ARIZONA COOPERATIVE EXTENSION
THE UNIVERSITY OF ARIZONA • COLLEGE OF AGRICULTURE AND LIFE SCIENCES

Backyards & Beyond

Spring 2008 RURAL LIVING IN ARIZONA Volume 2, Issue 1

Featured Plant

Common Name: Mexican Goldpoppy
Scientific Name: *Eschscholtzia mexicana*

Loretta Hostettler

Kim McReynolds, Area Extension Agent, Natural Resources, University of Arizona Cooperative Extension, Cochise, Graham and Greenlee Counties

Mexican goldpoppies are a familiar sight in many spring time photos hailing Arizona's colorful wildflowers during years of plentiful winter moisture. Naturalist Adelbert von Chamisso gave the genus (Eschscholtzia) its name in 1820 in honor of Dr. Johann Friedrich Eschscholtz. Both Chamisso and Eschscholtz were on an expedition by ship to the Pacific coast in 1817, sponsored by the Russian Count Nikolai Romanzoff. Eschscholtz was a surgeon and naturalist. Chamisso and Eschscholtz made the original collection of the California Poppy near the Presidio in San Francisco.

Mexican goldpoppies are smaller, more delicate plants that have adapted to the hotter, drier climate of Arizona. Also known as the desert goldpoppy, they can be found throughout most of Arizona, except in the northeastern part of the state. Mexican goldpoppies grow on plains, mesas, foothills and slopes from elevations of 4,500 feet and lower.

Mexican goldpoppies are annual plants that take advantage of warm, wet winters when they can cover whole hillsides. The plant itself has multiple stems that grow 12-16 inches tall. The leaves are narrow and heavily dissected, and are a blue-green color. The showy flowers are typically orange or yellow, but can rarely be found in white or pink. These plants have the potential to bloom over a very long time period during February through May, depending on the weather. The flowers open in response to the sun and close at night and under cloudy conditions. After the long, slender seed pods dry, they burst open spreading black seeds over a broad area.

In addition to Mexican goldpoppy adding color to the landscape, the plants attract doves and sparrows as they feed on the abundant, late-spring seeds. Mexican goldpoppies have an added benefit for those with allergies, as they are on several lists for use in landscaping due to their low production of airborne pollen.

Featured Bird

Common Name: Grasshopper Sparrow
Scientific Name: *Ammodramus savannarum*

Robert Shantz

Homer M. Hansen, Chairman of Wings Over Willcox Birding & Nature Festival.

Have you ever walked down by the pasture and seen a small bird perched on top of a fence post or hanging on to a strand of barb wire, singing away, but only heard the drone of the insects around you? Then its very likely you have seen and heard a Grasshopper Sparrow, so named for its insect-like song that sounds like the stridulation of a grasshopper.

If you do observe a Grasshopper Sparrow, they appear flat-headed with large bills and short tails, which sometimes makes these birds seem "top heavy." Overall, this sparrow is gray on the back and creamy white on the front, with a dark crown divided by a white stripe. But if you get a closer look with binoculars, subtle tans border a rich rusty color on the feathers of the back and hues of yellow and orange adorn the wings and head, surprising the observer with the delicate beauty of this sparrow.

A breeding bird of the prairies and grasslands, these sparrows build their nests at the base of grass or alfalfa. They may weave a partial dome into the overhanging grasses, concealing even more their well-hidden nest. Like most birds, the Grasshopper Sparrow captures insects during the breeding season to feed to their young. In fact, during the spring and summer, insects make up over 60 percent of their diet, with grasshoppers being one of their preferred prey, quite suitable to their name.

The Grasshopper Sparrow is unique among the sparrows of the U.S. in that it has resident populations extending into South America. The population estimates for this sparrow in the U.S. are around 11 million. However, don't be mislead by the extensive range and large population size. Like other birds of the grasslands, the Grasshopper Sparrow has declined significantly, with a drop of over 65 percent from the 31 million birds surveyed during the 1960's. Studies suggest that Grasshopper Sparrows do well in pastures that are light to moderately grazed, and not mowing hayfields and alfalfa during their breeding season in July and August prevents the destruction of their nest and young.

Though not as brilliantly colored as a cardinal, nor as melodious as a thrasher, the Grasshopper Sparrow holds true to its namesake and is a great bird to have in your neighborhood.

Backyards & Beyond

rural living in Arizona

Spring 2008
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Ron Hillard

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Jan Christensen

ARIZONA COOPERATIVE EXTENSION
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PROJECT BUDBURST
Launches Citizens Science Campaign!

Barron Orr, Ph.D., Geospatial Extension Specialist, Office of Arid Land Studies, Susan McGinley, Science Writer, Educational Communications and Technology, College of Agriculture and Life Sciences, and Jake Weltzin, Ph.D., Executive Director of USA National Phenology Network, all with the University of Arizona.

You and your family can join in to collect important climate change data based on the timing of leafing and flowering of trees and flowers in your area through Project BudBurst. Citizen-scientist volunteers will be able to help track trends in phenology (e.g., first leaf, first flower) on many different species and see how these relate to climate. Project BudBurst, operated by University Corporation for Atmospheric Research (UCAR) and a team of partners including the University of Arizona and the US Geological Survey USA National Phenology Network, allows U.S. students, gardeners, and other citizens to enter their observations into an online database that, over time, will give researchers a more detailed picture of global climate change.

Seasonal changes are all around us: flowers bloom, leaves turn color, butterflies emerge, birds and mammals migrate. By studying the timing of these periodic plant and animal cycles—a science known as "phenology"—scientists learn more about environmental trends across regions. Phenological data and models are important to agricultural planning, drought monitoring and wildfire risk assessment, as well as management of invasive and pest species and infectious diseases. Phenological research can contribute to a variety of areas as shown in the table below.

Follow these 5 simple steps to complete your phenological investigation!

You will find all the information you need to participate in Project BudBurst at **www.budburst.org.**

1) Select and identify one or more **plant for observation** using the plant list or by geographic area. (Note: If you do not have access to a plant that is on the Project BudBurst plant list, you can choose to observe any other plant species that is accessible.)

2) Describe the site where your plant is located. This includes finding the latitude and longitude of your site. You can enter your location in the UCAR Geocoder on the Project BudBurst website if you do not have access to a gps unit.

3) Determine the phenophase (phenological stage) you are looking for (i.e. Budburst/First Leaf, First Flower). For help, refer to the plant descriptions found in the plant list.

4) Now you are ready to **begin monitoring** your plant! Begin observations (before expected time of budding or flowering)!

