Evaluation of new introductions of South African plants from winter rainfall regions for California horticulture

Investigators

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Introduction

This goal of this project was to evaluate new South African plants for introduction into California, focusing on plants of the Western Cape, an area known for having a high diversity of woody species with ornamental appeal. Plants of South African origin already form a significant component of California ornamental plant palates. However, the majority of these plants come from the Eastern Cape, which experiences a bi-seasonal rainfall climate with summer rains. We selected and evaluated species from the Western Cape, which has a Mediterranean-style climate like Southern California.

Despite compatible climates, previous introductions from these areas have had limited success due to issues of soil nutrient conditions. The winter rainfall Western Cape is characterized by sandy, low pH soils. Many plants from this area adapt poorly to the richer and fine-textured clay soils of California. This project seeks to overcome this issue by matching soil conditions as well as climate conditions.

Materials and Methods

Plant Acquisition

The focus of this project was to introduce new taxa to the ornamental plant palate of California. As such, we sourced seeds directly from South Africa. Evan Meyer traveled to South Africa in October of 2018 to collect seeds from the Fynbos region of the Western Cape of South Africa. Stuart Hall, an expert in the flora of the Western Cape, joined the collection trip and assisted Evan Meyer in compiling a list of target taxa for the horticultural project. In total, seeds of 26 taxa were collected in the Western Cape. Seeds of a further 38 taxa were ordered from Silverhill Seeds, an established provider located in Cape Town, South Africa. Silverhill collects seeds from the region and has worldwide distribution.

Each seed collection was accessioned in the Mildred E. Mathias Botanical Garden plant records database and assigned a unique number. Detailed information on the collection locality, associated species and habitat, date, and collector(s) was included when available. Silverhill Seeds, however, does not provide this information.

Propagation

Plant Records Manager Sophie Katz researched native soil conditions and recommended seed treatment protocols and soil type for each species. She generated propagation data recording sheets for the Nursery technician to track seed pre-treatments, soil type, pot/flat type, germination success and fertilizer use. The Nursery technician, Theo Vuduris, also noted when seedlings were shifted to larger pots, tracked insect damage, noted losses and changes to soil types used. All seeds were sown 10” x 10” seed trays (Cat. No. 49-6190 from Grower’s Solution), except for *Nymania capensis*, which was sown in vented plug trays (Cat. No. 59-5025 from Grower's Solution) due to its exceptionally sensitive roots. The fertilizer used was Gro-Power 12-8-8 NPK extended release pellets. Smoke seed pretreatment was accomplished with a 24-hour soak in smoke-water solution made with Cape Seed Primer Super Smoker Plus.

Three soil types were used:

- M112 General purpose potting mix: 2 parts peat (Sunshine Professional Growing Mix #2), 2 parts Uni-Gro Potting soil, 1 part coarse pumice (3/16"), 1 part #2 vermiculite, 1 part washed plaster sand
- M132 Desert potting mix: 2 parts peat (Sunshine Professional Growing Mix #2), 2 parts Uni-grow Potting Soil, 6 parts 3/16" pumice, 1 part washed plaster sand.
- M155 Fynbos potting mix: 1 part peat (Sunshine Professional Growing Mix #2), 1 part washed plaster sand, 1 part coarse pumice (3/16")

Distribution

Prior to the start of this project, the following organizations agreed to accept plants and report whether they grew successfully: Huntington Library and Botanical Garden, San Diego Botanical Garden, San Francisco Botanical Garden, Los Angeles County Arboretum and Botanical Garden, University of California Botanical Garden at Berkeley, University of California Riverside Botanical Garden, and the University of California Santa Cruz Botanical Garden.

Results and Discussion

Seeds from a total of sixty different taxa were sown in November and December 2018. Table 1 lists the experimental taxa, corresponding accession numbers used in the plant records database, any seed pretreatment, and the soil mix used for sowing. Germination rate was calculated based on the number of seedlings obtained relative to the number of seeds sown and rated low (0-25%), medium (25-75%) and high (75-100%). Soil mix and fertilizer are described in Materials and Methods. Almost 40% of seeds failed to germinate, and there was no clear correlation between genera, soil type, or pretreatment and germination success (Table 1). Further experiments testing different germination conditions will be needed to optimize protocols for these species.

