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SAGUARO HORTICULTURE
Selecting and Planting Saguaro

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Saguaro cacti (*Carnegiea gigantea*) are easy to cultivate in most of southern Arizona where they are native. They are very well suited for xeriscape plantings in southern Arizona desert regions and are commonly planted in urban landscapes in Phoenix and Tucson. Saguaro can be costly to purchase and install when compared to many landscape plants. It is important to plant saguaro correctly and to provide for proper establishment to support this investment.

Selecting The Proper Size Saguaro To Plant

Seedling saguaro under three inches in height are poor prospects for planting into the landscape. These cacti have not yet produced stout protective spines and are still weaning off the higher water needs of seedlings (Figure 1). Saguaro in the 6-8 inch height range, or those sold in number 1 (one-gallon) nursery containers are reaching a minimum size for planting in the ground with good success (Figure 2). The nurse plant relationship which is crucial for saguaro seedling establishment (Banks 2008) is not required for planted saguaro. Planting under a tree is not advised, to avoid future contact between the growing saguaro and branches above. However, temporary shading should be provided for the newly planted saguaro.

Figure 1. Saguaro seedlings, still too small to be good candidates to plant into the landscape.

Saguaro in the 1-2 foot height range are ideal for planting in the landscape. Plants in this size class are often available as nursery-produced container grown plants (Figure 3). They can be transported in most vehicles with the plant in the container standing upright. Plants may also be offered by nurseries as bare-root plants which were grown in-ground in nursery beds (Figure 4). It can be desirable to clear off the nursery soil from the root ball and plant bare-root (Chamberland & Kelly 2020). This version of bare-root transplant involves planting a nearly intact root system, while bare-root technique for larger saguaro can involve the removal of many roots.

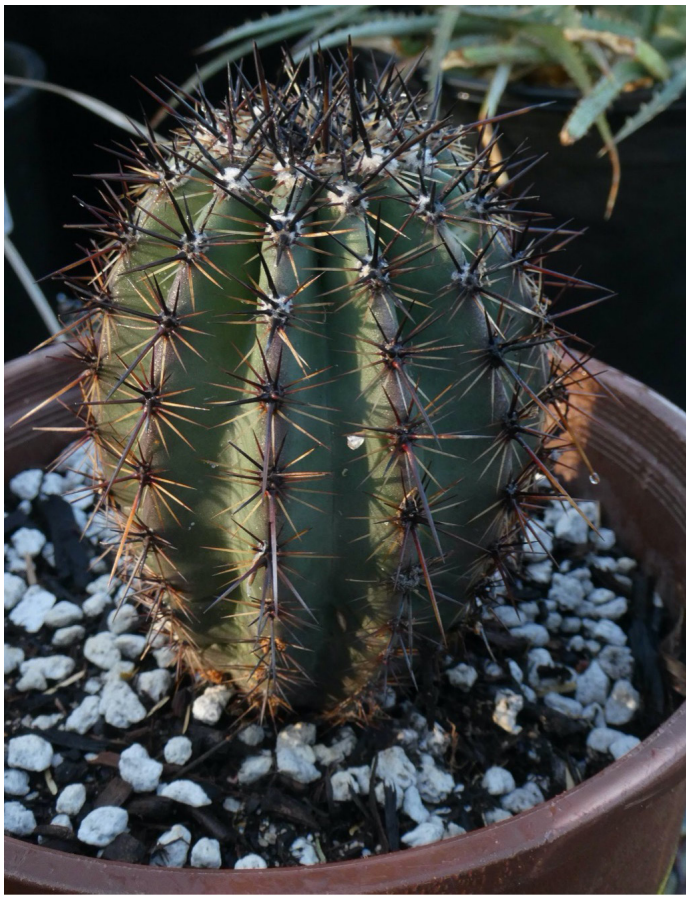

Figure 2. Young saguaro in a number 1 (one-gallon) container, a minimal size for good success when planting into the ground.