5) When a phenophase has occurred, **report your observations** online.

http://www.windows.ucar.edu/citizen_science/budburst/ActivityGuide_PB.pdf

Examples of six areas that phenological research can contribute

Scientific Research Effects of climate variability and change, ecological forecast models, ecological synchrony, carbon sequestration, ground truthing for remote sensing, ecohydrology	**Human Health** Timing and prediction of allergy (hay fever) and pulmonary (asthma) problems. Study of vector-borne diseases (lyme disease, avian influenza, West Nile virus)
Agriculture Timing of management activities (pest and disease control, planting, harvesting, and provision of pollinators), drought monitoring, range management	**Natural Resources** Prediction of forest pest and disease outbreaks, fire management, invasive species management, watershed management, selection of species and varieties to be used in "'assisted migration" to conserve ecosystem services as climate changes
Tourism and Recreation Informing tourists when and where to go for seeing bird migrations, wildflower displays, and fall colors	**Education** School children and citizen scientist involvement in scientific observations; establish college curriculum in phenology that encourages local observations and educational use of the data products of the network

John Hays, Jr.

Water Management in Arizona

Tom Whitmer, Regional Water Resources Planning, Section Manager,
Arizona Department of Water Resources

Water management in Arizona is sometimes considered to be as clear as mud and it begs the question of "why is everything to do with water so complicated?" To understand water in Arizona one needs to first understand some of the fundamentals:

- Arizona currently has an adequate water supply, but it is limited and it is not always located in the place that you need it.
- Everyone seems to want and need more water.
- No one wants to pay too much for water.
- People who have water protect it with a passion.
- People who don't have enough water, think the people who do, either use too much, should share, or should sell to them.

When it comes to the regulation of water in Arizona there are five categories of water rights and even within a category there may be differences based on geographic locations. The five categories of water rights recognized in Arizona are groundwater, surface water, Colorado River water, effluent, and reserved groundwater rights. For the purpose of this article we will focus only on groundwater and surface water.

Groundwater is Arizona's most abundant water resource and Arizona is lucky to have some of the largest and most productive aquifers in the southwest. Despite this fact, however, groundwater is not always located where it is needed. Because most of rural Arizona relies exclusively on groundwater as its source of water, many of the State's groundwater aquifers are being overdrafted (meaning more water is being withdrawn from the aquifer than is being recharged).

The regulation of groundwater in Arizona is dependent upon whether or not you are located inside or outside of an Active Management Area (AMA). There are five AMAs in Arizona and they are located within Maricopa, Pinal, Pima, Santa Cruz, and Yavapai Counties. The five AMAs are known as the Phoenix, Pinal, Tucson, Santa Cruz, and Prescott AMAs.

Inside AMAs there are certificated groundwater rights and the use and management of groundwater is strictly regulated. Outside of AMAs there are no certificated groundwater rights and the use of groundwater is based on the doctrine of reasonable and beneficial use. Outside of AMAs a landowner may drill a well on their property and put the water

to beneficial use with the only restrictions being that they own the property where the well will be drilled, the well is drilled by a licensed well driller who has received a drill card from the Arizona Department of Water Resources authorizing the driller to drill the well, and the water will be put to beneficial use. The only other regulation on the use of groundwater outside of AMAs is a restriction on interbasin transfers of groundwater. There are a few exceptions to the prohibition of interbasin transfers, but they are explicitly stated in statute.

Surface water is perhaps the most misunderstood of the water rights categories and the regulations governing its use are probably violated most often. To understand surface water, a person needs to understand what surface water is. Arizona Revised Statutes § 45-141 defines surface water as "waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, floodwaters, wastewaters, or surplus water, and of lakes, ponds and springs on the surface." The key words in the definition are water from all sources flowing in natural channels. Water that is flowing down a paved road or on the roof of a house is not considered to be surface water until it flows into a natural channel.

Surface water in Arizona follows the Doctrine of Prior Appropriation, which means the person who puts the water to beneficial use first has the senior right to the use of the water. Prior to capturing surface water in the State of Arizona an individual must first obtain a surface water permit, right or claim in order to impound or use the water. Surface water can only be appropriated for the beneficial uses as defined in statute. The beneficial uses defined in statute are domestic, municipal, irrigation, stock watering, water power, recreation, wildlife (including fish), mining, and nonrecoverable water storage. Flood and sediment control are not recognized beneficial uses. The type of beneficial use also dictates the quantity of surface water that may be appropriated. Surface water is appurtenant (attached) to the land to which it has been certificated and may not be used anywhere else without going through a sever and transfer process.

In recent years, with the continuation of drought and greater demands on the water supplies from an increasing population, there has been a growing trend in rural Arizona to construct one or more earthen or rock dams across washes or other natural channels in order to capture "flood flows." The reasons cited for constructing these structures have been for everything from recreational purposes, to erosion control, to wildlife, to recharge, etc. Earthen structures constructed in a natural channel that captures surface water and prevents it from flowing downstream without a surface water right or claim may be in violation of State surface water law. Newly constructed rock dams or gabions that allow the surface water to completely pass through the structure, however, may not be in violation of surface water law. Older rock dams or gabion type structures may be in violation of surface water law if they have become sealed over time with sediments resulting in the capture and impoundment of surface water. It is always important to consult with the Arizona Department of Water Resources prior to construction of these structures, as the Department will investigate every situation that is reported or found and take appropriate action. Additionally, the Department will soon begin working on developing Surface Water Rules that will clarify the requirement for beneficial use and permitting associated with the use of these structures.

Perhaps the biggest misconception by individuals or groups involved in constructing these types of structures is the perception that they are only capturing flood flows that would have otherwise just "runoff." The misconception is that the "runoff" that is not captured serves no purpose and is just lost. In most, if not all cases, there are downstream users that have surface water rights or claims that depend on those flood flows in order to receive the water they have a right to. Capturing some or all of the flood flows may prevent a downstream user with a surface water right or claim from receiving the surface water they are legally entitled to use.

The Arizona Department of Water Resources recommends to anyone considering constructing any type of structure that may divert, impede, or capture the flow of surface water to check with the Surface Water Section prior to construction to ensure surface water laws are not going to be violated. Other questions pertaining to the status of water in any particular groundwater basin within the State may also be obtained by going to the Department's website www.azwater.gov and looking at the Statewide Water Atlas. The Statewide Water Atlas presents all of the known information about water for each of the 50 groundwater basins in the State, including estimates of water in storage, current demands by water use type, groundwater trends, etc. The Water Atlas is divided into nine volumes with each volume focusing in on a specific planning area. The Department's website is also the place to download applications or to get additional information regarding water in the State of Arizona.

John Riggs

Gillian Bowser, National Park Service (NPS)

Managing Pocket Gophers

Jeff Schalau, Extension Agent, Agriculture and Natural Resources, University of Arizona Cooperative Extension, Yavapai County

Pocket gophers benefit wildland ecosystems in many ways. They aerate and redistribute soil, incorporate organic matter, and inoculate soil with beneficial microorganisms. However, they are also destructive to cultivated landscapes, orchards and crops. It becomes increasingly difficult to control gophers once they have developed a network of burrows in an area. In Arizona, it is legal to kill pocket gophers, and when done properly, this is the safest most effective method of control.

