

COMMERCIAL PRODUCTION AND MARKETING OF SUCCULENTS IN NORTHERN CLIMATES*

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Most succulents sold in the trade are xerophytes, which store water in their leaves or stems. They can survive and grow for long periods in arid and saline environments. The succulent group includes cacti, but also includes plants from at least 46 other families which offer a wide range of color, form and beauty.

The jade plant (*Crassula argentea*), the kalanchoe (*Kalanchoe blossfeldiana*) and the snake plant (*Sansevieria trifasciata*) and all their cultivars are examples of succulents which have a long history of popularity and are familiar to most consumers. The succulent group may include many other new flowering and foliage plants.

Recently, consumers have developed an interest in succulents. As consumer demand has increased, production of many succulent species, especially cacti, also has increased.

Many succulents grow exclusively in desert-like environments. As a result, many myths have developed about germination, development, cultivation and home care. Unfortunately, succulents are often considered difficult to grow because it is believed they require high light intensities and grow best with infrequent watering and fertilization. This is not wholly correct.

Research results (conducted at Cornell University) indicate that many of the accepted notions about succulent production are untrue, and that year-round commercial production is

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possible in the northern states. All of the more than 200 species and cultivars studied seem to respond well to frequent watering, fertilization and good cultural practices-- as do most other ornamental crops.

SEXUAL PROPAGATION--Seed propagation is easy and seed is relatively inexpensive. Many of the common species and cultivars cost less than 1¢ per seed and have high germination percentages. Systems are available whereby growers can produce salable 2 1/4-inch potted plants from seed in less than six months. Table 1 contains a

Table 1. Succulents which can be grown to salable 2 1/4-inch pots from seed. The list includes only plants actually grown; 36 species were studied. Additional species should be grown on a trial basis.

| Salable plants within six months | Salable plants within 12 months |
|-------------------------------------|------------------------------------|
| <i>Agave victoriaereginae</i> | <i>Astrophytum myriostigma</i> |
| <i>Aloe ferox</i> | <i>Carnegia gigantea</i> |
| <i>Cephalocereus</i> | <i>Cephalocereus palmerii</i> |
| <i>chrysacanthus</i> | <i>Echinocactus ingens</i> |
| <i>Cereus peruvianus</i> | <i>Echinocactus grusonii</i> |
| <i>Crassula falcata</i> | <i>Espostoa lanata</i> |
| <i>Echinocereus</i> | <i>Ferocactus latispinus</i> |
| <i>dasyacanthus</i> | <i>Ferocactus wislizenii</i> |
| <i>Mammillaria bocasana</i> | <i>Gymnocalycium</i> |
| <i>Mammillaria columbiana</i> | <i>michanovichii</i> |
| <i>Mammillaria elegans</i> | <i>Melocactus metazanus</i> |
| <i>Mammillaria elongata</i> | <i>Rebutia senilis</i> |
| <i>Mammillaria hahniana</i> | |
| <i>Mammillaria spinosissima</i> | |
| <i>Oreocereus celsianus</i> | |
| <i>Oreocereus trollii</i> | |
| <i>Pachycereus pringlei</i> | |
| <i>Stetsonia coryne</i> | |
| <i>Trichocereus chilensis</i> | |
| <i>Trichocereus pachanoi</i> | |
| <i>Trichocereus spachianus</i> | |

list of succulent species easily grown from seed. Species such as *Aloe ferox*, *Cereus peruvianus* and many of the mammillarias grow very quickly and can be sold in 3- or 4-inch pots in less than one year. Seed can be sown in flats or in small market packs as pictures in Figure 1. (These seedlings are about five months from a March sowing.)

Seed usually germinates in three to 14 days if given ample moisture, 75°F (24°C) medium temperature, and a light intensity (under fluorescent light) of approximately 1,500 footcandles for 18 hours a day. The medium temperature should not go below 70°F (21°C) nor above 85°F (29°C), or germination will be delayed. Seed are surface-sown and can be germinated under intermittent mist or in flats covered with glass. Rapid germination is possible in growth rooms where temperature and light are controlled. Commercial seedling mixes (peat-perlite or peat-vermiculite) are used successfully; mixes containing sand may dry out too fast and are not recommended. Fine seed will settle between coarse sand particles; this settling may slow or reduce germination.



Figure 1. Seedlings five months after sowing.

