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The Use of Sulfur in Desert Soils

While sometimes found on nursery shelves, few really understand the benefits and the proper use of soil sulfur.

Sulfur gardening products are often bypassed by shoppers in nursery aisles because, I suspect, we do not know what they are for or how to use them. When we go to the nursery, we are usually looking for nitrogen fertilizers, repair parts for irrigation systems, or a new plant to grace that special spot in the yard. Walking past the amendment in our search, we fail to recognize the positive benefits of sulfur in the garden.

In gardening, elemental sulfur has two main uses. The first use is as a nutrient or fertilizer for plants growing in sulfur-poor soils. The second use is as a soil additive to help reclaim poor quality soils and irrigation waters. Elemental sulfur, or soil sulfur as it is sometimes called, can play an important role in maintaining good plant health in desert soils, but it must be used correctly for best results.

First, the good news! Most desert soils in Arizona possess sufficient sulfur for good plant growth and there rarely is a need to specifically add sulfur as a fertilizer in home gardens and landscapes. This occurs as the native rocks break down during the weathering cycle releasing sulfur and other nutrients into the soil environment where they are picked up by the roots of plants and used in the process of growth and development.

In low sulfur soils, such as artificial potting soils, plant deficiency symptoms include a light green color of younger leaves with occasional dead spots in the leaf tissue. Unfortunately, these symptoms are also similar for other nutrient deficiencies and are easily confused. In these cases, an all-purpose complete fertilizer enhanced with micro nutrients may be a good choice for good plant health.

It is important to remember that elemental sulfur, in its natural form, cannot be used by plants as a nutrient. It must first be converted in the soil to the sulfate form through a naturally occurring process called oxidation. Oxidation occurs in aerated, moist soils when soil microorganisms change sulfur into sulfuric acid, which contains the sulfate ion. Once converted, plants can easily pick up and use the nutrient. Because the

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oxidation process is relatively slow, it may be best to use a sulfate-containing fertilizer, such as ammonium sulfate, for a quicker nutritional response.

The second use of sulfur is to help reclaim poor quality soils. This is the use that is most valuable in our area and where sulfur as a soil amendment really shines.

Poor quality soils can be quite damaging to non-adapted plants. The most common problems include high pH and high levels of sodium and bicarbonates. Sulfur, in the form of sulfuric acid, is valuable in solving each of these situations.

Sulfuric acid, by itself, is expensive and dangerous to use because of its corrosive capability. This is why it is not sold on the garden shelves, except in well diluted forms. The benefits of sulfuric acid, however, can still be achieved by adding powdered sulfur to the soil and allowing the safe oxidation conversion to take place. One of the drawbacks is the relatively slow pace in which the transformation occurs. Patience is required. However, the relatively slow speed of the process allows the benefits to be lengthened out over time giving a longer lasting effect.

Once the transformation occurs, the sulfuric acid actually does its work quite rapidly. Sulfuric acid acts to temporarily lower the high pH of alkaline soils and to help eliminate the buildup of sodium and other harmful chemicals in the soil. Regular additions of sulfur will ensure that the conversion process is continually occurring and continually providing the beneficial acidifying effect.

To eliminate sodium, an element essential to human health but harmful to plants, sulfur needs a little help from calcium, another element. Sulfuric acid combines with calcium to form gypsum which then works to chemically replace sodium in the soil. For the process to work, there must be enough calcium present to do the job. After the sodium is replaced in the soil with calcium, it is free to be leached out of the root zone by deep irrigation. If a soil does not contain sufficient calcium, no amount of sulfur will reclaim the soil. In low calcium soils, use gypsum first to get rid of the sodium and then add sulfur to help buffer the soil pH.

There are some dangers to using sulfur. The main caution is to prevent any sulfur dust from coming in contact with plant leaves and stems when the daytime temperatures are above 90 degrees F. Sulfur can burn tender foliage and seriously set back plant growth. It is a good idea to incorporate the sulfur into the soil by raking or light tilling to ensure that the sulfur is not blown onto the leaves by the wind or splashed up by sprinklers or rain.

