ARIZONA COOPERATIVE EXTENSION

THE UNIVERSITY OF ARIZONA
College of Agriculture and Life Sciences

Problems and Pests of Agave, Aloe, Cactus and Yucca

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Agaves, aloes, cacti and yuccas are classified as succulents - plants that have highly specialized anatomical features such as thick waxy cuticles, fleshy or minimal leaves, modified leaves (spines), and roots with extra storage capabilities for food and water. These modifications allow them to survive and thrive in harsh desert environments. They survive long periods of drought in areas of sparse rainfall and intense heat. During stressful periods many succulents cease to grow. They drop unnecessary leaves, dehydrate and become dormant until conditions for growth return.

Despite their adaptations succulents suffer from diseases, insect pests and cultural problems. Some of the more common problems that occur in agave, aloes, cacti and yuccas in Arizona are discussed in this bulletin.

Abiotic (non-living) problems

Abiotic problems are not caused by living organisms. They include poorly drained soils, sun exposure, and weather events such as cold and high temperatures, excessive rainfall, over watering, planting too deeply and hail damage. In transplanted agaves, aloes, cacti and yuccas, abiotic problems are probably the most common problems that growers and homeowners encounter.

Selecting the correct plant and planting location

Careful selection of species that are suited to your local conditions is necessary and will eliminate or diminish serious problems. Choose species that are found in your neighborhood or area. Visit specialty cactus and succulent nurseries and discuss cold hardiness, heat and cold tolerance, mature size of the plant, growth rate and known problems of a specific plant with the nursery personnel. Contact your local Cooperative Extension office for expert advice. Visit local arboreta that have extensive succulent collections. Choosing the right plant for the right place is the first step in successfully growing these unique plants.

Most succulent species originate in areas of diverse habitats. For example, many agaves grow in pine and oak forests, open grasslands and even in barren open areas. By researching a little about your plants and their special requirements, they can be planted in areas of your yard that fulfill most of their requirements.

Freeze Damage

Figure 1. Freeze damage on *Agave.*

Many of the more showy and exotic succulents originated in frost-free climates. As a result, when temperatures remain below freezing for several hours, they suffer freeze damage. The damage originally manifests itself as blackening of the exposed parts of the plant (Fig. 1). After a few weeks, the blackened area will dry out and become crisp. Freeze damage cannot be repaired; but unless the freeze is of particularly long duration or exceptionably cold, the damage may be only cosmetic, and the plant will grow out of it. When exposed to a severe freeze, portions of columnar cacti will yellow, and then die completely (Fig. 2). In freeze-damaged barrel-type cactus, the margins of ribs become straw yellow. If temperatures are not substantially below freezing (a "hard freeze") and the freeze lasts for only a few hours or less, only the epidermis may be damaged, and the plant will outgrow the damage in several years. Yuccas may be damaged by sub-freezing temperatures. The damage will appear similar to that of the freeze damaged agave in Fig. 1. When the freeze is of long duration, extreme, or the species is not suited for the local climate, damage may be severe.

Fig. 2. Severe freeze damage to *Cereus peruvianus.*

Freeze damage can be prevented. It is important to become acquainted with temperature requirements of the particular species. Protective measures often can be taken to assure survival. Cold-sensitive plants should be grown in areas that receive radiated heat at night from a patio or wall or in hilly areas where air temperatures are slightly warmer.

Covering the plant with a cotton sheet will help on nights that are just at or slightly below freezing. Another strategy is to place a 60-watt light bulb under the cotton sheet, taking care that the light bulb does not touch the plant or the cotton sheet. Do not cover the plant with plastic sheeting. Plastic is a poor insulator and will transfer the cold directly to the plant wherever it touches the plant. Containerized plants can be moved indoors until freezing weather has passed. If kept dry and placed in a brightly lighted area, they will survive without damage.

