

TECHNICAL NOTES

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Salvage Techniques for Saguaro Cacti, Barrel Cacti and Ocotillo

Abstract

*Effective salvage techniques for saguaro (*Carnegiea gigantea* [Engelm.]Britt. and Rose), barrel cactus (*Ferocactus* spp.) and ocotillo (*Fouquieria splendens* Engelm.) were reviewed and evaluated by the Tucson PMC in 1995. The evaluations were based primarily upon information gathered via telephone from salvage contractors, experts in the field, and literature review. Saguaros, ocotillos and barrel cacti can be transplanted at any time of the year with success, except during the winter rainy season when cool temperatures and moisture promotes decay in fresh transplants. Saguaro and barrel cacti under 5 feet can be transplanted by hand. For cacti above 5 feet, a cradle which supports the plant during removal and transport is necessary. All three species incur damage when moved and need a two week healing period before supplemental water is applied. The healing period allows the roots time to dry, sealing wounds, cuts, and abrasions. The commonly accepted industry standard to determine saguaro transplant success is one to two years. The consensus of the technical community is that 4 to 5 years is necessary to determine survival. Large saguaros over 8 feet do best with one year of irrigation but irrigation should be restricted to late spring and summer. Duplication of solar orientation when transplanting is crucial for cacti but not necessary for smaller ocotillo. Transplant success is generally greater for barrel cactus followed by saguaros then ocotillos. This information can be applied to the conservation practices such as Critical Area Planting (342), Land Clearing (460), and Land Reconstruction, Abandoned Mine Land (543).*

Introduction

Effective salvage techniques for saguaro (*Carnegiea gigantea* [Engelm.]Britt. and Rose), barrel cactus (*Ferocactus* spp.) and ocotillo (*Fouquieria splendens* Engelm.) were reviewed and evaluated by Archuleta and Dhruv at the Tucson PMC in 1995. The evaluations were based primarily upon information gathered via telephone from salvage contractors, experts in the field, and literature review. Although other species of native plants may be included in a salvage operation, the saguaro and barrel cactus present a large concern and transplant challenge. The ocotillo, although not a cactus, is an important plant culturally, aesthetically and ecologically and is included in this review.

The saguaro is a large, long lived, columnar cactus, native to the Sonoran Desert. It is typically found on rocky or gravelly soils of foothills, canyons and benches at 600 to 3600 feet elevation (Benson 1977). The saguaro lifespan has been estimated up to 200 years and can grow to height of 50 feet and attain a weight of 6 to 7 tons (Kearney and Peebles 1969). The saguaro is a very slow growing plant; it may only stand 2 feet at 30 years and reaches sexual maturity

around 60 years of age. The saguaro root system is shallow, mostly less than 4 inches deep and spreading in all directions to a distance approximately equal to the height of the plant. The shallow roots provide support and take advantage of very light showers. A few roots may descend to 3 feet.

The barrel cactus is another prominent plant of the Sonoran Desert. It is a single stemmed columnar cactus and typically grows to a height of 3 to 5 feet, although taller specimens do occur (Benson, 1977). Barrel cacti have a shallow root system that may extend 2 feet below the surface dependent upon the species.

The ocotillo is a woody shrub 10 to 20 feet tall with a short thick trunk and many long, spiny branches. The ocotillo occurs in Arizona, western Texas, southern New Mexico, Sonora, Chihuahua, and Baja California. . Typically, the ocotillo appears lifeless until a moderate rain occurs then, in as little as 48 hours it may completely leaf out (Kearney and Peebles, 1969).

Interviews

A series of 8 questions were submitted to contractors and other experts in the art of plant salvage. The questions addressed are as follows:

1. What is the best time of the year for transplanting?
2. What equipment is used in large scale salvage operations?
3. What is the procedure for transplanting and storage?
4. When can success be determined?
5. What are the irrigation requirements?
6. What backfill should be used?
7. Which species have the greatest survival rate?
8. Is transplant orientation critical for each species?

Mark Dimmit Curator of Botany. Arizona-Sonora Desert Museum.

1. All species can be planted at any time of the year with a 90 percent success rate. Large old plants will have lower success.
2. Equipment used includes shovels and tractor/backhoe. There is a grabber/backhoe designed for lifting and moving saguaros.
3. All three species incur damage when removed from the ground. Roots should be kept dry for a two week period before, and after replanting. They should not be "watered in", and the roots of all three species may require dusting sulfur to prevent rot. Saguaro and barrel cacti must be planted at the same depth when relocated. If planted too deep, they will slowly decay and die. Two feet of as many lateral roots as possible should be saved to help stabilize the transplant. Stakes are not necessary for supporting newly transplanted saguaros. Barrel cacti have a conical base from which the roots grow, it must not be damaged while moving or transplanting.
4. It will take a maximum of one year to determine success of an ocotillo transplant and 5 years for saguaro and barrel cacti.
5. Saguaros and barrels require one year of irrigation after transplant. Jet-spray rather than drip irrigation is used to water 4-5 inches of soil once per week directly around the cacti. Water should penetrate 4 inches into the soil. Ocotillos should be irrigated

during the first summer. Occasional spraying of the stems seems to initiate leaf growth.