Of the three species of pocket gophers found in Arizona, the Valley Pocket Gopher (*Thomomys bottae*) is most common. To be sure you are dealing with a pocket gopher, look for a fan-shaped mound of loose soil that has a smaller plug of loose soil in the center or to one side within the main mound (Figure 1). If you do not see this characteristic mound, then you may be dealing with a rock squirrel or vole. Moles are not known to exist in Arizona.

Pocket gophers live their entire lives in the soil, leaving only to occasionally feed above ground, to travel to a new area, or to get around an obstacle. They are usually five to seven inches long (without the tail), have pale to dark brown fur, a wide head, have enlarged front feet with long claws, long upper and lower front teeth, and a short tail with tactile hairs to allow them to feel their way when traveling in reverse. Pocket gophers are named for the fur-lined pouches outside of the mouth, one on each side of the face. These pockets are used for carrying food.

Feeding occurs in three ways: 1) on roots they encounter while digging; 2) surface feeding a body length or so from their tunnel opening; and 3) pulling vegetation into the tunnel from below. Their diet can include herbs, grasses, bulbs, shrubs, and trees.

Lethal trapping is the most effective method of gopher control. Wire body-gripping traps are the most common type. I recommend using two traps that are attached with two feet of wire to a common stake. Using a probe to find a main tunnel, excavate and expose the burrow. If you are near a mound, follow it back to where it connects to a main tunnel. Traps should be set in pairs (Figure 2). Set each trap and insert it well into the tunnel and cover the hole so that no light enters the tunnel. When gophers see light, they start pushing soil. This may trigger the trap without catching the gopher. Also, knock down any active mounds in the area to monitor for any new activity. Wear disposable gloves when removing dead gophers from traps and wash your hands thoroughly after handling. The benefit of trapping is that you know when you have been successful. Traps should be checked and reset daily until gophers are caught and no new mounds appear.

Gas cartridges are readily available from nurseries and hardware stores. Unfortunately, they are often not successful in treating pocket gophers. Unless the soil is moist, the gas diffuses into the soil rather than the burrow. Gophers also sense a change in the burrow system and can react by closing off that section of the burrow with soil.

Toxicants (poison baits) are often recommended for farms and orchards. Toxicants are effective, but can also kill non-target organisms or even cause secondary poisoning of non-target species such as domestic cats and dogs or other indigenous predators. Generally this method of gopher control is not recommended for home gardens and landscapes. If baits are to be used, then using a bait placement tool should be used to properly locate the bait in the burrow. Toxicants are not effective when placed above ground and will have a higher likelihood of killing non-target organisms such as birds and pets.

Flooding with water can be used to control gophers in some agricultural situations. However, it is not recommended in southwest urban landscapes. Simply putting a hose in the burrow will not effectively control gophers. Topography and burrow configurations often allow gophers to escape drowning. Flooding is only effective where it is used as an irrigation practice on large fields.

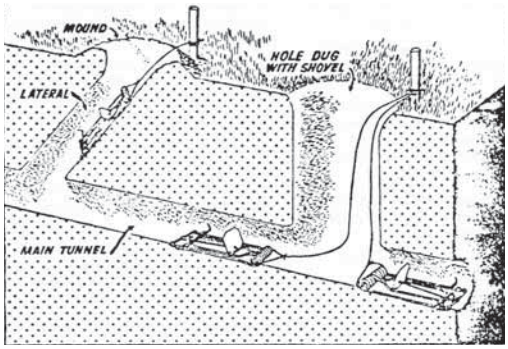
Pocket gophers can be excluded from small areas by creating a barrier. This is achieved by digging a trench 24-36 inches deep, and building a barrier of sheet metal, concrete, or hardware cloth. Remember, the barrier should also extend at least 12 inches above ground. Problems with exclusion include excessively rocky soil and the occasional creative gopher that will dig under the barrier. Raised garden beds can be lined with hardware cloth.

Old burrow systems should also be obliterated whenever possible. Existing burrows serve as pocket gopher highways that connect neighboring open space to your cultivated areas. Dogs and cats can act as biological control agents, but it really depends on the individual animal's hunting ability. Digging dogs can also be very destructive – maybe more so than the gopher. Sound emitting devices and windmills are generally ineffective as a control.

Effective pocket gopher management requires observation and persistence. Over time, you will reduce the gopher population on your property and minimize damage to your garden, orchard and landscape.

Jeff Schalau

Figure 1. Pocket gopher mound



University of Nebraska

Figure 2. Setting traps for pocket gophers.

Determining Ponderosa Pine Tree Density on Small Lots

Tom DeGomez, Forest Health Specialist, School of Natural Resources, University of Arizona

Past land management practices have often resulted in ponderosa pine stands that are overly dense, growing offsite, and prone to catastrophic wildfire, drought or bark beetle outbreaks[3,4,5.] Landowners and property managers in the Southwest now are faced with determining appropriate ways to prevent these potentially stand-replacing events. The best way to reduce wildfire threat, drought damage and attack by bark beetles is to lower stand density through mechanical thinning.

An additional benefit from reducing stand density is that remaining trees will grow more rapidly than when in an over-stocked condition. A century of research has shown that tree diameters increase at a faster rate in stands with lower densities, and ponderosa pine is no exception[7]. Thinning can greatly increase under story plant density in ponderosa pine forests[2,6.] Herbaceous plant growth, both grasses and forbes, typically increases when additional light reaches the forest floor.

A potential drawback to thinning may be the perception that the property's scenic beauty will be spoiled. Brown and Daniel (1986) found, in their study of predicting scenic beauty in ponderosa pine stands, that less dense (more open) stands had greater scenic value. The major components of higher preference were the increase in herbaceous plant growth and the remaining mature trees. (Refer to Figures 1a&b for a visual representation of various basal areas in a ponderosa pine stand with even-aged management.)

Figures 1a and 1b. Photos represent basal areas of approximately 60 and 120 square feet per acre, from an even aged stand in Flagstaff, Arizona.

HOW TO DETERMINE IF THE STAND HAS THE PROPER STOCKING RATE

Foresters use the term basal area to describe this stocking rate (or trees per acre when including their size in diameter); it is the total cross-sectional area of the tree in square feet measured at breast height. On small lots of 1-3 acres each tree can be counted and measured to determine the basal area of the stand.

Table 1 will help determine the basal area of each tree in each plot or each tree on the property if every tree is being measured. Use a flexible measuring tape (inches) to determine the circumference of each tree at 4.5 feet above the ground. Then multiply the number of trees in each diameter class times the basal area per tree (found in Table 1). Totaling all the trees and basal areas will give the total number of trees and total basal area for each plot sampled. (Note that inches become square feet in the conversion.) Adding in other tree species such as oak and juniper can help in getting a total assessment of the property.

Table 2 can assist in choosing the target basal area for thinning the property. Once the target basal area is determined for the stand, refer back

to Table 1 with the overall stand data to determine whether the stand has more or less basal area than is recommended for your location. If you have a lower basal area than recommended, no action is needed. However, if the basal area for the stand is more than the optimal amount listed in Table 2, it is recommended the stand be thinned.