Extremely low temperatures may cause a loss of turgor in saguaros. This causes sagging of branches (arms) or death of the apical meristem (growing tip) that results in saguaros with many stems or 'heads'.

Sunburn

Figure 3. Sunburn on golden barrel cactus.

Sunburn is a common problem in greenhouse or shade house grown plants. It is also problematic in plants grown in open beds or filtered sunlight in nurseries when these plants are transplanted into open landscapes. Those parts of the plant that have not been acclimated to direct sun will burn easily. Sunburned plants turn yellow. As the damage progresses, the epidermis turns straw yellow and dies. Barrel cacti and columnar cacti are very

susceptible to this kind of damage (Fig. 3). The entire plant usually does not die, but it is permanently scarred. Similar damage occurs on *Y. aloifolia, Y. gloriosa,* and *Y. recurvifolia,* especially during summer months. The apex of the leaf or the area where the leaf naturally curves will become yellow. In severe cases leaves may die, but if damage is not severe, they may recover at cooler temperatures.

Sunburn can be minimized in nursery-grown plants by placing the plant in the same direction as it had been previously growing. Many nurseries will mark one side of the plant so it can be transplanted in the same orientation. Placing shade cloth (30%) or cheese cloth over newly-acquired plants reduces sunburn. If possible, purchase locally grown plants that have been grown in full sun or partial sun (depending on the species) and acclimated to sunlight.

Greenhouse-grown plants that will be planted in the open garden can be acclimated by gradually moving them out into full sun over a period of weeks or planting in shade of a deciduous tree or shrub. Planting in late winter when solar radiation is less intense and using inorganic mulch such as gravel or decomposed granite around new plants also will reduce sunburn. Application of a mulch about two to four inches (5 - 10 cm) deep will help retain soil moisture and reduce reflected light and heat, but be sure the mulch does not cover the base of the plant and create a moist environment for rot organisms. Many species will benefit from partial or dappled shade. By planting near a deciduous tree or shrub, the plant will be protected from the summer sun and winter freezes.

Planting depth

Proper planting depth is essential for the survival of many succulents. In columnar cacti such as saguaro, green stem tissue should not be below ground. This is commonly done with *Carnegiea gigantea* (saguaro) and other columnar cacti and leads to poor establishment and death of the plant. Do not attempt to 'match' plant sizes so that all the plants are identical in height by planting some deeper than others. Young prickly pear (*Opuntia* spp.) should be planted deeply enough so that they remain upright after planting. This usually is ½ to ¾ of the depth of the lowest pad.

Poorly-drained soils

All succulents require fast-draining soils. Special 'cactus' mixes are available at many retail nurseries. These mixes are formulated for potted plants. Poorly-drained soils will predispose the plants to attack by soil-borne, root-rotting pathogens that may result in the death of the plant. Careful irrigation management is critical in growing cactus, agave, and yucca successfully in heavy clay soils. In outdoor landscapes, adding copious amounts (up to 25%) of pumice will improve drainage and soil structure.

Sandy soils should be avoided because they will drain very rapidly and retain little water and nutrients. They should be amended with well-rotted compost or peat moss. Fresh or uncomposted manures should not be used as soil amendments because the high salt content found in manures is detrimental to root development.

Irrigation

One of the most serious abiotic problems is over-watering. This combined with poorly drained soils is a recipe for plant failure. Plants should dry moderately to thoroughly between irrigations depending on the plant type and species. Conversely, in times of drought or no rain for prolonged periods, supplemental water will diminish problems associated with heat and sun damage. As a general rule, watering succulents in well drained soils on a 10 - 14 day interval is sufficient to insure plant health and growth during summer. On heavier soils such as clay soils the watering interval may be decreased. On sandy or very rapidly draining soils the frequency will have to be increased. Check the root zone 2–3 inches (5–7.5 cm) below the surface. If the soil is even slightly damp, wait until it has dried to irrigate. By regularly checking the root zone before watering, you can get a good idea of your plants' water needs. A thorough irrigation followed by a 2-14 day dry period (no rain, no supplemental water) will give the soil a chance to dry out completely which in turn will reduce the incidence of soil borne pathogens. As the daylight decreases in fall and winter, irrigation may be reduced. When nighttime temperatures drop below 60˚F. (16˚C.), discontinue irrigation; when nighttime temperatures are above 60˚F, water as described above. Most of these plants can survive on natural rainfall through late fall, winter and early spring.