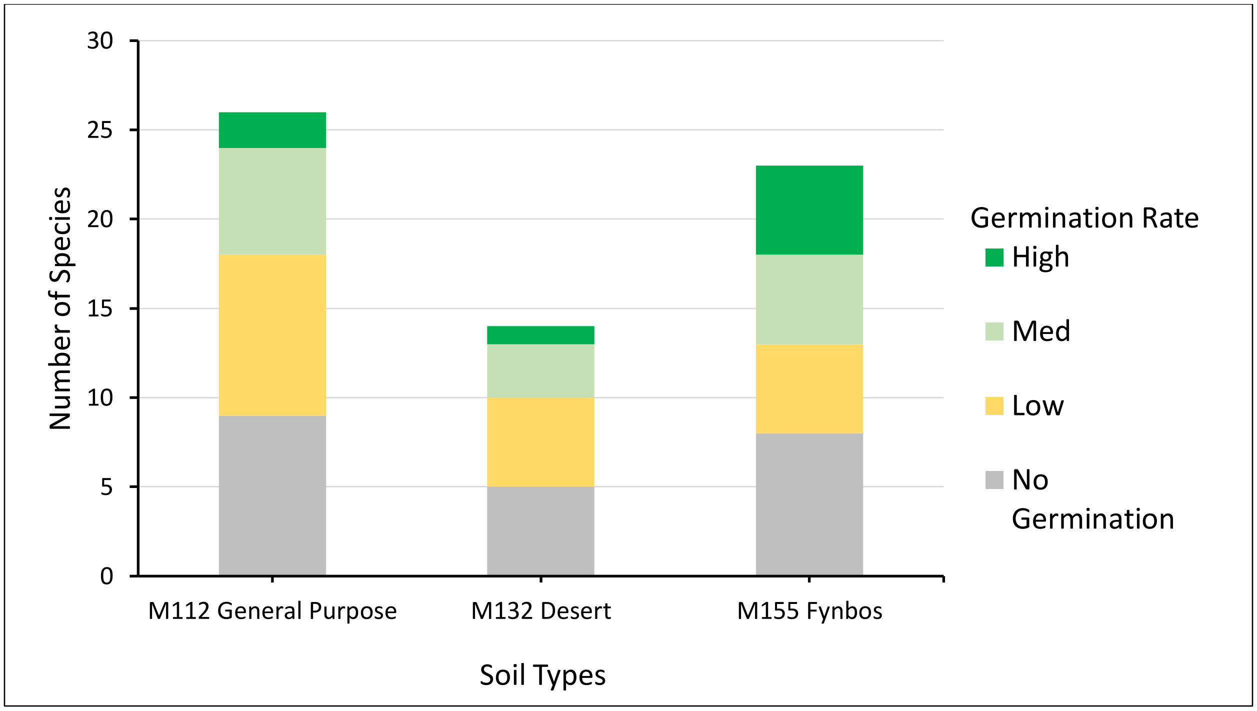

Figure 1. Germination success by soil type for all taxa assayed. Germination rate: 0-25% low; 25-75% medium; 75-100% high. Soil mix: M112 General Purpose mix; M132 Desert mix; M155 Fynbos mix.

The Fynbos mix (M155) used in this trial was a low nutrient mixture of peat moss, coarse pumice, and washed plaster sand at a 1:1:1 ratio. During periods of hot weather, the mix retained moisture well and was beneficial. However, its water-holding capacity encouraged dampening off and root rot of young plants of some species during stretches of cooler weather. The Desert mix (M132) used was a low nutrient mixture of peat moss, potting soil, coarse pumice, and washed plaster sand at a 1:1:3:0.5 ratio. Use of this mix resulted in the most success growing a wide range of species from both seed sources.