Depending on what your goals are for the stand, determining which trees need to be removed can be complex. Removing trees from a group of diameter classes (i.e. the smallest trees) may cause the stand to look more even-aged versus selecting trees in clusters that can lead to a more natural clumpy, uneven-aged look. For additional information on determining which trees to remove refer to: *Guidelines for Thinning Ponderosa Pine for Improved Forest Health and Fire Prevention,* University of Arizona, College of Agriculture and Life Sciences Bulletin AZ1397. It is available on the web at http://cals.arizona.edu/pubs/natresources/az1397.pdf or at your local county Extension office.

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Tom DeGomez

Figure 1a. Basal area of about 60 square feet per acre.

Tom DeGomez

Figure 1b. Basal area of about 120 square feet per acre.

Table 1. Tree circumference in inches as it relates to diameter at breast height (DBH) and basal area (BA). (Use this form to tally all the trees in each diameter. To calculate total basal area for a diameter class: multiply the number of trees in each diameter class times the corresponding basal area per tree divided by the number of acres.)

Circumference in inches at breast height (4.5' above the ground)	Diameter classes (inches in diameter at breast height -DBH)	Basal area (BA) per tree	Number of trees in each diameter class	Total basal for diameter class
12.6	4	0.09		
15.7	5	0.14		
18.9	6	0.20		
22.0	7	0.27		
25.2	8	0.35		
28.3	9	0.44		
31.5	10	0.55		
34.6	11	0.66		
37.8	12	0.79		
40.9	13	0.92		
44.1	14	1.07		
47.2	15	1.23		
50.3	16	1.40		
53.4	17	1.58		
56.5	18	1.77		
59.7	19	1.97		
62.8	20	2.18		
65.9	21	2.41		
69.0	22	2.64		
72.1	23	2.89		
73.3	24	3.14		
76.4	25	3.41		
79.5	26	3.69		
82.6	27	3.98		
85.7	28	4.28		
88.8	29	4.59		
92.0	30	4.91		
95.1	31	5.24		
Totals:				

Table 2. Recommended basal area (square feet per acre) for ponderosa pine stands in Arizona when matching elevation to precipitation. This table was prepared by several experts on growth and development of ponderosa pine. It is designed to be a guide to help landowners determine good stocking density for their particular location.

	ELEVATION				
Precipitation	5,500'	6,000'	6,500'	7,000'	7,500'
16"	35	40	45	50	55
18"	40	45	50	55	60
20"	45	50	55	60	65
22"	50	55	60	65	70
24"	55	60	65	70	75

Susan Pater

Locoweeds

George Ruyle, Ph.D., Range Management Extension Specialist, School of Natural Resources, University of Arizona

Astragalus is the largest genus of flowering plants in Arizona, with over 70 species plus 2 species of *Oxytropis*, a species that closely resembles locoweed in both appearance and poisonous principle. Species identification is often difficult and requires flowers and seed pods for proper identification. While most Arizona species have not been proved to be injurious, it is best to treat all loco's as poisonous to herbivores. This is especially important for cattle and horses, unless positive evidence of their harmlessness is available.

Typical loco symptoms usually don't manifest until after plants have been grazed for weeks, but death may occur within a few days after this period of ingestion. The action of a "locoed" animal includes jerky, uncoordinated moves, lowered head and a vacant stare. Head shaking and shying from common objects are also common. Abortion is a common symptom to loco poisoning in cows. Horses are especially sensitive and can be irreparably damaged after eating locoweed for one week.

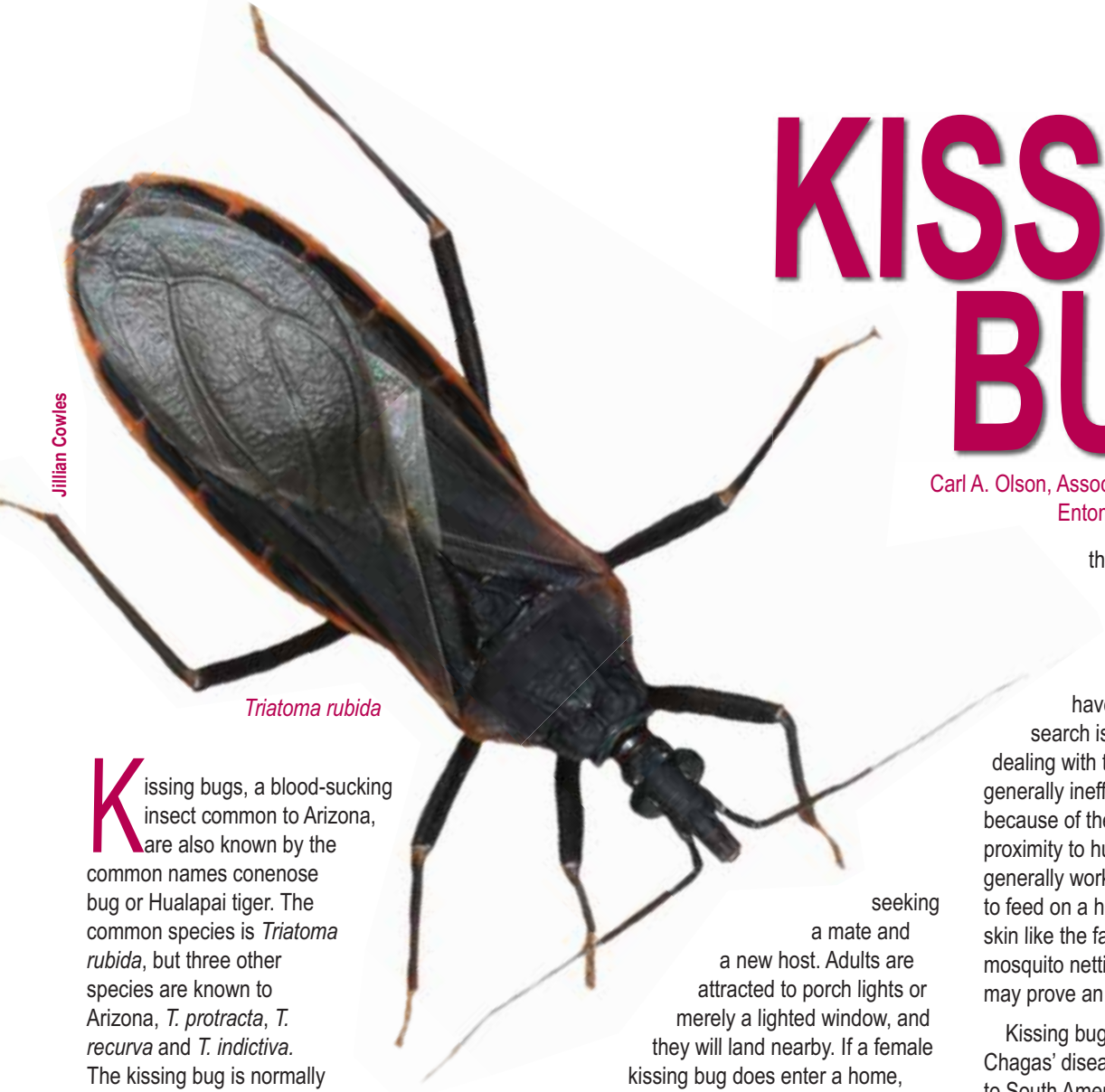
Poisonings are of three types. Some species cause typical loco poisoning from the alkaloid swainsonine. Others with nitro-toxins cause either acute or chronic poisoning with respiratory problems and rear-limb weakness. Still other loco species may accumulate selenium and cause hair loss, lameness and reproductive problems. At least 6-10 species that occur in Arizona cause the typical loco poisoning and at least 7 other species can be dangerously high in selenium. Locos are toxic in all stages of growth. Some are very toxic and cause a quick death (acute), yet others may require long periods of consumption before any ill effects are detected (chronic). Additionally, consumption of loco may go unnoticed in the pregnant female yet cause birth defects. Plants may be annual, biennial or perennial. Depending on the species, loco plants can be highly site specific, occurring only on certain soils or in certain localities. Limey uplands are typical loco habitat, but the species also occur on heavy clay sites. Loco plants tend to be cool season growers, so good winter and spring precipitation years are also good loco years.