Hail damage

Fig. 4. *Opuntia* pads damaged on one side by hail (L) and reverse side (R) undamaged.

In some areas of the desert southwest, hail storms cause considerable damage to young aloe, cacti, agave or other succulents. Hail damage on barrel type cactus results in wounds at the point of impact leaving scars that can vary from very small spots to larger lesions. On *Agave* species, leaves may be perforated by the impact of the hail. When hail storms are accompanied by strong winds, damage to the plant may be on one side of the plant only (Fig. 4). This distribution of damage is helpful in recognizing hail damage.

There is no protection from hail unless plants are covered before a hail storm begins. Small areas or a few specimens may be covered with a heavy blanket or tarp to minimize the damage.

Diseases

Fungal diseases of pads and leaves

Phyllosticta pad spot

Lesions on pads of prickly pear cacti (*Opuntia* species) may be caused by several different pests or environmental conditions. However, the most common pad spot on the Engelmann's prickly pear in the desert of Arizona is caused by a species of the fungus *Phyllosticta*. The disease is found throughout the

Figure 5. *Phyllosticta* pad spot on *Opuntia.*

desert. Lesions are almost completely black because of the presence of small black reproductive structures called pycnidia produced on the surface of infected plant tissue (Fig. 5). Spores produced within these reproductive structures are easily disseminated by wind-blown rain or dripping water and infect new sites on nearby pads. Pads on the lower part of plants are often most heavily infected since the humidity is higher and moisture often persists after rain. Once pads dry, the fungus becomes inactive and the lesions may fall out.

Severely infected pads or entire plants should be removed from landscapes to prevent spread of the fungus. No other controls are recommended.

Anthracnose of agaves

Figure 6. The anthracnose fungus causes lesions on *Agave* leaves in which spores are produced during wet weather.

Another fungus, a species of *Colletotrichum*, causes a disease known as anthracnose. It can be a problem on agaves during moist conditions or occasionally when agaves are grown in the shade and overhead irrigated. Infections cause lesions on the leaves and/or crowns. When the fungus is active, it produces a red to orange spore mass within the lesions (Fig 6). The spores are distributed by splashing water and windborne rain. Leaves with active lesions should be removed. In areas where disease has occurred, overhead watering should be avoided. Application of fungicides such as thiophanate methyl during wet weather may prevent new infections, but efficacy of fungicide treatments has not been established.

Other fungal lesions

Figure 7. Fungal lesions on *Agave weberi* develop during cool moist weather conditions.

Stem and leaf lesions on cacti and agaves have been associated with other fungi as well. They usually occur during prolonged periods of cool, wet weather. There is a great deal of variation in susceptibility among *Agave* species. For example, severe lesions have been observed on *Agave weberi* while other species growing nearby are not affected (Fig. 7). Species that are susceptible to fungal lesions should be replaced with more tolerant species of *Agave* or another type of plant.

Figure 8. Fungal lesions on barrel cactus.

Fungal lesions also may develop on barrel cacti (Fig. 8). These infections usually develop during spring rains and are more common on plants that are shaded. Infections rarely kill the plant but cause irreversible cosmetic damage. If cacti are planted in an area that is routinely problematic, the plants should be moved if possible. Heavily infected plants should be removed, placed in plastic bags and disposed of in the trash to reduce the spread of the fungi to nearby susceptible plants.