Of the species grown in the Fynbos mix, *Indigofera brachystachya*, *Gomphocarpus fruticosus*, *Podalyria myrtillifolia*, and *Podalyria sericea*, performed the most poorly. Seedlings that initially grew well then became stunted and began declining approximately six months after potting up. Of the two *I. brachystachya* seedlings initially obtained, only one in poor health survived. Nearly 50% of the *G. fruticosus* seeds germinated, resulting in forty-seven seedlings. However, forty seedlings died, with only seven plants in poor health remaining. Fewer *P. myrtillifolia* seedlings were lost, but the remaining ten seedlings were also in poor health. Although *P. sericea* seeds germinated readily, the majority of the forty-four resulting seedlings were in poor health. However, ten seedlings eventually outgrew their poor condition and looked very healthy compared to their cohorts. Of the four species, *P. sericea* seemed most tolerant of the Fynbos mix.

The proteaceous species generally performed well in the Fynbos mix, except for *Protea susannae* and *Leucadendron salignum*. Initially, *P.susannae* and *L. salignum* seedlings did not display issues with the soil mix. However, after approximately six months, thirteen seedlings of *Protea susannae* suddenly began showing signs of stress: yellowing/browning leaves and some to nearly all falling off. None of these distressed seedlings died, and the leafless individuals remain extant. Of the *Leucadendron salignum* seedlings, two began declining: one outgrew its poor condition, but the other died.

The mixed success growing these species in the Fynbos soil mix was likely due to the composition of the mix, the inappropriate use of the mix, and watering patterns. It was eventually discovered that the fynbos mix did not dry out evenly. When the top inch of the mix looked and felt dry, the mix below was still saturated. This resulted in more frequent watering than needed. It is possible that the soil mix was not blended homogenously, so batches of seedlings may have reacted to inconsistencies. Perhaps if aggregates of finer sizes and larger quantities were used, these materials would stay suspended in the peat providing more even drainage. Another possibility was that the proportion of peat moss was too high. Additionally, the overly-wet conditions may have been exacerbated by the 50% shade cloth and white plastic on our hoop houses, which would have reduced the rate of evaporation/transpiration. With that said, the mix has been generally successful with proteaceous species and species with higher water requirements, like *Chironia baccifera* and *Orphium frutescens*.

Our trial showed that the Fynbos mix is inappropriate for growing *I. brachystachya*, *G. fruticosus*, *P. myrtillifolia*, and *P. sericea*. It is possible that seedlings grown in this mix may have a higher rate of success when grown in full sun or in climates hotter and drier than western Los Angeles. However, we may have achieved greater success if they were grown in our Desert mix. Evidence of other species with similar needs from the same sources growing well in desert mix support this.

During the autumn of 2019, three *Solanum tomentosum*, fifteen *Lessertia frutescens* seedlings, and two *Pteronia adenocarpa* seedlings were planted out in the garden (Photos 5-7). Planting sites were amended with handfuls of large pumice to increase drainage in our clay soils. Seedlings received supplemental watering until the end of May 2020. Of the three species, *Lessertia frutescens* performed poorly with all fifteen individuals dying in early summer after blooming profusely in the spring. This suggests that *L. frutescens* requires more consistent watering to establish. In addition, seedlings were planted on a slight slope, making deep watering more challenging. Despite being unestablished, *S. tomentosum* and *P. adenocarpa* seedlings survived in the landscape without supplemental summer watering until late August. All three *S. tomentosum* individuals lost 90% of their foliage in response, but stems were turgid and two fruited (Photo 5, at time of planting). Neither *P. adenocapra* individuals showed any signs of stress until a record-breaking heatwave in August when approximately 5% of the leaves browned. This early drought tolerance may be due to milder climate of west Los Angeles, so these species may need more frequent supplemental watering to establish in hotter and drier climates.

Seedlings were slated to be distributed to collaborating botanical gardens in California in early spring 2020 (see list of collaborating institutions in Materials and Methods and Table 2). However, this plan was delayed by the COVID-19 pandemic and related shutdowns. As restrictions eased and new protocols were established, the newly-installed assistant director of the garden, Terence Huang, proceeded with distribution in August and September 2020. The most successful taxa, *Lobelia valida* (Photo 3), *Protea susannae*, and *Hymenolepis crithmifolia*, were distributed in the highest numbers. In total, seedlings from twenty-three taxa were disseminated to gardens in Northern and Southern California. We also plan to plant out the remaining seedlings for each taxon in the fall when the weather cools.