Another problem can occur when there is not good drainage of water through the soil. Sulfur in its various forms is another salt and high salt levels can damage roots and leaves of plants. Before adding any soil amendments, it is always a good idea to physically improve drainage by breaking up hardpans and caliche layers so that water can move freely down and out of the root zone.

Soil sulfur, is commonly used to overcome tough garden soil problems and to protect the long term health of landscape and garden plants. If used correctly, it can be a valuable tool in increasing the productivity of the arid desert soils of Pinal County.

How Water Moves Through Soil

In order to correctly place irrigation water where plants can find and use it, it is important to know how water moves through soil.

It is a well known fact that water is critical to the health and well being of plants. The way that water moves into and through the soil can often be the deciding factor as to whether a plant will be correctly irrigated, or whether it will come up short of water. Since water availability is so critical, an understanding of how water behaves in soil is an important key for good plant management.

Let's start with the basics by answering two questions. First, "What is soil?" Second, "What is water?" Afterwards, we need to discuss some of the various physical and chemical forces that govern the behavior of water in soil. Finally, we will finish up describing some of the steps that we can take to properly manage water movement in the soil.

Soil particles are small, separate pieces of rock broken down to the size of sand, silt, or clay. These particles, mixed together, form the soil that we know so well. Some soils have a lot of sand in them. We call them sandy soils. Other soils contain more silt or clay and we call them silty soils or clay soils respectively. No matter what the nature of the soil, these particles are all independent of each other and they have empty space around them. The space around the soil particles are called pores and depending upon the size of the soil particles, they can be rather large or fairly small. These pores will be filled with air or water. Plants do best when these pores contain about an even mixture of water and air.

Water is a combination of two hydrogen atoms attached to one oxygen atom. The chemical formula is H2O. The way that the hydrogen atoms are attached to the oxygen atom gives one water molecule a slight attraction to other molecules of water around it, and even to solid surfaces. Consider a drop of water on the kitchen counter. One molecule tends to cling to other molecules in the drop and to the counter surface itself. This attraction is part of the reason that water tends to attach itself to individual soil particles.

When a drop of water comes in contact with the surface of the soil, several forces immediately come to play. The first is gravity. Another major force is the attraction of water to external surfaces, such as we have been speaking. Other major forces include capillary action and boundary layer resistance.

Gravity acts on water just like it does on everything else. As water touches the soil, gravity begins to pull the water molecules down through the pores of the soil. It fills the pores and wraps around the soil particles and will keep pulling the water down until there is no more water upon which it can act. The power of gravity pulling on water can not be discounted.

We mentioned briefly the force of attraction that exists between the soil particles and the water itself. Because of that attraction, water will surround the soil particles and cling to their surface. This force of attraction to surfaces is greater even than the force of gravity. For this reason, a healthy soil just after an irrigation will have water clinging to the soil particles, but the pores will be filled with air. What happened to the water in the pores? The free water in the pores is normally pulled down and away by gravity to surround other particles further down. Unhealthy, water-logged soils retain water in the pores. That is never good. Why is that?

After an irrigation, we never want a soil to be completely filled with water to the exclusion of air. Soil pathogenic fungi have a heyday in that kind of environment. We likewise never want a soil to go blow-sand dry where there is no water at all in the soil. This condition is also lethal to plants. If you can envision a happy medium, you will come to understand why the best conditions for plant growth and development are where there is water surrounding the soil particles but the pores are filled with air.

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There is another force acting on water in the soil. That is capillary action. This force is one that helps draw water sideways in the soil, that is, to carry it laterally away from the water source. Capillary action acts much in the same way that fluid moves up a straw. As we suck on the straw, the fluid moves upwards through the straw and into our mouth. Likewise, the attraction that water has for the surfaces of soil tends to cause the leading edge of the wetted zone to be pulled into the empty soil pores in front of it. Thus, there is a constant sucking of water away from the point of water delivery. If the water is delivered to the soil surface, the capillary action will tend to draw it down and away laterally until the water is turned off. If the point of delivery is a subsurface drip irrigation tube, capillary action will pull the free water in 360 degrees, a full circle.

