

## Propagation Methods for *Agave*®

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**There has been an increase in interest in succulent plants, including agaves, likely because people are becoming more conscious of the need to reduce water use in their landscapes. There is also better availability of agaves because of advances in propagation methods. This talk will address the propagation methods we use at our nursery, including seed propagation, rhizome cuttings, planting bulbils produced in the inflorescence and the division of pups, both naturally forming and those induced by damaging meristematic tissue. The general principles of micropropagation for this group of plants will also be discussed.**

### INTRODUCTION

*Agave* is a genus of succulent monocotyledons grouped taxonomically with other plants that in the past were placed in the Liliaceae, then Amaryllidaceae and currently in the Agavaceae. The Agavaceae also includes the genera *Beschorneria*, *Furcraea*, *Hesperaloe*, *Hesperoyucca* (syn. *Yucca*), *Manfreda* (syn. *Agave*), *Polianthes*, and *Yucca* though recent treatment has merged *Manfreda* and *Polianthes* into *Agave* (Thiede, 2001). There are over 200 species in the genus with a main concentration from Mexico and 15 species within the boundaries of the United States with the rest distributed through Central America and the Caribbean basin (including Venezuela). They are found from arid deserts to lush forests from sea level to 7,000 ft (Irish and Irish, 2001). There are also many selections and cultivars with a total of 1,393 plants currently described (International Plant Names Index, 2009).

Agaves are rosette-forming plants with spirally arranged leaves that emerge from a central stem. The leaves vary in width, succulence, texture, and color. Some have spines on the leaf margins and/or leaf tips while others are unarmed. Most agaves are monocarpic, meaning they bloom once in the life of the plant, and most go many years before flowering and then dying. Many species offset prolifically from short rhizomes so that a clump may live on after a flowering event, while others are solitary and the entire plant dies after flowering (Gentry, 1982).

San Marcos Growers was growing just one agave, *A. attenuata*, when the nursery was established in 1979 and has since added additional species and cultivars each year. Our current product list has 79 different taxa and we are evaluating an additional 53 more. These plants, once only available at specialty succulent nurseries, are now more prevalent in retail nurseries and in the landscape. Our nursery has been a factor in the increased awareness and availability of new agaves and also the improved methods of propagation have helped fulfill the demand for these plants. This talk will address these methods and share our experiences in propagating and growing agave.

## PROPAGATION

**Seed Propagation.** The various *Agave* species flower between 3 and 50 years of age with most falling in the range of 7 to 25 years (Geling, 2008). After flowering and pollination, the fruit develops and is ripe within 6 to 9 months. The seed is in 3 chambers called locules that open lengthwise to reveal stacks of flat seed that are black and slightly swollen if viable or thin and pale when not. The seed has good viability for up to 5 years when stored in cool, dry conditions. There is no pre-treatment required, but germination is best in warmer temperatures so summer months are the best time to sow unless greenhouse space is available. Sow seed on top of a well-drained seed mix and cover lightly with perlite or sand and water lightly and repeatedly throughout daylight hours. We typically mist our seed flats 8 sec every hour and a bit more often if very hot. Germination occurs rapidly, often within 1 to 2 weeks. Leave on mist or irrigate regularly while seedlings are still young, but cut back irrigation once plants are well-established and transplant when plants develop strong roots. The transplant times vary with the species, but range from as little as 4 months for *A. attenuata* to as much as 18 months for *A. victoriae-reginae* (syn. *A. ferdinand-regis*). The seedlings can be left in seed flats for an extended period of time without damaging the plant, but optimum growth can be achieved by transplanting to individual pots and growing on in the greenhouse for 4–8 months before hardening off in the shade for about a month prior to planting outdoors into full sun (Kravitz, 2009).

**Pups.** One of the easiest ways to propagate many of the naturally clustering types of *Agave* is to remove suckering young plants, or pups, from around the mother plant. This can usually be done by cutting at the base of a plant between the pup and the plant, using a sharp knife or a shovel. If the pup has fresh roots it can be planted immediately into a well-drained soil, but without roots the cut surface should callous a few days prior to replanting. This is best done with pups that have developed several leaves though, with care, even newly emerging pups can be propagated using this method. There are a few arborescent agaves, of which *A. attenuata* is the most common. These often have pups that form on the trunk, particularly after flowering has occurred. These stem pups can be left to form roots or be cut off and rooted in the same manner as discussed above for unrooted basal-forming pups.

**Rhizome Cuttings.** The clustering types of agave produce pups at the end of stout rhizomes and the rhizomes themselves can be used to propagate new plants. Cut the rhizomes into pieces with each having at least one dormant bud and lay flat on top of a well-draining soil covered with perlite. Water occasionally and in 4 to 6 months the dormant buds will have produced small plants that can be transplanted. It has also been noted that an agave planted in a translucent pot will form small plants along the pot wall from these dormant buds, which can then be removed and planted (Prinzing, 2008).