Conclusion

In spite of the unforeseen delays due to the COVID-19 pandemic, the project overall was a success. Of the 59 taxa sown, 40 were cultivated successfully and 23 were shared with partner institutions. We had mixed results growing seedlings in the Fynbos mix due to the high peat content and disproportionately lower amounts of aggregates, though it was generally successful with proteaceous species and taxa with higher water requirements, like *Chironia baccifera* and *Orphium frutescens*. The General Purpose M112 potting mix was suitable for starting seeds, as long as seedlings were pricked out and transplanted into a well-drained mix such as the M132 Desert mix for growing on. The majority of taxa preformed the best in our Desert mix, showing that these species require excellent drainage. The Fynbos mix can be improved by adding more aggregates for drainage. With the success of *Solanum tomentosum* and *Pteronia adenocarpa* in the garden, we look forward to planting out the remaining taxa and evaluating their adaptability to our richer and fine-textured clay soils. We hope to introduce more taxa from our trials as they prove themselves to be good candidates for Californian gardens.

Table 1. List of experimental taxa, germination conditions and success. Germination rate: 0-25% low; 25-75% medium; 75-100% high. Soil mix and fertilizer are described in Materials and Methods; M112 General Purpose mix, M132 Desert mix, M155 Fynbos mix.

MEMBG Accession	Taxon Name	Seed Pretreatment	Soil Mix (Sowing)	Germination Rate	Time to first shift	Soil Mix (Seedlings)	Fertilizer
2018-137	*Arctopus echinatus*	None	M112	Low	6 months	M132	GP
2018-138	*Arctotis revoluta*	None	M112	No germination			
2018-139	*Arctotis revoluta*	None	M112	No germination			
2018-140	*Arctotis revoluta*	None	M112	No germination			
2018-141	*Lycium sp.*	None	M112	Medium	3.5 months	M132	GP
2018-142	*Salvia africana-lutea*	None	M112	Medium	3.5 months	M132	GP
2018-143	*Othonna macrophylla*	None	M112	Low	6 months	M132	None
2018-144	*Othonna retrorsa*	None	M112	Low	6 months	M132	None
2018-145	*Solanum tomentosum*	None	M112	Medium	3 months	M132	None
2018-146	*Searsia incisa*	None	M112	Low	3 months	M112	None
2018-147	*Widdringtonia wallichii*	None	M112	Medium	3 months	8 shifted to M132, 3 M112	GP for seedlings in M132 mix
2018-148	*Olea europea ssp. africana*	None	M112	Medium	4 months	M132	GP
2018-149	*Osteospemum corymbosum*	None	M112	No germination			
2018-150	*Cyclopia genistoides*	None	M112	Low	3 months	M132	None
2018-151	*Senecio acaulis*	None	M112	High	9 months	M132	None
2018-152	*Melianthus comosus*	None	M112	Low	2.5 months	M112	None
2018-153	*Searsia glauca*	None	M112	Low	2.5 months	M132	GP
2018-154	*Diospryos lyciodes*	None	M112	No germination			
2018-155	*Lessertia frutescens*	None	M112	High	3 months	M132	GP
2018-156	*Anisodontea scabrosa*	None	M112	No germination			
2018-157	*Berkeya coriacea*	None	M112	No germination			
2018-158	*Muraltia spinosa*	None	M112	No germination			
2018-159	*Pteronia adenocarpa*	None	M112	Low	2.5 months	3 shifted to M132, 2 M112	GP for seedlings in M132 mix
2018-160	*Pittosporum viridifolium*	None	M112	Medium	3 months	M112	None
2018-161	*Cussonia spicata*	None	M112	No germination			