Capillary action plays a key role in salt movement. Since the highest concentration of salt will always be at the outside edge of the wetted front, movement of water in whichever direction through capillary action will also tend to create a concentration of salts at its outside edge. Knowing this, we can manage those salt levels with deep irrigations as necessary.

There is one other critical force to remember, boundary layer resistance. If in the soil there are layers of different textures of soil, such as a sand layer laying on top of a clay layer, or vice versa, water moving into the soil tends to fill the first layer completely before moving across the boundary into the second layer. The first layer must be saturated before it will move across the barrier. If insufficient water is applied to the soil, irrigation water may never reach the lower roots. That is not a good thing either.

This boundary effect also happens when we plant a tree, shrub, or other type of plant and we create a different soil condition within the planting hole as compared with that outside the hole. This is one reason that we do not recommend adding organic amendments to the soil when we plant trees. It creates an artificial boundary at the edge of the planting hole.

When water fails to move past boundary layers, natural or artificial, roots naturally tend to stay in the moist soil. Because of shallow irrigations and boundary layer problems, small, constricted root systems often result. These regularly fail to hold up a tree in a wind storm.

Another related effect is common when drip irrigation systems are used to water larger trees. Depending upon soil conditions, a drip system running, say twenty minutes, may be sufficient to fill the top layer and move to a lower layer in a sandy soil. In a clay soil, twenty minutes may be insufficient to move across a boundary layer. I like to use a soil probe to check to see how deep the water is actually going after an irrigation. In this way, it is possible to properly ensure that our trees, shrubs, and other plants are receiving the amount of water necessary to stay healthy and successful.

Armed with an understanding of how water moves through the soil profile, we can better adjust our irrigation schedules and techniques to improve the health and success of our garden and landscape plants.

Desert Adapted Plants Cope with Heat and Drought

What makes a desert-adapted plant immune to the harsh conditions found here in the Sonoran Desert?

As it turns out, there are many ways that our plants deal with the intricacies and challenges of life. No matter whether it is hot or cold, wet or dry, or something in between, plants can adapt to local conditions that would otherwise spell the demise of less well-adapted plants, particularly those that live in the desert.

Take spruce trees for example. Well-adapted and hardy to live at high elevations, unfazed by plunging temperatures and blizzard conditions, they simply do not have the capacity to grow in our hot, dry desert conditions. Likewise, you will never find a mesquite or palo verde growing next to a spruce tree at high elevations. They can't take the cold. There are definite reasons why plants can grow at one location but not at another.

These reasons can be due to a number of different attributes. For one plant it may be simply a physical characteristic or structure that gives them an edge. For others it may be a chemical pathway in its life processes, or the way the plant itself responds to conditions in its environment. Let's define a few terms and then take a look at the features plants often use to survive desert conditions.

We use the phrase "desert-adapted plants" regularly as though we expect others to understand exactly what we mean. Some used to the desert and its ways may be well-versed in the harsh realities that all living things have to put up with to survive the dryness, the heat, and the soil issues that can limit the growth and development of plants. They may well realize that when we speak of a plant being desert-adapted, we mean that it can live in and thrive in these desert conditions. Others may not realize that a non-adapted, or less adapted plant may struggle to survive. When that happens, wrecks in the garden can happen.

One of the most important of the special adaptations of plants living in the desert is the ability to capture energy in more effective ways. Most plants create three-carbon sugars (C3) during the photosynthesis process. There is nothing wrong about the C3 photosynthetic process, but plants that are able to create a four-carbon sugar (C4) and those that possess the capacity to use the Crassulacean Acid Metabolism (CAM) cycle are more energy efficient than their C3 neighbors. That gives them a definite edge.

In addition, the CAM process also allows the plant to take in carbon dioxide during the cooler temperatures at night. Since summer days can be quite hot, CAM allows the plant to shut the openings of its stomata, the doors that allow carbon dioxide into and oxygen out of the plant, as necessary. With the stomata closed, there is less water loss from the plant. Pretty nifty, don't you think? Succulent plants, those that tend to store water inside in specialized tissues, most commonly use the CAM process. Cacti, agaves, and other fleshy plants fall into this category.