Fungal crown rot of *Echinocereus*

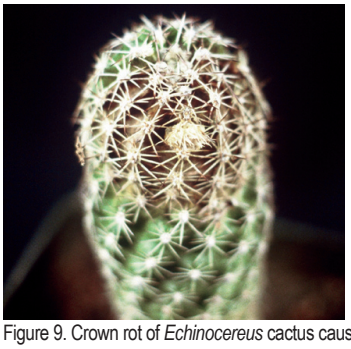

Figure 9. Crown rot of *Echinocereus* cactus causes dark sunken areas in which tissue has rotted.

Figure 10. Internal rot of *Echinocereus* cactus.

Soft rot of several species of *Echinocereus* is caused by a species of *Helminthosporium*, a fungal pathogen that produces airborne spores abundantly. These spores are easily disseminated in splashing water and windborne rain. They require free water for germination and penetration into the host. Most occurrences have been in plantings in commercial nurseries on *Echinocereus* species, but the fungus is found on pad cacti occasionally. The first symptom of infection is dark, sunken areas that are soft and water soaked (Fig. 9). In *Echinocereus*, disease may begin anywhere on the upper part of the cactus and causes an internal soft rot (Fig. 10). In pad cacti, sunken soft-rotted areas appear on the pad surface.

Water management is probably important for prevention of this disease, but to date no research has been done to determine the optimum conditions for disease development. Applications of fungicides such as thiophanate-methyl may help prevent infection where disease has been problematic. Infected plants should be removed so that they are not sources of spores that will infect nearby plants.

Pythium rot of barrel cacti

An internal soft rot of barrel cacti is caused by species of *Pythium*, a soil borne pathogen that is favored by moist conditions (Fig.11). Golden barrel (*Echinocactus grusonii*) is commonly affected. *Pythium* sp. can cause root and/or crown

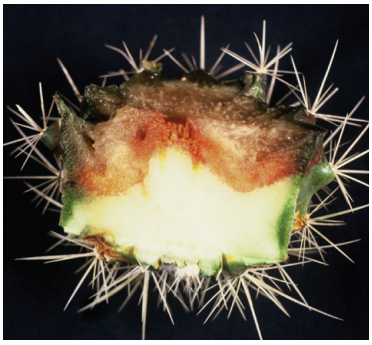

Figure 11. Internal rot of barrel cactus caused by *Pythium*.

rot if plants are placed in the ground too deeply when transplanted or are wounded and then overwatered.

Barrel cacti should be planted so that the roots are placed firmly in the soil but no soil is placed around the base of the plant. Care should be taken to avoid wounding the fleshy part of the barrel when planting. Since the rot is internal, it is often too late to treat cacti once disease is detected. Preventive treatments of mefanoxam or phosphytyl-Al may be warranted in valuable species, but the best prevention is proper planting and watering.

Root and crown rot of agaves

Several soil borne pathogens including a species of the bacterium *Erwinia* and the fungus *Fusarium* have been implicated in root and crown rots of agaves. Disease is usually in concert with infestations by the agave weevil, and currently it is thought that weevil feeding enables these pathogens to enter and cause disease when they normally would not be pathogenic on healthy plants. See the section on agave weevil for more information on this insect vector. Other than preventing wounds in the plant, such as those caused by the agave weevil, there is no control for the bacterial and fungal infections once the microbes have entered the plant.

Bacterial necrosis of saguaro

Figure 12. Symptoms of bacterial necrosis of saguaro.