2018-162	*Diospryos lyciodes*	None	M112	Low	3 months	2 shifted to M132, 3 M112	GP for seedlings in M132 mix
2019-103	*Erica versicolor*	Smoke	M155	No germination			
2019-104	*Artemisia afra*	None	M132	No germination			
2019-105	*Chironia baccifera*	None	M155	Medium	2 months	M155	None
2019-106	*Clutia polygonoides*	None	M155	Medium	6 weeks	M155	None
2019-107	*Gomphocarpus physocarpus*	24hr soak in water	M155	No germination			
2019-108	*Helichrysum patulum*	None	M132	No germination			
2019-109	*Lebeckia sepiaria*	Scarification	M155	Medium	2 weeks	M155	None
2019-110	*Lobelia valida*	None	M132	High	1 month	M132	None
2019-111	*Orphium frutescens*	None	M155	High	6 weeks	M155	None
2019-112	*Leucadendron galpinii*	Smoke	M155	Low	2 months	M155	None
2019-113	*Leucadendron meridianum*	Smoke	M155	High	1 month	M155	None
2019-114	*Leucadendron muirii*	Smoke	M155	No germination			
2019-115	*Leucadendron salignum*	Smoke	M155	High	1 month	M155	None
2019-116	*Leucospermum grandiflorum*	24hr soak in smoke with 1% H2O2	M132	Low	2 months	M132	None
2019-117	*Leucospermum muirii*	Smoke	M155	Low	6 weeks	M155	None
2019-118	*Leucospermum patersonii*	24hr soak in 1% H2O2, then remove seed coat.	M132	Low	2 months	M132	None
2019-119	*Protea obtusifolia*	Dip in 10% bleach solution; Smoke	M155	No germination			
2019-120	*Protea susannae*	Dip in 10% bleach solution; Smoke	M155	High	2 months	M155	None
2019-121	*Agathosma apiculata*	Dip in 10% bleach solution	M155	Low	2 months	M155	None
2019-122	*Agathosma capensis*	Dip in 10% bleach solution	M155	No germination			
2019-123	*Ehretia rigida*	None	M155	No germination			
2019-124	*Euclea racemosa*	Soak 24hr in lukewarm water	M155	No germination			
2019-125	*Euryops brevipapposus*	None	M132	No germination			

2019-126	*Euryops lateriflorus*	None	M132	Low	2 months	M132	None
2019-127	*Euryops linearis*	None	M132	No germination			
2019-128	*Euryops rehmannii*	None	M132	Medium	1 month	M132	None
2019-129	*Euryops speciosissimus*	None	M132	Medium	3 weeks	M132	GP
2019-130	*Euryops thunbergii*	None	M132	No germination			
2019-131	*Gomphocarpus fruticosus*	Soak 24hr in warm water	M155	Medium	1 month	M155	None
2019-132	*Hymenolepis crithmifolia*	None	M132	Medium	3 weeks	M132	None
2019-133	*Indigofera brachystachya*	Smoke	M155	Low	3 weeks	M155	None
2019-134	*Lobostemon belliformis*	Smoke	M132	Low	1 month	M132	None
2019-135	*Nymania capensis*	None	M132	Low	N/A	M132	None
2019-136	*Otholobium bracteolatum*	Dip in 10% bleach solution	M155	Low	1 month	M155	None
2019-137	*Podalyria myrtillifolia*	Dip in 10% bleach solution, 24hr soak in water	M155	Medium	1 month	M155	None
2019-138	*Podalyria sericea*	Dip in 10% bleach solution, 24hr soak in water	M155	High	3 weeks	M155	None
2019-139	*Ozoroa paniculosa*	24hr soak in water	M155	No germination			