If mist is used, it should be frequent enough to keep the seed and medium moist, and reduced after most of the seed has germinated (usually within 14 days). Young seedlings should be misted in the morning, and the medium surface should dry before evening to reduce damping-off. Some species, such as *Astrophytum myrystigma* and *Espostoe lanata* are very susceptible to damping-off.

Seedlings grown under nutrient mist using a complete nutrient fertilizer with 100 ppm nitrogen developed faster than seedlings not fertilized, or seedlings fertilized at other nutrient levels. Some species can be transplanted in three to four months; however, most succulents appear to grow fastest when left crowded together (such as *Agave victoria reginae* in Figure 2).

Most seed can be sown any time of the year, but are best sown in February or March. Natural light intensities are adequate for rapid and



Figure 2. Eight-month-old *Agave victoria reginae*, from seed, in 5 x 7 pack.

uniform germination in the greenhouse and many species can be ready for sale in 2 1/4-inch or 3-inch pots by the following fall.

VEGETATIVE PROPAGATION--Many succulents propagate vegetatively with ease and grow rapidly (Table 2). Cuttings generally can be taken any time of the year and rooted directly in the finished pot. Most species studied rooted in three to four weeks. Pots were usually spaced pot-to-pot, and this resulted in efficient space utilization. Most species rooted well under intermittent mist. However, some rosette forms collected water and the leaves were damaged.

Misting should cease after noon to allow the medium to dry and help reduce disease problems. Rooting is equally satisfactory without mist if the medium is kept moist and if it is well-drained. A well-drained medium, 1/2 peat, 1/2 perlite, is suitable for propagation and growth of all succulent species studied (Table 3). Cuttings should be rooted at 70°F (21°C). Bottom heat is beneficial when medium temperatures are 70°-75°F (21°-24°C).

There is no need to let most cuttings callus before sticking. Some cacti and euphorbias exude a milky latex; this will stop within an hour. These succulents can also be stuck without waiting for them to dry. No benefit is gained by allowing unrooted succulent cuttings to lie in the sun for several days or weeks, as is sometimes recommended, although many species survive.

Stock plants are easy to produce and to maintain. Building stock plants for winter propagation can be an ideal way to use summer space. Leaves may be propagated from species such as *Kalanchoe tomentosa*, *Crassula argentea* and hundreds of other succulents. Many species have dormant buds in the leaves at

Table 2. Succulents easily propagated from cuttings, offsets or plantlets. This list includes only plants actually grown; more than 200 species were studied. Many additional species and cultivars could also be included.

| | |
|--------------------------------|----------------------------------|
| <i>Aeonium haworthii</i> | <i>Hylocereus undatus</i> |
| <i>Aichryson x domesticum</i> | <i>Kalanchoe blossfeldiana</i> |
| <i>Agave americana</i> | <i>Kalanchoe</i> |
| <i>Aloe barbadensis</i> | <i>daigremontiana</i> |
| (<i>Aloe vera</i>) | <i>Kalanchoe fedtschenkoi</i> |
| <i>Aloe humilis</i> | <i>Kalanchoe marmorata</i> |
| <i>Aloe nobilis</i> | <i>Kalanchoe tomentosa</i> |
| <i>Aloe variegata</i> | <i>Kalanchoe tubiflora</i> |
| <i>Chamaecereus sylvestri</i> | <i>Mammillaria elongata</i> |
| <i>Crassula arborescens</i> | <i>Opuntia cylindrica</i> |
| <i>Crassula argentea</i> | <i>Opuntia glomerata</i> |
| <i>Crassula lactea</i> | <i>Opuntia linguiformis</i> |
| <i>Crassula lycopodioides</i> | ' <i>Maverick</i> ' |
| <i>Crassula perforata</i> | <i>Opuntia microdasys</i> |
| <i>Crassula pyramidalis</i> | <i>Opuntia vulgaris</i> |
| <i>Crassula schmidtii</i> | <i>Portulacaria afra</i> |
| <i>Echeveria affinis</i> | <i>Portulacaria afra</i> |
| <i>Echeveria pulvinata</i> | var. <i>variegata</i> |
| <i>Echeveria retusa</i> | <i>Rhipsalidopsis gaertnerii</i> |
| <i>hybirds</i> | <i>Sansevieria</i> spp. |
| <i>Echinopsis oxyagona</i> | <i>Schlumbergera bridgesii</i> |
| <i>Euphorbia lactea</i> | <i>Sedum adolphi</i> |
| <i>Euphorbia milii</i> | <i>Sedum dasyphyllum</i> |
| <i>Euphorbia resinifera</i> | <i>Sedum mexicanum</i> |
| <i>Euphorbia tirucalli</i> | <i>Sedum morganiianum</i> |
| <i>Graptopetalum McDouglii</i> | <i>Sedum x Graptopetalum</i> |
| <i>Graptopetalum</i> | <i>Sedum pachyphyllum</i> |
| <i>paraguayense</i> | <i>Sedum x rubrotinctum</i> |
| <i>Harrisia tortuosa</i> | <i>Sempervivum</i> spp. |
| <i>Haworthii reinwardtii</i> | <i>Senecio herreianus</i> |
| <i>Hoya bella</i> | <i>Stapelia gigantea</i> |
| <i>Hoya carmosa</i> | |
| <i>Huernia</i> spp. | |