Preventing loco poisoning is easier said than done. Knowing which plants can be toxic is the first step in preventing poisonings. With loco this can be difficult, but in order to know the toxicity you must know which loco you have. Also, understand the plant's growth cycle and whether it has favored growth areas. Managers who recognize loco and can spot problem areas, can plan a strategy to minimize losses. Grazing management is one key in preventing animal loss. Pastures in good condition will reduce the chance that the animals will eat a toxic plant. If they have something else to choose from, they will often leave locoweed alone. The most effective strategy is to deny access to locoweed infested sites during critical periods. Early detection is critical and can be key to minimizing losses.

Susan Pater

KISSING BUGS

Carl A. Olson, Associate Curator, Department of Entomology, University of Arizona



Jillian Cowles

Triatoma rubida

Kissing bugs, a blood-sucking insect common to Arizona, are also known by the common names conenose bug or Hualapai tiger. The common species is *Triatoma rubida*, but three other species are known to Arizona, *T. protracta*, *T. recurva* and *T. indictiva.* The kissing bug is normally a resident of packrat dens, but may live with other rodents. The kissing bug normally stays in the nest. If homeowners try to eliminate packrat nests, but don't remove the bugs, the bugs will find the next readily available blood meal, generally that homeowner.

Kissing bugs lay pearly white cone-shaped eggs singly in a habitat near its food source. These eggs hatch in 10 to 30 days into small, soft-bodied nymphs (small and wingless) that soon will be ready for a blood meal. There are five nymphal stages, each requiring at least one to several full blood meals to stimulate molting to the next growth stage. Completion of growth from egg to adult takes 1-2 years.

In Arizona, the flight period of adult kissing bugs is usually in May and June, coinciding with high nighttime temperatures in the 70's and low humidity. A second activity period may occur in September when conditions again are similar to early summer. This activity means new adults leaving their juvenile home, seeking a mate and a new host. Adults are attracted to porch lights or merely a lighted window, and they will land nearby. If a female kissing bug does enter a home, feeds, mates and lays eggs, the people may encounter these bugs any month of the year. Incidental contact with adult kissing bugs can occur during the other summer months, but their activity is lower.

One good way to manage populations is to inspect outside your house around the windows before going to bed, for the bugs may be sitting on the house then. During the day, the bugs seek dark shelters, so inspect beneath flowerpots or other potential hiding places near the home. The bugs are flat and can enter a home through narrow openings, so good home maintenance such as caulking and replacing damaged wood around doors and windows is necessary to prevent entry.

If a kissing bug does get into the house, it will become active once it gets dark, seeking a host. Once it has fed, the bug will not venture too far away, often found between the bed frame and springs or mattress. This also will be the area a female will deposit her eggs, so check the sheets, etc. and vacuum thoroughly in the bedroom during this season. Just because you have been bitten once, or you have found an adult in your home, it does not indicate you have an infestation. A concentrated search is the most effective means of dealing with these insects. Pesticides are generally ineffective and not recommended because of their secretive habits and proximity to humans. Kissing bugs do not generally work beneath sheets or pajamas to feed on a host, preferring naked, exposed skin like the face, hence the name. Use of mosquito netting during peak activity periods may prove an effective deterrent.

Kissing bugs are sometimes vectors of Chagas' disease, known to occur in Mexico to South America. All species of kissing bugs may harbor the pathogen, *Trypanosoma cruzi* is the causative agent of this disease. Transmission of the pathogen is through the kissing bug feces that are deposited near the feeding site and later rubbed into the itchy wound site by the victim. The four species of *Triatoma* found in Arizona, due to their behavior of defecating away from their feeding site, have never been implicated in transmitting this pathogen.

The bite of the kissing bug usually is painless, because the mouthparts are very sharp and big enough for only a single blood cell to flow through. Most people never know they have been bitten, and the results may simply be a welt like a mosquito bite. Some people react more adversely, developing hives or experiencing an allergic reaction resulting in an anaphylactic response. People being bitten a lot may develop this more adverse response to the bites over time and should consult a physician for proper care.

Puncturevine

William B. McCloskey, Ph.D., Associate Specialist, Weed Science,
Department of Plant Science, University of Arizona

Puncturevine (*Tribulus terrestris L.)* is a prostrate summer annual weed that is widely distributed in Arizona and is also known as bullhead, goathead, Mexican sandbur or tackweed. Puncturevine is a prohibited and regulated noxious weed (Arizona Dept. of Ag.) that was introduced from Europe and when eaten in quantity is toxic to livestock, especially sheep. Plants usually have several stems of up to 3 feet long radiating from the root with opposite leaves each divided into 4 to 7 pairs of oblong leaflets ⅛ - ½ inch long. Stems and foliage often have silky or bristly silver hairs. Heavy infestations of this weed can form dense mats in disturbed habitats such as roadsides, waste areas and agricultural fields. The solitary bright yellow flowers have 5 petals (rarely 4) and occur on short stalks in the axils of leaves. The seedpods separate into wedge-shaped burs or nutlets, each with two stout spines ⅛ - ¼ inch long that can puncture bicycle tires and shoes. Germination requires warm temperatures and seedlings emerge in early spring through summer often in flushes following increased soil moisture. Seedlings can produce a deep root system in a few weeks; flowers may be produced within 3 weeks of germination and burs within 6 weeks. Each plant produces innumerable burs and it is almost impossible to prevent mature burs from falling to the ground. The seeds remain viable for decades until there is sufficient moisture for germination.