Figure 3. Saguaro growing in number 5 (five-gallon) containers, an ideal size to purchase, transport and plant in the ground without special skills or tools.

Figure 4. Saguaro grown in a nursery bed, mostly the same size class as in Figure 3.

Saguaro in the 3-4 foot range are less available as container grown plants but may be available in tree boxes (Figure 5). More often saguaro of this size are bare-root plants sourced from in-ground nursery beds, dug from the desert, or moved during construction. Plants in this size class are reaching the size and weight limit of easy handling, and typically must be lain horizontal for transport. Saguaro over four feet tall are subject to additional regulation concerning relocation (Native Plants, Arizona Department of Agriculture 2020).

Saguaro over 5 feet in height often display a proportional increase in girth which makes this size class notably bulkier and heavier than shorter saguaro. A 5 to 6 foot tall saguaro may weigh 300-600 pounds depending on its girth (Arizona Game and Fish Department 2019). These saguaro can require several handlers and dedicated moving tools, such as a heavy-duty stretcher or cradle padded with carpet.

Figure 5. Mid-sized saguaro offered for sale in tree boxes.

A saguaro "spear" is a large saguaro without arms, particularly an adolescent plant nearing the age when it might begin making arms (Figure 6). Saguaro can begin developing arms after the plant reaches about 8 feet in height. A saguaro spear is a good choice for a large standout specimen in a landscape.

Saguaro with developed arms are considerably more difficult to deal with. Not only do these plants have immense weight as a consequence of their height, but the arms add additional bulk and potential imbalance. Care must be taken to avoid spraining or splitting arms under their own weight when a plant is tilted off of vertical. Custom wooden frameworks may be built around the plant to support the arms during transport. Transport vehicles with tilting hydraulic lifts are often employed. These specialty saguaro transport "rigs" have been described by the Arizona Game and Fish Department (2019).

Studies of saguaro transplants indicate survival is inversely related to size. Plants under two feet tall nearly always survive, while plants over 25 feet tall rarely survive the process (Arizona Game and Fish Department 2019). The complexity and cost of a transplant increases with saguaro size. These trends strongly encourage planting young saguaro. This

Figure 6. A saguaro spear moved by a crane for careful landscape placement.

recommendation may seem to be contradicted by the visibility of large multiple-armed saguaro which have been planted along many Arizona roadways. Their transplanted condition is obvious by the presence of support braces, which may be left in position for many years. These saguaro have been moved as part of construction and road work operations (Arizona Game and Fish Department 2019). Native plant ordinances often require salvage and relocation of qualifying native plants in these circumstances. The low survival rate of these saguaro is considered acceptable when the alternative would be their destruction. Best Management Practices for translocating saguaro for restoration have been detailed by the Arizona Game and Fish Department (2019).

Transplanted (or translocated) saguaro are those which have been dug from the ground and moved to a new site. Regulations come into effect for saguaro originating from wild sites, and with the removal, destruction, or transport of such plants. Saguaro in Arizona are salvage restricted protected native plants. Removing saguaro from private land in Arizona requires a Blue Seal Permit and a Saguaro Tag, which comes at a nominal fee (Native Plants, Arizona Department of Agriculture 2020). A permit is not needed to transplant a saguaro to a new spot within the same residential property, nor to transport or plant a container-grown saguaro (Native Plants, Arizona Department of Agriculture 2020). The City of Scottsdale has local native plant laws and local permits for transport of saguaro, and similar regulations may exist for other Arizona jurisdictions.

It is not legal to remove saguaro of any size from National Parks & Monuments, National Forests, City and County owned natural areas, or other public lands except by permit. Permits are usually issued for scientific research and rarely to salvage plants threatened by construction. Increasingly such plants are salvaged and retained by the land management agency, eventually to be planted back near the disturbed site. Rules and permits of the Arizona Department of Agriculture cover the trade and transport of saguaro from private land and authorized salvage.