Many of the hardiest plants do very well under our environmental conditions while others, usually those that we want to grow, seem to struggle during times of drought. Many of these hardy plants are C4 plants. That is, they produce the four-carbon sugar. This pathway, and the different internal anatomy give them a decided leg up. Common C4 plants include corn, sugarcane, and bermudagrass.

Adaption is not just confined to what happens inside the plant. There are also structures on the outside of the plant that provide relief from drought and heat conditions. Many desert plants, such as mesquite and palo verde trees have large and expansive root systems that spread well beyond the edge of the tree. Many of these roots are quite shallow in the soil enabling the plant to pick up any scarce rainwater that might fall.

Some roots are specialized in that they store water for the plant during dormant seasons, which allows the plant to save during times of plenty for use when drought occurs. Others, growing from a seed in place, naturally have a monstrously large taproot that not only stores water, but extends down deep into the soil to find hidden treasures of water.

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The leaves also often play a key role. Some plants, like the agaves, have sword-shaped leaves with slick sides that capture raindrops and direct them down towards the base of the plant where they are absorbed into the plant's interior. Other plants may have hairy leaves, we call those hairy-looking structures tricomes, that help filter water out of the air and direct it to the plant tissues for absorption.

On the leaves, there may be a super thick waxy covering, called the cuticle, that helps keep water inside the plant, even during droughts. It also is a barrier to help keep out grime, diseases, insects, and all the other stuff that is supposed to remain on the outside. The waxy cuticle is a critically important part of the plant's anatomy.

The color of leaves also plays an important role in water conservation. The lighter colors of silver and grey reflect light, and therefore heat. As leaves stay cooler, the rate of transpiration remains relatively slow. The slower the movement of water through the plant, the slower will be the loss of water. Likewise, the size of the leaf has an impact on water usage. Smaller leaves will release less amounts of water than larger leaves.

Some desert plants, like the ocotillo, go into drought dormancy. When water becomes short, they just drop their leaves and go to sleep until the rains come again. Some people worry when these plants abruptly lose their leaves. Not to worry, this type of behavior is entirely normal. Other plants have the capacity to fold their leaves or turn their leaves away from the direct sun when they start to run short of water.

While these various mechanisms for dealing with low water-conditions are just a sample of the various strategies for water savings, we cannot end without mentioning storage capacity. Just think about the tremendous advantage that comes to a cactus over other plants because of their ability to store water, not only in their roots, but also in their trunks, arms, and pads. Even still, these plants can run short during extended periods of drought.

Desert-adapted plants have many ways to "beat the heat." If we know how these particular characteristics work, we often can use them to protect plants from extreme weather conditions, save water, and improve the look of our landscape plants.

Overseeding Bermudagrass Lawns with Annual Ryegrass

Where has the year gone!

It seems like just yesterday that we last spoke about preparing bermudagrass lawns for the winter, but October 1 is just two weeks away and it is time to start thinking about overseeding once again. Let's review again the basics of this annual task by looking again at what we discussed this time last year.

First of all, there is no lawn grass that will stay green and growing year round. In the summer, bermudagrass hybrids grow well and are generally hardy but they go dormant during the winter months. On the other hand, winter grasses, like annual and perennial ryegrass, cannot take the heat and dry of our summers.

To solve this problem, many turf managers choose to overseed the hardy bermudagrass with winter grasses to keep lawns green and looking good through the winter. Then, in the spring, the winter grasses are scalped back so that the bermudagrass can begin to grow uninhibited. The annual ritual of converting all forms of bermudagrass and other warm weather lawns to a winter-hardy grass goes into full swing around the first of October throughout the desert areas of Arizona. The conversion process is fairly easy to do, as long as a few simple rules are followed.