Puncturevine populations or infestations can be managed by physically removing plants (and hopefully burs) followed by repeated cultivation or soil disturbance to prevent the establishment of germinating seeds. Postemergence and preemergence herbicides can be used to kill established plants and to greatly reduce the emergence of seedlings. Planting competitive vegetation may also help, but hand removal of puncturevine may then be required.

In most desert areas of Arizona, puncturevine populations are suppressed by two weevils that provide biological control of this species. A stem weevil (*Microlarinus lypriformis*) and a seed weevil (*Microlarinus lareynii)* were imported from Italy by USDA entomologists and released in Pima County, Arizona in the summer of 1961 along with releases in many other states. The weevils became widely established throughout the southwest and close inspection of plants often reveals the exit holes chewed in burs and stems by the adult weevils as they exit the plant. Both weevils overwinter as adults in surface debris and plant litter and in the shelter of adjacent perennial plants. The weevils' life cycles typically start in June when the adult weevils emerge and lay eggs in seed pods and stems. Adult weevils continue to feed and lay eggs producing about a generation each month in the summer by attacking new plants and reinfesting older surviving plants. Puncturevine weevils can be introduced to new areas by moving infested plants or by purchasing and releasing commercially reared weevils. The two puncturevine weevils are usually mixed together when sold commercially (an internet or World Wide Web search will identify suppliers). Puncturevine will not be eradicated by the seed and stem weevils but the density of the weed is usually greatly reduced. Small numbers of puncturevine plants must survive to sustain the populations of weevils in a particular location.

William McCloskey

"Puncture vine" from *An Illustrated Guide to Arizona Weeds* by Kittie F. Parker © 1972 The Arizona Board of Regents.
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TIME IT RIGHT WITH IRRIGATION CONTROLLERS

Automatic irrigation systems are terrific — as long as you are in control of your controller.

Kathryn "Cado" Daily, Water Wise Program Coordinator, Cochise County Cooperative Extension, University of Arizona.

Irrigation controllers (also called "clocks" or "timers") are at the heart of an automatic irrigation system and are often the component least understood by the homeowner. Controllers only do what they are programmed to do. If they aren't programmed correctly they can cause a beautiful landscape to suffer from poor watering.

Irrigation systems are usually installed with a new landscape. If the system is professionally installed, the controller will most likely be programmed for the homeowner. For new landscapes, the schedule is usually every few days. If the controller isn't re-programmed within a few months to accommodate establishing plants, the landscape will be watered excessively causing high water or electric bills and possible plant death from root rot.

Controllers can be intimidating at first glance - so many buttons and choices! But they do nothing more than tell irrigation valves how long and how often to open. Even though there are different brands and types, most controllers operate in the same way. There are electromechanical controllers that use gears, pins and dials to set a watering schedule, solid-state controllers that are like small computers and hybrid controllers that combine the best features of electromechanical and solid-state computers.

Hybrid controllers are the most popular choice because even though they are sophisticated, they are easy to program. Electromechanical controllers are not commonly found in stores, but the new owner of an older home may find one as part of an inherited irrigation system. Solid-state controllers are the most versatile of the three types of controllers; they are a good choice for users who want state of the art technology and advanced water management. A new breed of solid-state controllers called "Smart Controllers" are now on the market. Smart Controllers receive a signal from a weather station and determine the watering schedule based on weather factors. No manual scheduling is needed.

How does a controller work? The controller tells the valves (also called stations or zones) when (frequency) to open. The controller pictured uses "Schedules" and "Start Times" to do that. It also tells the valves how long (duration) to stay open. On this controller "Value Run Times" performs that function.

Sometimes more is better. In this case, the more valves/stations on the irrigation system and the more programs on a controller, the more precise the watering schedule can be.

When learning about an irrigation controller, read the manual! If the controller manual is lost, contact the manufacturer either via a website or call an irrigation supply store for a replacement. Once a manual is obtained put it where it can be easily accessed.

EXAMPLE

Let's go through an example to learn how to program a controller. The Smiths have a small lawn, a vegetable garden, high water use shrubs, low water shrubs and low water trees. For watering flexibility, the Smiths bought a controller with six stations. It has a maximum watering frequency interval of 31 days and three programs. They want to schedule the controller for the hot spring months. Before programming, the Smiths need to answer some questions:

Does it matter how the plants are watered - drip or sprinkler?

Yes. Sprinkler nozzles deliver more water at a faster rate than drip emitters. Drip emitters have an output of gallons or liters per hour (gph or lph). Sprinkler nozzles have an output of gallons per minute (gpm). The Smiths want to sprinkler irrigate the lawn. They want to drip irrigate the garden with 1 gph emitters. They want to use 2 gph emitters on the high and low water use shrubs, and low water use trees.

How Often (Frequency) Do The Plants Need To Be Watered?

The Smiths asked their Cooperative Extension office about watering frequencies. They were advised to put a 2-3 inch mulch layer of bark, gravel, or for their vegetable garden alfalfa hay, on top of the soil around their plants to reduce evaporation and watering frequency. The Smiths learned that during the hot season their mulched garden will need water every three days. The high water use shrubs with bark mulch will also

need water every three days. The Smiths were also advised that their gravel mulched low water shrubs will need water every two weeks. The gravel mulched low water trees will need water every month. The Smiths know that weather and plant water needs vary seasonally. Therefore each season they will need to re-program the frequency of watering. The Smiths can also access watering guidelines on the Water Wise website listed below.

For how long (duration) do the plants need water?

The Smiths know that water should penetrate to the root zone depth at each watering. Grass, vegetable and flower roots grow to approximately one foot deep, shrub roots to approximately two feet, and tree roots to approximately three feet deep. They also know that once they learn how long it takes for their watering system to water to those depths, they won't need to seasonally re-program the duration of the watering, only the frequency. The Smiths did a soil probe test (www.ag.arizona.edu/cochise/waterwise/soilprobe) and found that in one hour in their sandy-loam soil, 1 gph emitters wet the soil to a depth of one foot, and the 2 gph emitters wet the soil to a depth of two feet.

Which plants on what station?

The Smiths know it is best to have similar plants on the same irrigation valve and not to mix drip with sprinklers. Because each plant type is different and requires different watering frequencies and durations, each gets its own station/valve. The garden will be on valve 1, high water shrubs on valve 2, turf on valve 3, low water shrubs on valve 4, and low water trees on valve 5, and valve 6 is available for future use.

Which stations on what program?

The Smith's controller has three Programs: A, B and C. This is great because they can schedule each program to water at different frequencies. Program A will control valves 1, 2 and 3; Program B will control valve 4 and Program C will control valve 5.

How to program the controller?

Now that the Smiths have their landscape water needs categorized, they can schedule their hybrid controller. They go out to their controller and with their manual, program in the current date and time. They are now ready to enter the information for their watering schedule.

The Smiths know that a Program determines the frequency of watering. They move the Program switch on the controller to Program A.