Saguaro may be removed from wild environments scheduled for development, as part of saguaro rescues with permission of the land owner and under permit from the Arizona Department of Agriculture. The Tucson Cactus and Succulent Society has, since 1999, conducted nearly 500 cactus rescue operations and rescued over 107,000 plants, many being saguaro (Tucson Cactus and Succulent Society, 2021). These plants may be sold to the public. Always look for an Arizona Department of Agriculture tag affixed to a bare-root cactus being sold.

Digging Saguaro

Most of a saguaro's weight is due to its water content. It is tempting to consider transplanting a dry and shrunken saguaro to reduce the weight involved. However, a saguaro must rely on stored water to survive while re-growing roots and it may lose 30 to 50 percent of its mass before regaining water uptake ability (Arizona Game and Fish Department 2019). It is therefore best to transplant only hydrated saguaro. Saguaro benefit from a deep watering several weeks before digging, allowing sufficient time for the plant to take up and store the water.

Saguaro produce long horizontal roots, which must be cut when a plant is dug from the ground. A tap root is often present, but has not been found to exceed three feet in length even for large saguaro (Arizona Game and Fish Department 2019). The tap root must be cut when digging a saguaro, and at least 18 inches should be saved. It is not practical to attempt to preserve the entire length of these roots. However the practice of extreme removal of roots is also undesirable. Retaining a minimum of a 12-18 inch spread of lateral root is recommended, with the excess roots trimmed cleanly with sharp pruners, or a saw for thicker roots. Use of a 10 percent

bleach solution to sterilize cutting tools is a wise precaution for this and other horticultural pruning before moving to a different plant. Infection of cut roots is a concern. Dusting with both a bactericide and a fungicide is recommended by the Arizona Game and Fish Department (2019). They recommend Agri-Mycin® 17 as a bactericide and Bordeaux Mix as a fungicide. The use of dusting sulfur is an older practice which lacks study and may be considered to be superseded by the use of a bactericide and fungicide. Allow the roots to air-dry for one to two weeks before planting. This is not always possible, and sometimes a saguaro must be dug and replanted as a continuous operation. If so, maximize the amount of time the roots may dry in the air during the process, and emphasize the significance of utilizing bactericide and fungicide (Arizona Game and Fish Department 2019).

The Planting Process

Saguaro may be planted at any time of year, if done in warm dry weather. Spring is ideal. Saguaro should be planted into dry soil and preferably not before a rain.

The step-by-step process of planting or transplanting small and moderate size saguaro follows most of the same technique used for barrel cacti. This has been described by Chamberland & Kelly (2020). The receiving hole in which the saguaro is planted should be prepared to accommodate the tap root in its original shape.

Four of the most important considerations when planting saguaro are: 1) plant the saguaro in the same compass direction in which it was previously growing, 2) plant no deeper than the depth it previously grew, 3) refill the planting hole firmly and without any organic amendments, 4) do not water the saguaro after planting for several weeks.

Saguaro Orientation

Each side of a saguaro endures a different intensity of sunlight. The west side catches the hot afternoon sunshine as the sun sets. The south side intercepts sun all day in the winter when the sun travels lower across the sky. The east side catches the early morning sun, which can be important for warming the plant on cold mornings. The north side is mostly shaded by the plant itself. The saguaro's skin will develop differently and will be thicker on the side receiving the most sun. For this reason a saguaro must not be rotated to a different orientation when transplanted (Arizona Game and Fish Department 2019). One side of the saguaro should be marked before moving it from its established location. This may be done using a dab of white paint or by tying a cord around the plant with the knot facing a particular compass direction (most tie materials catch among the spines and are not likely to shift in position). Nurseries often mark the south-facing side, while saguaro movers often mark the north side (Arizona Game and Fish Department 2019). It is important to know which convention is being used as it is not easy to visually discern which side is which by visual inspection. It does not matter which side of the saguaro is marked as long as the technique results in planting the saguaro in the same compass direction it previously faced. Saguaro planted in the wrong orientation are vulnerable to sunburn, which may be severely damaging and can threaten the life of the plant. The rule of orientation should be modified for saguaro growing in the shade of a tree or building. Shade cloth should be laid over a saguaro (including roots) if it is on its side in the sun for any extended period, such as during transport or preparation of the planting site (Arizona Game and Fish Department 2019).