6. All species must be planted in well drained soil such as coarse river sand.
7. Survival rate for each species is dependent on many factors. Generally the plant will do very well if it is young and healthy. Saguaros less than 10 feet tall that are accustomed to full sun throughout the day have better than 95 percent survival. Saguaros that exceed 15 feet have a lower survival rate. Barrel cacti that are small can attain a 95 percent survival rate. Ocotillo and saguaro have similar transplant requirements. Large, old plants are not as receptive to relocation.
8. Duplication of solar orientation is critical for saguaro and barrel cacti but not for the ocotillo. Plants salvaged from the shade canopy of adjacent vegetation will not survive direct sunlight and will sunburn (M. Dimmit, 1995, Personal Communication).

Commercial Contractor

1. Transplanting can be done any time of the year with equal and excellent success.
2. A backhoe is the typical piece of equipment used to remove plants.
3. As much of the ocotillo root system as possible should be removed and replanted. The long lateral roots of the saguaro that are removed do not grow back. The cut areas of the roots must be treated with an anti-bacterial solution (contractor trade secret) and root growth hormone before replanting. The saguaro is then planted deep for stabilization.
4. The survivability of a saguaro can be determined within 18 months, after transplanting, twelve months for a barrel cactus and less than one year for an ocotillo.
5. Ocotillos and barrels must be deep watered after transplanting. Saguaros must be hand watered for 1 to 2 years, based on observation.
6. For the ocotillo and barrel cacti, a 50 percent river sand mix is necessary for adequate drainage. Saguaros require a 60/40 ratio of river sand and top soil.
7. All plants can achieve a 90 percent survival rate if they are in good vigor when they are transplanted.
8. Saguaro and barrel cacti must be oriented to the sun in the same way as when removed to prevent sun scalding. Duplicating solar orientation is not essential when transplanting the ocotillo (Private contractor, 1995, Personal communication).

Cesar Mazier, Superintendent of Horticulture at the Desert Botanical Gardens

1. The best time to transplant saguaro and barrel cacti is in the spring and fall. Summer should be avoided due to the extremely hot temperatures which will further stress the transplants. Ocotillos can be planted at any time of the year; extremes in temperature should be avoided if possible.
2. A 'cradle' is used in combination with a front end loader for removing a saguaro. The plant column is strapped to the cradle and lifted from the ground. Excavation of soil from the basal area is necessary prior to lifting the cradled plant.
3. When removing a saguaro, excavate 12-18 inches around the plant. Take as much of the root system as possible from the specified excavated area, keep these roots intact. After removal, spray roots with an antibiotic (streptomycin) and dust with a fungicide

- (sulfur). Plants being stored for later transplant should be placed in a sand medium only. Do not use carpet against the plant to support in an upright position. This practice retains moisture, promoting decay and eventual demise of the plant. The preferred support system consists of three guy wires strung through sections of round hose. These sections are placed around the plant two-thirds up from the base of the plant. Triangulate the three guy wires from the hose sections surrounding the plant column, take out the slack, and stake to the ground, making sure the hose collar is not overly tight. This procedure is used only when storing the saguaro. Permanently transplanted saguaros require no supplemental support.
4. It may take up to one year for an ocotillo to respond to supplemental irrigation. A successful saguaro transplant can be determined in a minimum of twelve months if closely monitored. An original diameter measurement must be taken from the saguaro as soon as it is transplanted. Ten days after the saguaro is irrigated, a diameter measurement is again taken to determine if water uptake has occurred. If the roots are functioning, the diameter of the saguaro will increase. The diameter measurement of saguaros should be monitored 10 days after each supplemental irrigation or rain fall events that exceed a quarter of an inch. If the girth of the saguaro has shown no increase in size (due to water intake) after twelve months, the transplanting can be determined as unsuccessful. Saving most of the roots greatly increases the success rate. Transplant success for the barrel cactus can be determined in the same way as the saguaro.
 5. Saguaros should be watered once every three weeks; especially during the first summer (soil dries in 7 to 14 days). Two, one gallon drip irrigation emitters should be placed approximately twelve inches from the base of the cactus, giving the plant 48 gallons of water in a 24-hour period. If an excavated water basin is provided, water should be directed to the plant. The size of the water basin around the base should be proportional to the size of the plant. The basin should be three times the diameter of the plant, for example, a twelve to twenty foot tall saguaro will require a water basin five feet in diameter with a six inch water retention berm.
 6. Backfill for a saguaro should consist of native soil amended with clean sand (30 percent sand if native soil contains clay, additional sand is not necessary if soil is granitic. Backfill halfway then allow water to soak in before completing the backfill operation. This water and back fill operation should only be applied if the saguaro has been stored for a two week healing period.
 7. Barrel cacti transplant well, followed by ocotillos then saguaros.
 8. Solar orientation is crucial for saguaros and barrel cacti, but is not necessary for ocotillo (C. Mazier, 1995, Personal communication).