The Smiths now schedule the days of watering for the hot season for their high water plants. They decide they want to water on Saturday and Thursday. They also want to water in the early morning when the air is cool and still. But they want to be able to see their system function, so the Smiths set the watering to start when they get up at 6 a.m. They schedule both of those choices into the controller on Schedule and Start Times.

Now they select how long (duration) they want each valve to water. From their soil test they know that the 1 gph emitters for the garden need to be on for one hour. Using Valve Run Time they set valve 1 to run for one hour. They know that the 2 gph emitters for the high water shrubs will deliver water to a depth of 2 feet in an hour so they also set the run time for valve 2 for one hour. The Smiths also did a "catch can" test for their lawn sprinklers (www.ag.arizona.edu/cochise/waterwise/wateringturf) and found out that the lawn sprinklers should be on for 30 minutes, so they set valve 3 for 30 minutes.

Because the low water shrubs and trees have different watering frequencies, each needs to be on a different Program. The Smiths move the Program switch to B and repeat the process for the low water shrubs making sure to schedule the frequency for every two weeks. They repeat the process for the trees on Program C with a frequency of every 30 days.

Finally, the Smiths write down their spring watering schedule and valve locations, put it inside their controller cover, and are glad to have conquered their controller and their irrigation system.

For more information on irrigation, contact your local Cooperative Extension office and visit the Water Wise website at **www.ag.arizona.edu/cochise/waterwise.**

VALVE NO.	VALVE RUN TIMES			VALVE LOCATION
	A PROGRAM	B PROGRAM	C PROGRAM	
1	1 hour			Veg Garden
2	1 hour			High Water Shrubs
3	30 min			Turf
4		1 hour		Low Water Shrubs
5			1.5 hours	Low Water Trees
6	X	X	X	X
PROGRAM	START TIMES 1ST	2ND	3RD	WATERING DAY (SCHEDULE)
A	6 am	X	X	Sat, Th
B	6 am	X	X	Every 14 days
C	6 am	X	X	Every 30 days

Soil Sampling and Analysis

James L. Walworth, Ph.D., Extension Specialist, Department of Soil, Water and Environmental Science, University of Arizona

Soil analysis can provide important information about physical conditions, fertility (nutrient) status, and chemical properties that affect a soil's suitability for growing plants. Four steps associated with soil testing include: 1) soil sample collection, 2) laboratory analysis, 3) interpretation of results, and 4) fertilizer or other management recommendations. We'll look at soil sample collection and analysis.

SOIL SAMPLE COLLECTION

The first step in soil analysis is soil sample collection. It's important to realize that only a tiny portion of a field is actually analyzed in the laboratory. Thus, collecting a representative soil sample is critical for accurate results.

The most common method is composite sampling. Sub-samples are collected from randomly selected locations in the field. The sub-samples are thoroughly mixed to obtain a representative sample and analysis of this sample gives average values for the entire area. Although the actual number of sub-samples depends on field size and uniformity, no less than 5 sub-samples should be taken, and 15 to 25 are preferred. Usually samples are collected to a depth of about 6 to 8 inches or to the effective rooting depth.

Soil samples should be immediately air-dried at room temperature for two to three days and should not be heated or dried in an oven. If samples cannot be dried immediately, they can be refrigerated for several days and taken to a laboratory as soon as possible.

The primary consideration for timing of soil sample collection is convenience. Collect samples early enough to allow for interpretation and soil management adjustments. Status of some soil nutrients can change quickly, whereas others do not. For example, phosphorus levels in soil are unlikely to change rapidly and frequent testing is unnecessary. Nitrogen levels, on the other hand, change very quickly and only very recent tests will reflect current plant-available levels. When making substantial changes to soil fertility levels, it is a good idea to make the change over a period of two to three years, retesting the soil annually. Otherwise, occasional testing (once every few years) is adequate in the absence of any noticeable nutritional deficiencies.

SAMPLE ANALYSIS

A soil test determines the soil's nutrient supplying capacity by mixing soil during the analysis with a very strong extracting solution (often an acid or a combination of acids). The soil reacts with the extracting solution, releasing some of the nutrients. As soil supplies most of the mineral nutrition for higher plants through the plant's root system, the extracted nutrient concentration is evaluated based on research that relates plant utilization to soil nutrient concentrations. This works well for some nutrients, but is less accurate for others. Nutrients supplied from soil organic matter (OM) decomposition (such as nitrogen and sulfur) depend more on the rate of OM decomposition than on extractable levels of these nutrients.

Standard or routine soil tests vary from laboratory to laboratory, but generally include soil texture; electrical conductivity (EC, a measure of soil salinity); soil pH; available phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg); sodium (Na); cation exchange capacity (CEC); and often an analysis of OM content. Most laboratories offer nitrogen (N), sulfur (S), and micronutrient analyses for additional cost.

The methods used to test soils vary depending on soil chemical properties which are affected by geographic region. A listing of local soil test laboratories that use methods suitable for local soils can be found in the University of Arizona publication, "Laboratories Conducting Soil, Plant, Feed or Water Testing" (AZ1111) http://cals.arizona.edu/pubs/garden/az1111.pdf.

STANDARD SOIL TESTS

Soil Texture

Soil texture reflects the amounts of various sized particles (sand, silt, and clay) in the soil. Relative amounts of these particles are used to categorize soil into textural classes. Listed generally from most clayey to most sandy these are clay, silty clay, sandy clay, silty clay loam, clay

loam, sandy clay, loam, sandy clay loam, silt, silt loam, sandy loam, loamy sand, and sand. Clayey soils hold more water and nutrients, but are more difficult to till and may absorb water very slowly. Sandier soils accept water quickly, are easy to till, but hold little water and may require frequent irrigation and fertilizer application.

pH

Soil pH is a measure of the acidity or alkalinity of a soil. Arizona soils are generally alkaline (high pH; pH 8.0 to 8.5), and, although pH adjustment is not a common practice, amendments containing sulfur can be used to lower pH levels.

Electrical Conductivity (EC)

Electrical conductivity (EC) of a soil extract is used to estimate the level of soluble salts. This is one of the most useful soil tests for desert southwest soils because salt buildup is one of the leading causes of poor plant growth. Higher EC equates to saltier soil. The acceptable limit depends on the salt tolerance of the plants grown. EC is a very reliable test for soil salinity, and this is a routine test in the arid southwest.

Nitrogen (N)

Nitrogen analyses are not difficult to conduct, but interpreting results can be problematic. This is because plant availability of soil N depends on OM breakdown, which can not be predicted from a soil test. Nitrogen in the nitrate form (NO3-N) is directly available to plants, however, NO3-N can be quickly lost from soil. Be aware that nitrate analyses provides a 'snapshot' of available N, but may not indicate N availability later in the growing season.