Saguaro Planting Depth

Arborists inspecting woody trees will look for trunk flare, a widening of the trunk at the point it meets the soil. Widening of the trunk just above the soil surface is a sign of good trunk flare that bodes well for health of a tree. Saguaro exhibit no trunk flare, or a narrowing (inverse) trunk flare. Young saguaro stems pinch to a narrowed diameter just above the soil surface, as is typical of a barrel cactus. In older saguaro this narrowing trunk flare is usually not evident. The older saguaro stem has widened through secondary growth of wood inside the trunk. The expansion ruptures the skin of the once-narrow base, which becomes bark-like as it expands. The trunk base of an older saguaro can resemble a gray-skinned elephant's foot (Figure 7). Roots spread out horizontally just below the point where the stem meets the soil.

Figure 7. Narrowing trunk flare (right) and/or a bark-like base (left) of the saguaro is seen where the stem meets the soil.

A saguaro planted too deeply can be seen to have no inverse trunk flare. The stem meets the soil with no change in diameter at the contact point, and will have green skin and spines all the way down to the soil level (Figure 8). Planting too deep is unfortunately a common practice. It results in a region of the green skin of the saguaro being buried under soil, which is not a natural situation. It also results in the hub of the root system buried at a greater depth than rainfall regularly wets the soil. The saguaro root hub then receives inadequate water for re-growing a root system. Such plants may take several years to die.

The practice of deep planting is supposed to give the saguaro more stability immediately after planting, but if this is detrimental to the life of the plant, that is a poor tradeoff. A tall saguaro planted at the correct depth will require stabilization braces for at least two years during establishment while a root system forms. The need for braces can be avoided by planting younger smaller saguaro.

Figure 8. Saguaro stem meeting the ground with no transition, a sign the plant has been planted too deep.

Saguaro Planting Soil

The planting hole should be refilled with material dug from the hole, however refilling with pea gravel has also been recommended (Arizona Game and Fish Department 2019). No compost or organic matter should be added. The fill should be tamped down firmly, as with the butt of a shovel.

After-Planting Treatment

Most plants require deep watering immediately after planting. Not so with saguaro and most cacti. The planting site should be left dry for several weeks, longer during cool weather. This allows time for any damage the roots may have sustained when planting to dry out and heal before watering. Saguaro will need irrigation to establish, to be described in the next section. It is best not to plant before a significant rain storm is forecast.

Saguaro Establishment

Support

Saguaro of small to moderate height may not need additional support after planting, especially if they were planted with roots that were not overly trimmed. Plants on slopes or loose soil may need evaluation. The Arizona Game and Fish Department (2019) indicates saguaro under 12 feet tall do not need additional support if the soil has been well tamped in. This recommendation may pertain to transplants into wild situations where a fall is less significant than in a residential environment. In urban settings greater precaution is warranted and braces should be used on shorter plants. The Arizona Game and Fish Department (2019) has moved away from the use of 2x4 wooden braces (Figure 9), while these may still be seen supporting saguaro along some Arizona roadways. They have instead recommended the use of three guy wires, staked at the ground and attached to a hose-lined collar around the saguaro stem. The pros and cons of this system versus 2x4 bracing supports should be evaluated for urban settings. Wooden braces have greater visibility and may present less of a tripping hazard. Wooden 2x4s must always be topped with a wide padded wooden section in contact with the stem. Bare 2x4s supporting a saguaro are prone to puncture the stem. Supports should be left in place for at least two growing seasons (Arizona Game and Fish Department 2019) and should be evaluated before removal as situations will differ.