Figure 13. Bacterial necrosis of saguaro causes exudation of dark brown liquid

Bacterial necrosis of saguaro is caused by the bacterium *Erwinia cacticida.* The initial symptom is a small, light-colored spot with a water-soaked margin on the surface of the trunk or branches that may easily go unnoticed. The tissue under the infection site soon becomes brown or almost black. As disease progresses, the tissue may crack and exude a dark brown liquid (Fig. 12, Fig. 13). If decay is slow, the tissue may not have the liquid exudates. As infected tissue breaks down the woody skeleton is exposed (Fig. 14)

The pathogen, *E. cacticida*, survives in soil or

Figure 14. Bacterial necrosis of saguaro causes soft tissue to break down leaving only the woody skeleton.

plant tissue for long periods of time. The bacterium is spread by insects and in infested soils. Infections take place at wound sites on roots, trunks and branches, especially those made by insects, weather-related events, or rodents. Dead and dying plants serve as reservoirs of the bacterium and as sources of bacterial inoculum for new infections. In large natural stands where disease occurs, proximity of saguaros to dead and dying plants significantly influences mortality.

If noticed in time, new infection sites can be treated when very small (less than two inches (5 cm) in diameter) by carefully removing the infected tissue, along with a small margin of healthy tissue, using a clean sharp knife. Allow the wound to heal on its own. Older infection sites exuding dark liquid, especially those at the base of the plant, are not treatable. Plants with advancing decay should be removed to prevent infection of nearby saguaros and damage or injury of persons or property. All infested plant material should be completely removed from the site and away from any other saguaros.

Sammons' virus of *Opuntia*

Figure 15. Characteristic rings on *Opunti* pads infected with Sammons' virus.

Opuntia Sammons' virus is common on Engelmann prickly pear (*Opuntia englemannii*). It causes light yellow rings with some mosaic pattern in the pads and is often called a ringspot virus (Fig. 15). The disease is more of a curiosity than a problem since infections do not cause noticeable harm to the plant. The only known native hosts are species of *Opuntia*. Opuntia Sammons' virus has no known insect vector, but it is sap transmissible. It is a member of the genus *Tobamovirus* and is closely related to viruses such as tobacco mosaic virus. It is typically spread by propagating cuttings from infected plants. Do not use infected plants as a source of propagation material. No controls are recommended.

Insects

There are several insects that can potentially damage many aloes, cacti, agave and yuccas. Most do not require chemical treatment for adequate control. A healthy, non-stressed plant will withstand the occasional insect pest better than a plant stressed by planting in poorly-drained soil, improper plant-

ing location, and general neglect. Whenever purchasing cacti, agaves or yuccas, examine the plant carefully to avoid bringing the insects home with you and infecting your other plants.

Agave Snout Weevil (*Scyphophorus acupunctatus)*

The adult weevil attacks many species of agave. The very large *Agave americana* or century plant is more susceptible to weevil damage than the smaller species. The adult weevil is about ½ inch (12 mm) in length, is brownish-black and has a dull body (Fig. 16). The adult female enters the base of the plant to lay eggs. Decay microbes also enter through this injury and as the tissue rots, the plant has a wilted appearance. Infested plants soon collapse and die (Fig. 17). The larvae (grubs) develop in the dying plant and infect other hosts nearby. Agave snout weevil also infests the canes of several Yucca species.

Fig. 16. Adult Agave Snout Weevil (*Scyphophorus acupunctatus*). Actual size approximately ½ inch (12 mm).

Fig. 17. Damage to *Agave* caused by agave snout weevil.

Control of the agave snout weevil is difficult. Selecting species that are less susceptible and typically smaller than the century plant is helpful, especially in areas where the problem has occurred previously. With rare or special specimens, chemical prevention using a broad-spectrum insecticide applied in spring is often effective in reducing damage.

Cactus longhorn beetle (*Moneilema gigas*)

Figure 18. Cactus longhorn beetle feeding on *Opuntia.*

The cactus longhorn beetle attacks several species of cacti including prickly pear and cholla cactus (*Cylindropuntia* species), barrel cactus (*Echinocactus* and *Ferocactus* species), young saguaro cactus (*Carnegiea gigantea*), and others. The adult beetle is about 1 to 1¼ inches (2.5 - 3 cm) long, shiny black, and has distinctive white markings on the antennae. The antennae are often longer than the overall body length of the adult beetle. Damage to the plants is the result of feeding on the margins of prickly pear pads or terminal buds of other cacti (Fig. 18).