Phosphorus (P)

Most soil P is tightly bound to soil particles. The P-containing complexes in alkaline soils are very different than those in neutral or acidic soils. The amount of P removed during soil extraction is dependent on the nature of P complexes and on the specific extractant used, so it is critical that P extractants be matched to soil properties. The Olsen or bicarbonate extractant is appropriate for Arizona soils and is a reliable and useful soil test in our state. On a soil test report, the analysis may be reported as PO4-P.

Potassium (K), Calcium (Ca), Magnesium (Mg), and Sodium (Na)

The four major exchangeable cations in arid-region soils are K, Ca, Mg, and Na. All except Na are essential plant nutrients; however Na is included because it plays an important role in soil physical properties. Sodium levels are expressed as exchangeable sodium percentage (ESP) or sodium adsorption ratio (SAR) which are measures of soil Na content relative to other soil cations. High levels of sodium (reflected in high SAR or ESP values) are associated with instability of soil physical structures, and affected soils may not absorb water or drain adequately due to lack of aggregate structure. Many desert soils contain Ca or Mg minerals (carbonates) that are not available to plants, but which may elevate the levels of these nutrients indicated in a soil analysis. This is not usually a large problem and K, Ca and Mg tests generally provide excellent estimates of plant available levels of these nutrients.

Cation Exchange Capacity (CEC)

Cation exchange capacity is usually estimated by summing the major exchangeable cations (K, Ca, Mg, and Na). This provides a measure of a soil's ability to hold nutrients.

OPTIONAL SOIL TESTS

Sulfur (S)

Measuring total soil S does not provide a good estimate of plant available S because S release from OM can not be predicted. Sulfate (SO4-S) is a common test and an accurate measure of sulfur availability, although it provides a better estimate of immediately available S than the soil's long-term ability to supply S.

Micronutrients

Micronutrient analyses are optional at most laboratories and are slightly less accurate for predicting plant deficiencies or responses to added nutrients than are analyses of K, Ca, and Mg.

Copper (Cu), Iron (Fe), Manganese (Mn), and Zinc (Zn) - It is difficult to estimate plant-available levels of these micronutrients. The tests are best for identifying extremely high or extremely low levels.

Boron (B) – Boron is very easy to extract from soil and analyses provide a good estimate of plant available B. However, B is easily leached from soil, so plant-available levels can change rapidly. Also, some water supplies contain high levels of B. If soil irrigated with B-rich water is not adequately leached, B can reach plant-toxic levels.

Organic Matter (OM)

The amount of OM in a soil can be easily determined, but these tests do not determine how it will contribute to soil fertility. Although organic matter content is not routinely determined in southwestern soils, typical OM contents are rarely above 1 to 2% in most Arizona soils.

SUMMARY

As part of a soil analysis the laboratory will usually supply some interpretation, which includes an indication of whether individual soil tests are low, medium, or high. The laboratory may also provide fertilizer recommendations based on the analysis, although these recommendations are plant and soil specific.

Routine sampling and analysis can be useful tools for the management of small acreages. Maintaining a record of soil analysis results also can give valuable information on long-term changes in soil properties. Contact your county extension agent for more information.

What Does Organic Really Mean?

Donna Matthews, Coordinator, Coronado Resource and Conservation Development, Inc.

We can walk down supermarket isles today and see produce labeled "organic" or even milk or spaghetti. Many of us buy our food from Farmers Markets or directly from the farm because we know it is fresher and in some cases it is organic. What does organic really mean and is it healthier for us and our families?

The commonly understood definition of organic is a food product grown or raised without synthetic pesticides and conventional fertilizers. However, according to the National Organic Standards Board (NOSB), an advisory panel to the US Department of Agriculture, organic agriculture is: "an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based upon minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony."

Organic farming had its origins in the 1940's with J.I. Rodale's launch of Organic Farming and Gardening magazine advocating "non-chemical" farming and gardening. This soon became known as the primary source of information on this approach to food production. Rodale had been influenced by the earlier writings of Sir Howard on the subject. In 1962, Rachel Carson's publication of *Silent Spring* brought a heightened concern of the impact of pesticides on the environment. This created an identity for "organics" as an alternative to pesticide issues.

A decade later, organic farming and marketing began to develop as an industry and the complex issue of defining "organic" was undertaken. Early concepts of organic were that one could produce crops by doing nearly nothing. This practice of "farming or gardening by neglect" depleted soil nutrients and resulted in poor yields and dismal quality. As a result of some of the set backs organic agriculture experienced during this era, current standards for certified organic production require producers to have an "organic plan" that outlines the use of soil building activities and natural pest management.

In 2002, the US Department of Agriculture adopted the National

Angel Rodriguez

Organic Standard that spells out what farmers and food processors must (and must not) do to be certified "organic." The certifications are made by third-party certifiers that inspect both the property and practices of the producer and "certify" that they conform to the standards of the National Organic Program (NOP). Certified organic production means production by approved methods with precautions taken to eliminate contamination with prohibited materials and mixing with "non-organic" products. This requires that producers work closely with their certifying agent and understand the standards well. Those that meet those standards are allowed to market their products as "USDA Certified Organic" and display the official USDA seal on their packaging.

Although organic farming is possible on a large scale, traditionally, the average size of organic farms is smaller, largely due to labor requirements. Organic farms tend to be more labor intensive. It involves the inclusion of the following principles in the operation: biodiversity, integration, sustainability, natural plant nutrition, natural pest management and integrity on the part of the producer. Most organic operations will reflect all of these to some degree. Each farm is a distinct entity so there is a large degree of variation among them.

Organic production is a viable system of agriculture based upon sound farming practices that does not include conventional chemicals. Organic production focuses on renewable resources, soil and water conservation, and management practices that restore, maintain and enhance biological function. Practices include the use of cover crops, green manures and crop rotations to maintain soil fertility, biological activity and long term soil health. Pests in the form of weeds, insects and diseases are controlled through biological controls such as crop rotations and natural predators. Biodiversity is the mimicking of nature by planting of a variety of crops rather than a single one. This reduces insect and disease problems, and increases nutrient cycling. Rotational grazing and mixed forage pastures are used for livestock operations to maintain the health of the forages and meet the nutritional requirements of the animals. Careful attention is given to avoiding overcrowding and monitoring animals to maintain healthy herds. Only alternative health care is used for livestock marketed as "organic".

Organic producers reduce the external and off-farm inputs and eliminate synthetic pesticides and fertilizers and other materials such as hormones and antibiotics.

Organic meat, poultry, eggs and dairy products come from animals that are given no antibiotics or growth hormones and fed organically grown feeds. Organic food is produced without using most conventional pesticides, fertilizers made with synthetic ingredients or sewage sludge, bioengineering, or ionizing radiation. Companies that handle or process organic food before it gets to the supermarket must be certified organic too. The complete rule along with detailed fact sheets is available on the National Organic Program's website http://www.ams.usda.gov/nop/Consumers/brochure.html

Source: Kuepper and Gegner, NCAT Agricultural Specialists, *Fundamentals of Sustainable Agriculture*, ATTRA, August 2004

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