If overseeding seems right for you, now is the time to start getting ready. The warm temperatures of late September and early October are ideal for overseeding. If you wait until November, the cooler temperatures may slow the germination of the new seed and leave a skimpy, uneven lawn. The patches of bare ground scattered through the seeded area can be quite unsightly. Early October provides excellent temperatures for good germination and growth of the young seedling plants.

The winter grass to plant is ryegrass. You have your choice of either annual or perennial rye. Annual ryegrass seed is fairly inexpensive and germinates well. The grass will stay green well into the spring, only dying out when the heat of June arrives.

There are several benefits to planting perennial over annual ryegrass. Perennial ryegrass has a much finer leaf structure that is less coarse rather than the tall and lanky-growing annual ryegrass. In short, many people feel that perennial ryegrass makes a better looking turf than the annual forms. The finer leaf feature of perennial rye also helps it blow through the lawn mower easier. The more rank annual rye tends to clog mowers. Both the annual and perennial varieties work well in our winter climate.

When preparing to plant ryegrass, it is important to remember that the heat-loving bermudagrass will most likely still be green at the first of October and will continue to stay green until the frosts come. At least my bermudagrass was still green this past Saturday when I did my overseeding. In order to ensure proper seed contact with the soil, it will be necessary to thin out the summer grass growth. This is most easily done by lowering the lawn mower blades gradually until you have scalped the lawn area close to ground level. It is important to remove all grass clippings. If grass catcher was not used, it will be necessary to rake the area with a flexible leaf rake and remove the litter.

The next step is to apply ryegrass seed over the relatively bare surface at the rate of one to one and one-half pounds of seed per 100 square feet. Distribute the seed evenly by hand or with a lawn seeder. Overlap seeded areas to be sure of complete coverage. You can be sure, of course, that this procedure will be watched with interest by every bird in the neighborhood.

After seeding is completed, apply manure or some other organic mulch to lightly cover the seeds. The mulch will help hide the seed from the birds and also help keep the seeds moist between irrigations. The mulch should be evenly distributed to a depth of about one-fourth inch thick over the entire area.

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It is critical to keep the seed moist until it has germinated and has developed a root system capable of picking up sufficient water to meet the plants needs. Set the sprinkler to wet the entire lawn area. For best seed germination, apply light irrigations to the seeded area several times during the day, especially during the warmer parts of the day. The germinating seed must not be allowed to dry out during this stage or it will die. If water accumulates on the surface of the soil, it is okay to turn off the sprinkler temporarily, but do not forget to keep an eye on the seed and water again as necessary.

Water accumulating on the soil surface is bad because it may float out the rye seed and expose it to the air, birds, or drying temperatures. Sometimes it will wash the seed into lower lying areas causing an uneven stand. When the water disappears from the soil surface, and the surface of the mulch begins to dry, be sure to start the sprinklers again. Scratch the surface to make sure water has penetrated the manure covering and has thoroughly wet the seed surface.

After the seed has germinated and the area has a green cast, the frequency of irrigation can be cut back to once each day or once every other day. If wilting of the new grass seedlings becomes evident, be sure to water immediately!

The new lawn should be first mowed only when the entire area is approximately two to three inches tall. Use a sharp mower and remove the clippings during the first mowing. Set the mower to cut at one and one-half to two inches above ground level and repeat the mowing when the grass grows about one inch above the set level.

It generally takes about two weeks to get a good stand of ryegrass in the fall, so patience and diligent care are essential.

The transition back to summer grass in the spring is much more simple even than the fall transition. Simply scalp back the annual ryegrass with the mower in May or early June, whenever the nighttime temperatures reach 60° F. on a regular basis, and deep irrigate the lawn. Soon the bermudagrass will start growing again.

With a little advance planning and an eye for detail, beautiful, deep green winter lawns are possible throughout the desert regions of Arizona.

If you have questions, you can reach one of our Master Gardener volunteers every week day between 9 am and 12 pm by calling the Master Gardener hotline at (520) 374-6263. You can also call the Cooperative Extension office, 820 E. Cottonwood Lane, Building C, in Casa Grande at (520) 836-5221, extension 204 and leave a message.

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