Cholla cacti are attacked by the beetle when the adults lay their eggs, hatch and the larvae burrow into the stems. Waste (frass) is pushed out the entry holes and forms a black crusty deposit on the canes. Larvae may burrow into plant roots and cause collapse and death of the plants.

Cactus longhorn beetle is controlled by hand picking the insects off infested plants. The beetles are most active and easier to detect and destroy in the early morning or late evening, especially after warm summer rains. Very spiny species are less likely to have damage from the beetle due to a natural defense by the spines. Chemical control is not recommended since the populations usually are not high and hand picking is effective.

Cochineal scale (*Dactylopius coccus*)

Figure 19. Waxy coat of cochineal scale

Figure 20. Red body fluid of the cochineal scale on *Opuntia.*

Prickly pear (*Opuntia* species) and cholla cacti (*Cylindropuntia* species), are attacked by cochineal scale. The insect covers itself with a waxy coat that makes it appear as white cottony tufts attached to the pads and stems of the cacti (Fig. 19). To positively identify cochineal scale, crush the waxy coat with a pencil eraser. If the result is a deep red material-actually the body fluid of the insect-then it is cochineal scale (Fig.20). Cochineal scale is used by native peoples as a source of red dye and also as a natural food coloring in processed foods.

Cochineal scale usually can be controlled by using a strong stream of water to wash the insects from the plants. If the infestation is heavy or the insects return, an application of insecticidal soap may be needed.

Plant bugs

Fig. 21.Agave plant bug (*Cautotops barberi*) magnified

Caulotops barberi, small bugs measuring about 0.6 inches (1.6mm) long, tack agaves and other rosucculents (Fig. 21) Large ulations may be found on given plant. The populareach damaging numbers late summer or early fall. bugs feed on leaves and cause a light yellow-tan

Figure 22. Damage to *Agave* caused by minute plant bug.

Figure 23. Damage caused by leaf footed plant bug.

Coccid scale, soft scale

Fig. 24. Coccid scale on *Agave* spp.

scar at the point of feeding (Fig. 22). If left untreated, plant will decline and eventually die.

Caulotops barberi may be controlled by using insecticidal soap or a broad spectrum ornamental plant insecticide. Chemicals should be applied in early morning or late evening when the bugs are most active. Several applications of the insecticidal material may be needed for complete control.

A larger species of plant bug attacks prickly pear (*Opuntia* spp.) and leaves a tan scar at the point of feeding (Fig. 23). The damage is cosmetic but can be reduced by application of insecticidal soap or a broad spectrum insecticide.

Agaves that are stressed are more susceptible to soft scale (*Coccid* spp.) The stress may be the result of inadequate water or poor growing conditions. Neglected plants are most vulnerable and should be inspected regularly for signs of all pests. By the time the scale is discovered, the plant may be irreparably damaged.

Scale insects firmly attach themselves to the agave leaves and damage the plant by sucking the plant juices from the leaves (Fig. 24). Soft scales have a flattened, plate-like cover that, when the insect reaches adulthood, is less than 1/8 inch (3.0 mm) in diameter concealing the actual insect body that is underneath the 'shell-like' cover. If left untreated, the scale will eventually kill the plant or cause enough cosmetic damage to make the plant unattractive.

One option for control of coccid scale is to separate the infected plants from the healthy plants. Provide plants with good growing conditions and proper cultural care and appropriate irrigation, so they are more resistant to scale attack. If the scale is only attacking an individual plant, discarding the plant is the best control. When large groups of plants are infected, judicious sprays of a systemic insecticide such as imidacloprid (Merit®) or acephate (Orthene®) are effective. Systemic insecticides are absorbed and moved within plants and as the insect feeds on the plant they are killed.