Table 3. Summary of cultural methods for commercial propagation and growth of succulents.

Medium: Grow in a peat-perlite (1:1) medium.

| AMOUNT FOR 1 CUBIC YARD | | AMOUNT FOR 1 CUBIC METER |
|-------------------------|------------------------|--------------------------|
| .5 yd ³ | shredded peat | .5 m ³ |
| .5 yd ³ | coarse #2 perlite | .5 m ³ |
| 10.0 lbs | calcium limestone | 6 kg |
| 1.0 lbs | superphosphate | 600 g |
| 1.5 lbs | calcium nitrate | 400 g |
| 2.0 oz | fritted trace elements | 74.0 g |
| 3.0 oz | granular wetting agent | 100 g |

FERTILITY: Fertilize with 200 ppm N and K plus trace elements (Compound 111) with each watering; 100 ppm N-P-K plus trace for seedlings.

WATERING: Water frequently: Daily during the summer, and when medium surface is dry the remainder of the year.

CONTAINER: Plastic or clay pots.

TEMPERATURE: Plants grow rapidly at 62°F (17°C) nights and 70 to 75°F (21 to 24°C) days. Optimal temperature depends upon species; however, quality appears superior when plants are grown at 50°F (10°C) nights.

LIGHT: Seedlings should be shaded during the summer. Most other plants should be grown in greenhouses with the highest light intensity, although there are some exceptions, such as several of the Haworthia species.

PEST CONTROL: Follow a regular spray program to keep mealybugs and other occasional pests under control. Malathion as a wettable powder is an effective control for mealybugs. Do not use in an oil base.

the base of the petiole. Adventitious roots and shoots develop quickly when leaves are detached and laid face up on the medium surface. Leaves and medium should be kept moist and the petiole should not be covered (Figure 3). Some species such as *Kalanchoe daigremontiana* form plantlets (Figure 4) and initiate roots while still attached to the parent plant. These will fall off (Figure 5), or they can be removed and then grown. Many plants are quickly generated from a few. Cuttings can then be taken year-round, rooted and sold in less than a month.

CULTURE--Maximizing growth of succulent crops requires cultural practices similar to many other horticultural crops. Good light is essential but light intensities similar to those found in the deserts are not necessary. In fact, some of the best succulent collections in the world, such as the one at Kew Gardens in England or at the Kiel Botanic Gardens in Germany, are grown in areas with relatively little sunshine.



Figure 3. Sedum plants propagated from detached leaves.

In the northern U.S., spring and fall appear to be the best periods for growth. Summer intensities are ideal for many succulents, but may be too high for some species and some seedlings. Shading can be beneficial even for some mature plants such as some of the haworthia species. Unquestionably, light is

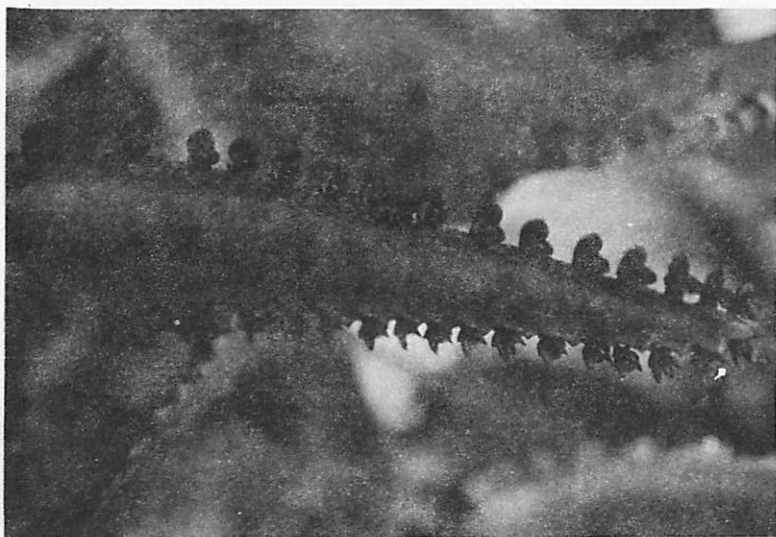


Figure 4. Plantlets on mature *Kalanchoe daigremontiana*.