Hisashi Kokubun, Horticulturist at the Boyce Thompson Arboretum

1. Any time of the year is good for planting except the rainy seasons of late summer and winter. Excess moisture promotes decay of freshly cut roots on newly transplanted succulent species.
2. A mechanism that 'cradles' saguaros and large barrel cacti is often used. Ocotillos can be moved with a backhoe.
3. Major root cuts and other damage, commonly expected when moving a saguaro, usually require a minimum of a fourteen day 'healing' period in which the plant

- receives no irrigation. (No recommended or prescribed method was offered for barrel cacti or ocotillos).
4. After transplanting, ocotillos may not leaf out during the first growing season. Two growing seasons may be required to determine transplant success. Saguaros require at least 3 years of vigilance and barrel cacti at least 2 years before success can be determined.
 5. Irrigation is generally not necessary unless the soil has a poor water holding capacity. Sandy soils are not able to retain much water.
 6. Native soil in which the plant grew provides the best backfill. If it is not available, a coarse, well draining soil is recommended.
 7. Barrel cacti have the greatest transplant success rate.
 8. Barrel and saguaro cacti must be correctly oriented to the sun when transplanted, but it is unnecessary with ocotillos (H. Kokubun, 1995, Personal communication).

Discussion

Moving and Transplanting

Salvage activities should be allowed ample time to move/transplant cacti and ocotillos, especially saguaros that exceed ten feet in height. A minimum of an hour is required to move a 10 foot saguaro, a minimum of one and a half hours is required if it has up to two small arms. Adequate time and care is required to achieve a high survival rate (Wheat-Gallaher. 1995. Personal notes).

Salvage contractors assume a good chance of survival for saguaros if they are alive after one year. It is generally accepted that if they live for one year, they will usually survive a long time. However, it may take years for a saguaro to die after it has been transplanted.

Spring is the optimum time for transplanting due to cooler, dry weather which is not conducive to tissue decay, and this is the time of year when saguaro roots actively elongate. (Wheat-Gallaher. 1995. Personal notes). Three to four lateral roots up to two feet in length should be retained when moving saguaros (M. Dimmit. 1995. Personal communication). Roots that incur damage should be pruned and immediately dusted with sulfur (Wheat-Gallaher. 1995. Personal notes).

When storing cacti, allow for raised, open areas where air circulates freely around plants (Wheat-Gallaher. 1995. Personal notes). Care should be taken not to bruise the plant. If a cactus is bruised, the section should not be planted below grade (Wheat-Gallaher. 1995. Personal notes). It is very important to try to transplant cacti in their original solar orientation. Irrigation is only necessary during the dry months of the year and only for one or two years after transplant. Too much water will promote decay. Generally, ocotillo do not transplant as well as cacti. A minimum of 75 percent success can be expected. (Wheat-Gallaher. 1995. Personal notes).

Equipment

The 'hydraulic saguaro rig' is acceptable for moving saguaros greater than 3-6 feet or plants too large to move by hand. A limited number of contractors design and build their own equipment, and attach them to trucks for moving large saguaros and barrel cacti.

A sling-type saguaro mover, or come-along, is basically an obsolete method although it is occasionally used. It involves lifting the saguaro out of the ground, using chains and relying on luck and gravity. This method is very damaging to the saguaro (Wheat-Gallaher. 1995. Personal notes).

Summary

The following conclusions are based upon information gathered from available sources including those from the preceding interviews. This information is meant to summarize the most technically correct procedures for removing and transplanting saguaros, barrels and ocotillos.