**Propagation from Bulbils.** Some *Agave* species develop small plantlets, called bulbils, in the axils of the spent flowers, often alongside developing fruit. We have observed abundant bulbils produced on *A. vilmoriniana*, *A. desmetiana*,

*A. horrida*, and *A. gypsophila*, and to a lesser extent on *A. salmiana*. Bulbils have also been observed in Oaxaca on *A. atrovirens* (Chemnick, 2009). These bulbils can last for a year or longer on the inflorescence and are easily broken or cut off and rooted in the same manner as unrooted pups. Bulbils on variegated plants often show considerable variability ranging from plants lacking any variegation to those lacking the chlorophyll necessary to survive.

**Propagation by Coring.** We regularly propagate agaves by a method we call coring. We use a sharp knife to cut out the central growth core of a plant which damages a ring of meristematic tissue, promoting the growth of many new shoots from the region damaged. This work is usually performed in late spring and within 5 to 6 months many new plants can be seen emerging from the damaged area. These plants can be divided with roots at their bases about 1 year later.

**Micropropagation.** A propagation technique that is becoming the most popular method of producing agaves is micropropagation, also called cloning or tissue culture. We do not operate a laboratory to do this work on-site but, instead, contract with others to produce plants for us. One such company is Shady Oaks Nursery in Waseca, Minnesota which has been using this propagation technique since 1983, primarily on *Hosta*. While viewing the extensive agave collection at the Ruth Bancroft Garden in 2003 the close relationship between *Hosta* and *Agave* was discussed as was the fact that some botanists have suggested that *Hosta* should be placed in the Agavaceae (Aden, 2003). By the following year Shady Oaks was micropropagating their first agave and now offer 39 different species and varieties. We thank Mr. Gordon Oslund for sharing the following information on his techniques to propagate agaves.

Shady Oaks uses meristem cultures to produce their agaves. The first work performed involves cleaning a plant by removing layers of the tissue exposed to where soil and bacteria may exist. These new cultures are placed in a sterilized growth medium with a carbon source, mineral nutrients, vitamins, water, and hormones to start the culture process in the stage often referred to as Stage I. Continual monitoring is performed until they start to divide. The medium is changed periodically to continue to supply nutrients to the plantlet and it can take a few months for the plantlet to adjust to the medium and actually divide. The plantlets are divided as they multiply in their containers during Stage II. Transfer hoods with HEPA filters are used in a clean room and tools are disinfected to minimize bacteria and mold infestation. The cultures are placed under artificial light between divisions and rooting. When the desired number of divisions is obtained, plants are transferred to rooting media, typically called Stage III. When roots have developed sufficiently, the plants are planted in plug trays containing soilless medium to produce the rooted plugs commonly called Stage IV (Oslund, 2009). The time it takes for agave plants to be produced by this method varies by taxa but the range has been between 11 to 20 months from the time the process is started and first 100 plants have been produced to Stage IV. (Avent, 2009) Some plants, such as *A. victoriae-reginae*, have yet to be successfully micropropagated.

**LITERATURE CITED**

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One of the presentation at the 2013 Succulent Extravaganza was entitled "Coring agaves." What does that mean, you might ask? I must admit I didn't really know either when I arrived at Succulent Gardens. Since the talk was about agaves, my favorite group of plants, my curiosity was piqued, and yet for a brief second I toyed with the idea of skipping it in favor of hanging out with other Succulent Fanatics folks. In hindsight, I'm very glad I didn't because it ended up being my favorite presentation of the entire event. RIGHT: Regular Agave "Blue Glow" LEFT: Highly variegated Agave "Blue Glow". Plants are propagated by two methods: 1. Sexual propagation or seed propagation. 2. Asexual or vegetative propagation by vegetative plant parts like root, stem, leaf etc. Seeds can be defined as a dormant plant which develops into a complete plant subjected to required environmental conditions. The activation of the metabolic machinery of the embryo leading in the emergence of a new seeding plant is known as germination. Germination is essentially a quickening of the growth of the embryo. As The propagation of uncertainty method is applied for a cautious controller, where the cautiousness is accounted for in a cost function that does not disregard the variance associated with the model's estimate. 4 ii Declaration I declare that this thesis was composed by myself and has not, nor any similar dissertation, been submitted in any other application for a degree. Lecture 3: Linear methods for classification Rafael A. Irizarry and Hector Corrada Bravo February, 2010 Today we describe four specific algorithms useful for classification problems: linear regression, More information. 3.1 State Space Models.