Shade Cloth

Wrapping a saguaro with horticultural shade cloth is recommended following planting (Figure 9). This is especially important if the plant is moved from a shaded location to a full-sun site. Use of 30% shade cloth (allowing 70% of sunlight through) is recommended. Heavier shade cloth blocking more

Figure 9. A trio of wooden braces support a young adult transplanted saguaro. The plant has been wrapped in shade cloth prior to installation of braces. A temporary irrigation system provides water for establishment.

sun is detrimental, as saguaro may sunburn after removal of the cloth. Shade cloth should be wrapped around the plant, with the seam on the north side (Arizona Game and Fish Department 2019). The cloth may be held by the cactus spines, but should be additionally tied to the stem to prevent it blowing away. The cloth should be left on through the first summer (Arizona Game and Fish Department 2019).

Watering Saguaro

Saguaro live in the Sonoran Desert where the mean annual precipitation ranges from 4 to 18 inches (Yetman et al. 2020). Mature saguaro can survive during years with even less rainfall. The plants have a remarkable ability to recuperate after a prolonged drought. Saguaro may take up water in any season (Yetman et al. 2020). This is assuming they have a root system. Transplanted saguaro commonly have a severe reduction of their root system. The saguaro will contain sufficient stored water to initiate new roots, however it will not have enough stored water to regrow a root system. When new roots are initiated they will need irrigation to support continued root growth, water uptake and time to develop into a root system. It is estimated that expansion of the root system may proceed no faster than the upward growth of the stem of the saguaro (Arizona Game and Fish Department 2019).

The newly-planted saguaro should not be watered for 2-4 weeks if planted in the warmer months. If planted in the cooler season it should be allowed a full month or longer before watering (Arizona Game and Fish Department 2019). Saguaro require time to respond to the loss of roots from the transplant process and begin the growth of new root initials. This is accomplished by utilizing resources stored in the stem. Only after new roots have initiated can the saguaro begin to uptake water from the soil. Allowing several weeks to months before watering the saguaro aids in the drying of any roots damaged in the transplant process and reduces likelihood of root rot.

A pair of concentric berms forming a "donut" around the base of the saguaro can help retain water until it infiltrates into the soil. The function of an inner berm approximately a foot from the base of the saguaro is to keep water away from the base of the plant, which is vulnerable to rot. Water infiltrating into the soil will move laterally and reach the root zone.

During the warm months watering may be done once every three weeks, allowing soil to dry thoroughly between watering. Watering may be increased to once every two weeks when temperatures exceed 110°F (Arizona Game and Fish Department 2019). Watering schedules during the cooler months are less defined, and will be influenced by rainfall and temperature.

The amount of water applied can approximate one gallon per linear foot of the cactus, including arms, for each watering (Arizona Game and Fish Department 2019). Once roots begin to grow out laterally, the amount of water applied should infiltrate to a depth of 4-5 inches in the soil.

The outer surface of the saguaro has vertical pleats called ribs (not to be confused with the woody ribs inside the saguaro stems). The form of the saguaro stem allows the plant to expand and contract with the uptake and storage of water. A dehydrated saguaro will visually shrink and offers a visual cue that irrigation would be appreciated (Figure 10). The transplanted saguaro will ideally have been well-hydrated when installed. It will gradually dehydrate during the months following transplant, but it should reverse course and visibly expand after several months of active irrigation, a sign of active root growth and water uptake.

Supplemental watering should be applied to the planted saguaro for at least four years for establishment (Arizona Game and Fish Department 2019). After this time, saguaro may be sustained by rainfall alone. During times of drought, an infrequent irrigation will be appreciated by saguaro. Transplanted saguaro may never re-grow a root system as extensive and effective as saguaro which grew undisturbed.

Figure 10. A hydrated saguaro (left) compared with a dehydrated saguaro (right) with visibly shrunken ribs during a period of drought.

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