)	4.0	2.0
Tersan 1991 (50% benomyl)	0.5	2.3
Bayleton (25% triademefon)	0.5	3.0
Control (not sprayed)	—	3.0

*Average of four replications: 1 = light disease, good control; 2 = moderate disease, some control; 3 = severe disease, no control.

mixes 3 and 4. Table 1 summarizes their physical properties that are important in evaluating the results.

Each soil mix was placed in nine 5-inch plastic pots and nine 9-inch sleeves (tubes) formed by rolling and stapling squares of roofing paper. Each container held approximately 1 liter of soil mix. Cuttings were planted and kept under shade for 1 week, at which time they received one of the following fungicide treatments:

1. Ridomil (Ciba Geigy) 50W — 10 ppm active ingredient
2. Terrazole 4 pounds EC — 200 ppm active ingredient
3. Control — water only

Fungicides and rates were determined by initial experimentation on nursery plants of *Leucodendron argenteum* (silver tree protea).

Containers were placed on benches outdoors and irrigated when dry at a depth of 1 inch. (All containers received uniform fertilization with dilute Hoaglands solution every 2 weeks). The winter of 1977-78 was unusually wet; the plants received up to 25 inches of rainfall and were therefore exposed to wet soil conditions for weeks on end. Growth data were measured monthly, and dates of cutting death were recorded. Soil from declining cuttings was periodically cultured for the presence of soil-borne pathogens. The trial was ended at 20 weeks.

Results and discussion

Table 2 presents the growth response of cuttings averaged by soil media. Growth was measured as the change in height in centimeters. A visual ranking was used to accompany these data, which incorporated information on the number of breaks, quantity of new growth, and general appearance of the plant.

Soil mix 1, the fine-textured mix, possessed such low air-filled porosity that the young roots were unable to function in supporting growth. By 14 weeks, all the plants had essentially drowned. Soil mix 3, also with a low total porosity, is a very droughty mix with high air porosity but low water-holding capacity. Such a mix is hard to manage and demands frequent irrigation to prevent stress to young plants. A noticeable difference could be seen in growth response between shallow and deep containers with media 3. Average growth at the end of 12 weeks in pots was 0.2 cm, whereas plants in tall tubes grew an average of 3.2 cm.

Figure 1 compares the root systems of two cuttings grown in mix 5. Plant A, grown in the 9-inch sleeve, developed an extensive root system that was able to utilize a large portion of the container. Such a root system would be more adaptable than plant B to stress during production caused by inadequate or infrequent watering. It is more likely that the compact root ball of plant B would dry out under a missed irrigation or that growth would be reduced due to water stress. On transplanting, the larger root system of plant A provides a better balanced root-to-shoot ratio, which would ease

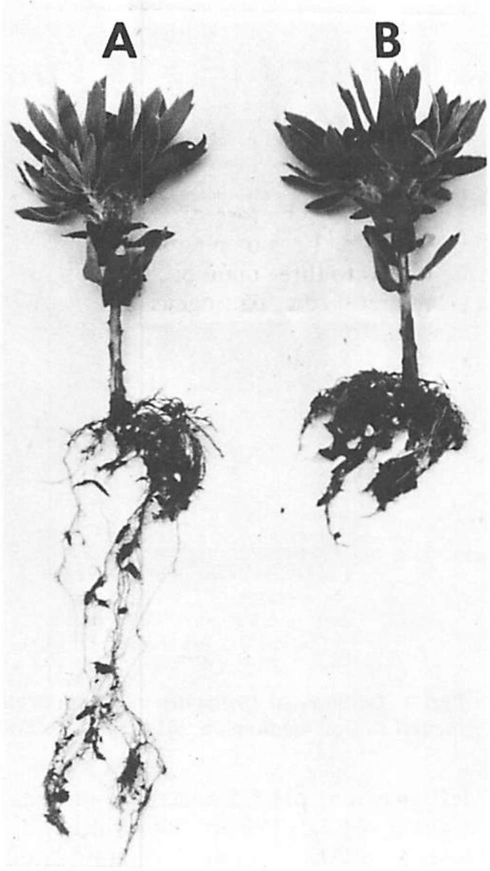
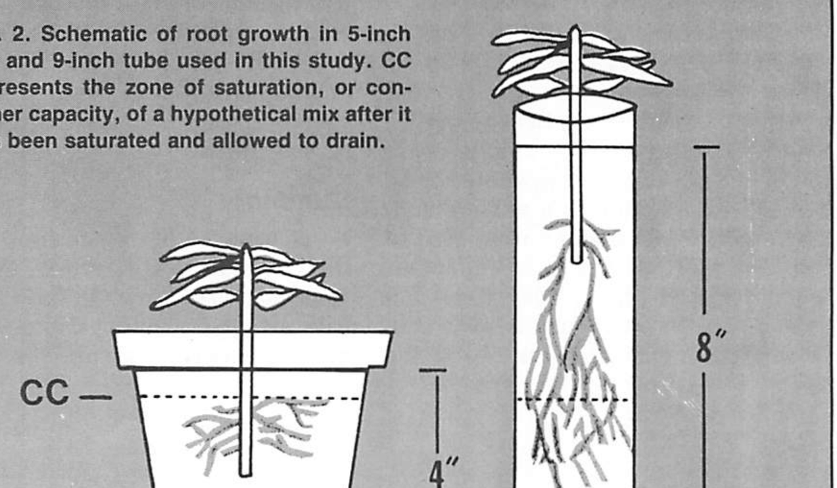