Table 2. Seedlings distributed to collaborating institutions, retained at MEMBG, grouped by assesment of overall success.									
MEMBG Accession	**TaxonName**	**UCB**	**SFBG**	**LACA&BG**	**SDBG**	**HBG**	**UCR**	**UCSC**	**Retained at MEMBG**
High overall success									
2018-151	*Senecio acaulis*	1	2	3	3	3	3	Upcoming	5
2018-155	*Lessertia frutescens*	1	-	3	1	2	1	Upcoming	2
2019-110	*Lobelia valida*	6	15	7	6	6	-	Upcoming	33
2019-120	*Protea susannae*	10	10	5	6	6	6	Upcoming	19
2019-129	*Euryops speciosissimus*	-	-	5	1	5	-	Upcoming	28
2019-132	*Hymenolepis crithmifolia*	10	-	10	10	10	-	Upcoming	144
2019-138	*Podalyria sericea*	3	3	5	5	5	3	Upcoming	32
Medium overall success									
2018-141	*Lycium sp.*	-	-	-	-	-	-	-	12
2018-142	*Salvia africana-lutea*	1	1	1	1	1	-	Upcoming	3
2018-145	*Solanum tomentosum*	2	-	-	2	2	-	Upcoming	3
2018-147	*Widdringtonia wallichii*	-	2	1	2	2	2	Upcoming	2
2018-148	*Olea europaea subsp. africana*	-	2	1	1	1	-	Upcoming	3
2018-160	*Pittosporum viridiflorum*	-	1	1	1	1	-	Upcoming	4
2019-105	*Chironia baccifera*	-	3	-	1	1	-	Upcoming	6
2019-106	*Clutia polygonoides*	-	-	-	-	-	-	-	6
2019-111	*Orphium frutescens*	-	-	-	-	-	-	Upcoming	50
2019-112	*Leucadendron galpinii*	1	-	1	1	1	-	Upcoming	3
2019-113	*Leucadendron meridianum*	1	-	1	1	1	-	Upcoming	3
2019-115	*Leucadendron salignum*	-	1	1	1	1	2	Upcoming	5
2019-117	*Leucospermum muirii*	2	2	1	1	1	2	Upcoming	6
2019-131	*Gomphocarpus fruticosus*	-	-	-	-	-	-	Upcoming	7
2019-135	*Nymania capensis*	2	-	-	1	2	2	Upcoming	5
2019-137	*Podalyria myrtillifolia*	2	3	2	2	2	-	Upcoming	4
Low overall success									
2018-137	*Arctopus echinatus*	-	-	-	-	-	-	-	10
2018-143	*Othonna macrophylla*	-	-	-	-	2	-	Upcoming	6
2018-144	*Othonna retrorsa*	-	-	-	1	1	-	Upcoming	3
2018-146	*Searsia incisa*	-	-	-	-	-	-	-	1
2018-150	*Cyclopia genistoides*	-	-	-	-	-	-	-	1
2018-152	*Melianthus comosus*	-	-	1	1	1	1	Upcoming	3
2018-153	*Searsia glauca*	-	-	-	-	-	-	-	1
2018-159	*Pteronia adenocarpa*	-	-	-	-	-	-	-	3
2018-162	*Diospryos lyciodes*	-	-	-	-	-	-	-	3
2019-109	*Lebeckia sepiaria*	-	-	-	-	-	-	-	1
2019-116	*Leucospermum grandiflorum*	-	-	-	-	-	-	-	-
2019-118	*Leucospermum patersonii*	-	-	-	-	-	-	-	1
2019-121	*Agathosma apiculata*	-	-	-	-	-	-	-	2
2019-126	*Euryops lateriflorus*	-	-	-	-	-	-	-	2
2019-128	*Euryops rehmannii*	-	-	-	-	-	-	-	5
2019-133	*Indigofera brachystachya*	-	-	-	-	-	-	-	1
2019-134	*Lobostemon belliformis*	-	-	-	-	-	-	-	1

Photo 1. Seedlings in the shadehouse, Summer 2020.

Photo 2. *Euryops speciossimus* in the shadehouse.

Photo 3. *Lobelia valida* seedling in bloom.

Photo 4. *Nymania capensis* seedlings germinated and grown in individual plugs.

Photo 5. Three *Solanum tomentosum* seedlings planted out in December 2019.

Photo 6. Group planting of *Lessertia frutescens* on a slope in December, 2019.

Photo 7. *Pteronia adenocarpa* planted in December 2019 and photographed in August 2020.