Mites

Figure 25. Galling and distorted growth of aloe caused by aloe mites.

Mites are not insects, but are closely related to spiders. Mites are very small and can be observed only with a magnifying lens or microscope. The mites that attack aloe and other species such as *Haworthia* and *Gasteria* are eriophyid mites, a group of plant-feeding mites that often cause galling or abnormal growth of the host plant tissues (Fig. 25, Fig. 26). Unlike their spider mite relatives that have four sets of legs, aloe mites have only two sets of legs. They cause malformations in plants by injecting a chemical that induces galling into the plant tissue. Stems, leaves and flowers may be affected. The damage to the aloe plant is irreversible, and infected plants should be removed. After removal, place all infected plants in plastic trash bags to prevent re-infestation of remaining plants.

Two spotted mites (*Tetranychus urticae*) also attack certain species of Yucca (e.g. *Yucca gloriosa*, *Y. aliofolia*, and *Y. recurvata*). They are difficult to see, but under a microscope, two spotted mites are about 0.02 inches (0.5mm) in length and are red, pink, or yellow-green in color with two dark spots on their body. They have eight legs and no wings or antennae. The mites leave a tell-tale speckling of he foliage that eventually turns tan or gray. With severe infestations, a fine webbing is also present on the undersides of the leaves. When mite infestations get out of control, the plant will slowly die.

Two spotted mites are controlled by maintaining high humidity around the plant using periodic misting or washing. Washing also will remove mite webbing and help reduce mite populations. Chemical control includes products known as acaricides. Always check and carefully follow the label instructions for effectiveness and safety

Figure 26. Eriophyid mite damage on *Opuntia* sp.

Animals

Ground squirrels, pack rats, rabbits and mice can severely damage agaves, yuccas and cacti. Aloes are relatively free of rodent damage. During periods of prolonged drought these mammals attack and destroy both mature and young plants.

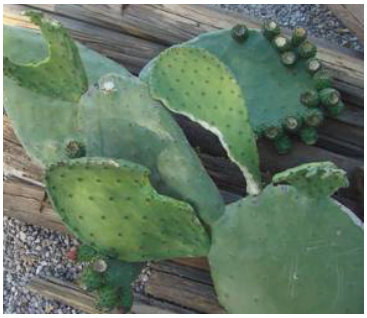
Figure 27 Rabbit damage of *Opuntia*.


Fig. 28. Rabbit damage on *Agave* spp.

Damage of the foliage is very typical (Fig. 27, Fig. 28). If the damage is not too severe the plants will recover, but prized specimens may be irreparably damaged. In some cases damage is so severe that the plant dies.

Control measures include exclusion of the pests by fencing, using live and other traps, and using poison baits. Poison baits should be used carefully and according to the manufacturer's recommendations since they may cause injury or death of non-target animals such as birds. Fencing should completely surround the plants and be buried 4–6 inches (10–15 cm) below ground to prevent the animals from burrowing underneath. Only through diligence can these pests be controlled.

In times of drought, larger animals such as javelinas (wild peccaries) will often grub out many desert plant species. They eat the roots and small portions of the foliage. Fencing is the only effective solution to this problem. Fencing should be sturdy and at least 4 ft. high. The bottom 4 - 6 inches (10 - 15 cm) of fencing material should be buried below grade to prevent rabbits from borrowing under the fence. Commercial growers have reported success with electric fences that deter both rabbits and javelinas.

For more information

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Cactus, Agave, Yucca and Ocotillo, Bulletin Az1225, University of Arizona, and Life Sciences College of Agriculture, Tucson, Arizona, 85721

Control of Bacterial Necrosis of Saguaro. Bulletin # 8837, University of Arizona College of Agriculture and Life Sciences, Tucson Arizona, 85721

How to Transplant a Cactus, Bulletin #1376, University of Arizona College of Agriculture and Life Sciences, Tucson Arizona, 85721

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