Figure 5. Plantlets fell from parent *K. daigremontiana* and rooted.

the limiting factor during the winter. Experiments with supplemental high-intensity lights at 1,000 footcandles for 18 hours a day resulted in doubling of the dry weight compared to unlighted plants for 12 species grown in 3-inch pots in just 13 weeks.

Nutritional studies conducted during the winter and summer without supplemental lighting showed that 10 species of plants fertilized with 200 ppm nitrogen and potassium plus trace elements had twice the dry weight over unfertilized plants after 10 weeks. In addition to emphasizing the importance of nutrition for succulents, this work also showed that, even during



Figure 6. Specimen *Kalanchoe tomentosa* in 6-inch pot.

December, January and February, there was substantial growth of plants when given adequate water, nutrients and growing temperatures.

During the summer, plants are watered and fertilized every day. To maximize production, watering could be increased to twice a day during very hot periods. During the winter, plants are watered every two or three days. Watering is always done in the morning.

Night temperatures of 62°F (17°C) and day temperatures of 70-75°F (21-24°C) are suggested although higher quality may be obtained at lower night temperatures. Plants grown in the perlite (1:1) medium rooted faster and grew larger than



Figure 7. *Senecio herreianus* grown in 6-inch hanging basket.

plants grown in mediums containing sand. The mix used is a slightly modified Cornell peat-lite medium developed by Boodley and Sheldrake (1). The pH should be around 6.0. The recommended medium is shown in Table 3 (page 14).

Insect pests and diseases with succulents are few. Mealybugs present the most serious and persistent problem. Scales, aphids and mites are occasional problems. Malathion is recommended for control of mealybugs. However, the oil base formulation, not the pesticide, is phytotoxic (2). Malathion used as a wettable powder is effective and does not appear phytotoxic. A regular spray program is suggested, especially for stock plants, to keep chronic mealybug infestations under control.

Succulents store well in cool conditions if watering is reduced or eliminated. Succulents which have salable size may be held for long periods at low temperatures until sold. Plants from more than 50 species were kept at 50°F (10°C) nights and not watered for three months. After watering was resumed, the plants were salable within one to two weeks. Watering once a week or every other week is recommended



Figure 8. Flowering *Mammillaria elegans* grown from seed.

when plants are held for long periods of time. Plants should be shipped dry to reduce chances for disease and to reduce freight costs if weight is a factor.

Overall, succulents are easy and inexpensive to grow. They tolerate a low night temperature and are a good energy-saving crop. Stock flats and seedling trays can be grown and maintained at low cost. Plants are usually spaced pot-to-pot and can be sold one to two months after rooting or transplanting into 2 1/4-inch or 3-inch pots. Many succulent species, especially cacti, can be grown from seed within six to 12 months, and some will be in flower by that time. Total space used per plant is very little, and the return per square foot can be very high.

There are many succulents which could easily achieve the popularity and sales volume of the kalanchoe, jade and snake plants. More effort is needed to select species, breed cultivars and develop production schedules. Succulents are very diversified and easy to produce and maintain. They should be considered seriously by more growers.

Literature cited:

1. Boodley, J.W. and R. Sheldrake Jr. 1977. *Cornell peat-lite mixes for commercial plant growing. Information Bulletin 43, Cornell University, Ithaca, N.Y.*
2. *Cornell Recommendations for Commercial Floriculture Crops, Part II, Disease, Pest and Weed Control.* 1977. New York State College of Agriculture and Life Sciences.

EDITOR'S NOTE: *The water at Cornell University where this was written contains an appreciable amount of calcium. For areas with low calcium waters such as we have at the University of Connecticut, 15 lbs. dolomitic limestone is recommended. We also recommend at least three to five lbs. 0-20-0 superphosphate. It should be noted that "200 ppm N and K" is really N and K₂O. For most crops we find that 200 ppm N and 240 K₂O provides a better N:K balance (as obtained with 15-0-18 from a 3:2 ratio of calcium and potassium nitrates using 18 oz/100 gals.).*