- 1) Saguaros, ocotillos and barrel cacti can be transplanted at any time of the year with success, except during the winter rainy season when cool temperatures and moisture promote decay in fresh transplants. This may require some advanced scheduling to prevent a long operation from advancing into the wet season. Spring is the optimum time due to the typically dry weather and dry soil conditions which help reduce transplant rot. Although monsoons occur during the summer, the rain tends to be fast and furious with little soil penetration and the hot weather tends to prevent fungal growth.
- 2) Saguaro and barrel cacti less than 5 feet can be transplanted by hand. For cacti above 5 feet, a cradle which supports the plant to a holding yard or to a new location is necessary. Arms should be supported. If arms cannot be adequately supported, a small arm or 'button' can be cleanly removed and treated with an antibiotic such as Agromycin 17 (use of trade name does not indicate or suggest their effective use by the Natural Resources Conservation Service). Roots that are damaged should be sliced off cleanly and treated with sulfur. Ocotillos can be removed with a backhoe, saving as much of the root system as possible.
- 3) All three species incur damage when moved. The plants must have a two week healing period before supplemental water is applied. This period allows the roots time to dry, sealing wounds, cuts, and abrasions. When removing saguaro, excavate 12 to 18 inches around the plant. Take as much of the root system as possible from the excavated area. After removal, all damaged roots should be cut cleanly and treated with dusting sulfur to retard fungal growth. The transplant site should be prepared in advance to allow immediate plant transfer. The site should be dry, with no supplemental irrigation for a two week period. This procedure is imperative for the healing of roots and other damaged plant tissue. Immediate transfer of ocotillos, saguaros and barrel cacti is the recommended procedure, but storage of plants is necessary if the transplant site is unprepared or excessively moist. The storage area should be open; allowing good air circulation, and covered with shade screen to prevent sunburning. Stored plants must remain in an upright position and their roots covered in dry sand. This temporary storage condition requires plants to be supported.

The preferred support system for saguaro consists of three guy wires strung through sections of hose. The sections of hose are placed around the plant two thirds up from the base. Triangulate the three guy wires from the hose sections surrounding the plant column and stake them into the ground, making sure the collars are not too tight. Carpet should not be substituted for hose sections. Carpet retains excess moisture and promotes decay. Storing plants is only recommended when circumstances dictate. Immediate transfer of plants to their permanent location insures the best survival rate. This method results in the reduction of excessive mechanical handling, reducing the probability of plant damage.

- 4) The commonly accepted industry standard to determine saguaro transplant success is one to two years after transplanting. The consensus of the technical community is that 4 to 5 years is necessary to determine survival. It may be possible to evaluate a saguaro's condition during the first year if water uptake can be determined. To determine water uptake the diameter of the plant must be taken soon after transplant. The diameter is then remeasured 10 days after irrigation (provide a two week healing period with no irrigation) this, includes rainfall exceeding 1/4 inch. Water uptake is occurring when the saguaro shows an increase in diameter. If the saguaro is not increasing in girth after one year of irrigation it can be assumed that the roots are not functioning adequately and the plant is perishing. This method requires careful monitoring and scheduling to acquire accurate information. Barrel cacti do not have supporting ribs like that of the saguaro, so it requires less time (2 to 3 years) to detect the declining vigor of a plant. Ocotillos should be allowed two growing seasons before death is concluded. Often, newly transplanted ocotillo will not respond to the first growing season due to transplant shock or excessive root damage.
- 5) Large saguaros over 8 feet do best with one year of irrigation. Irrigation should be restricted to late spring and summer. A small mound of soil should be built around and against the base of the saguaro (below the fleshy part to prevent decay). The mound should slope away from the saguaro into a basin that surrounds the cactus. The basin should be 3 to 4 inches deep and three times the diameter of the plant. The saguaro will need water once per week (after the 2 week healing period has concluded) with 4 inches of soil penetration. Ocotillos generally do not require irrigation if enough roots were saved with the plant. Ocotillos should not be watered in. Small barrel cacti do not generally require irrigation, but larger cacti may, for only the first summer. Large barrel cacti should receive the same irrigation requirements as saguaros.
- 6) Backfill should be a mixture of native soil and coarse river sand to achieve proper soil drainage. It is important that water does not remain next to the fleshy parts of the saguaro. The water should drain down and away from the plant to prevent fungus and decay. This is also true for barrel and ocotillo. The planting depth for the barrel and saguaro cacti should not exceed the callused portion of the base. Moisture contact to the callused area does not appear to promote plant tissue degeneration.
- 7) Generally, transplant success is greater with barrel cactus followed by saguaros then ocotillos.

- 8) Duplication of solar orientation when transplanting is crucial for cacti but not necessary for smaller ocotillo. It may be beneficial for large, old ocotillo to be planted in its original solar orientation. Saguaro and barrel cacti that were removed from the shade of another plant (such as Palo Verde) should be transplanted into locations that will provide shade or they may sunburn and their survival will potentially be diminished.

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