Fig. 1. Rooted cuttings of *Leucospermum cordifolium* grown for 20 weeks in a peat-perlite medium: (A) grown in 9-inch tube; (B) grown in 5-inch pot.

Fig. 2. Schematic of root growth in 5-inch pot and 9-inch tube used in this study. CC represents the zone of saturation, or container capacity, of a hypothetical mix after it has been saturated and allowed to drain.



transplant shock and hasten new growth.

Figure 2 presents a diagram of root growth variations with increased container depth. The dashed line (CC) represents the zone of saturation or container capacity of a mix after it has been saturated and allowed to drain. Properties of the mix (such as pore size and water-holding capacity of the amendments) determine the depth of this saturated zone. This depth for any particular mix is independent of the container depth, as this figure illustrates.

Optimal root growth in containers typically occurs in that fraction of soil with both available water for uptake to the plant and sufficient air porosity for root metabolism. The surface soil in containers usually dries rather quickly after irrigation, providing an unfavorable zone for root growth. Under frequent irrigation, much of the soil in a "shallow" container can remain at container capacity, thus confining root growth to the area between the extremes of dryness and saturation. When a deeper container is used in this situation, there is a large area for favorable root growth above the zone of saturation.

The remaining soil media tested all contained peat, an amendment with excellent water-holding capacity and porosity characteristics. Because native South African protea populations are found in acid soils, peat appeared to be a beneficial addition to a nursery container mix. Mixes 5 and 6 were used to test the effect of pH independent of other physical properties. Figure 3 shows representative plants grown in these identical mixes — those on the left grown at pH 5.5 and those on the right at pH 7.2. The growth results and visual ranking in table 2 demonstrate the marked benefit of using acid soil over a neutral medium. The averaged visual ranking in the pots of acid mix was 7.9 and that of the neutral medium 2.9.

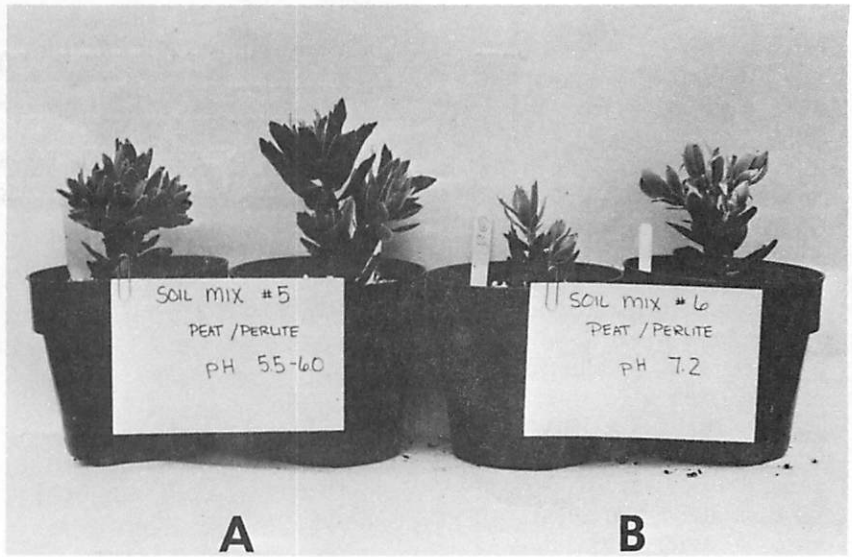


Fig. 3. Cuttings of *Leucospermum cordifolium* after 12 weeks of growth in peat-perlite media. A. Soil medium #5, pH 5.5-6.0. B. Soil medium #6, pH 7.2.

Fungicide treatments were inconclusive in this experiment, because no pathogenic organisms were isolated from the plants during the course of the study. There was no phytotoxicity apparent from these compounds, however, and their use as a preventive may be warranted.

Summary

Cuttings of pincushion protea showed marked differences in growth response when grown in the soil media with a range of physical properties. A balance between high porosity for adequate irrigation and good water-holding capacity to prevent water stress is essential in the nursery mix. Under conditions of poor aeration or low water-holding capacity, 9-inch tubes proved to be more easily managed than standard 5-inch pots. Larger root systems produced in the tubes would also be of benefit in transplant survival in the field.

Protea cuttings grew more rapidly and to a greater size in acid container media than in an identical neutral mix. The use of an amendment such as peat and maintenance of an acid soil pH would be recommended from this trial.

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