

Desert Soils and Fertilizer Use



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A University of Arizona trained gardener who completes a Cooperative Extension semester-long specialized course in gardening/horticulture.

A non-paid volunteer who agrees to complete a specified number of volunteer hours and continuing education hours each year to remain certified.

What is an Arizona Master Gardener?

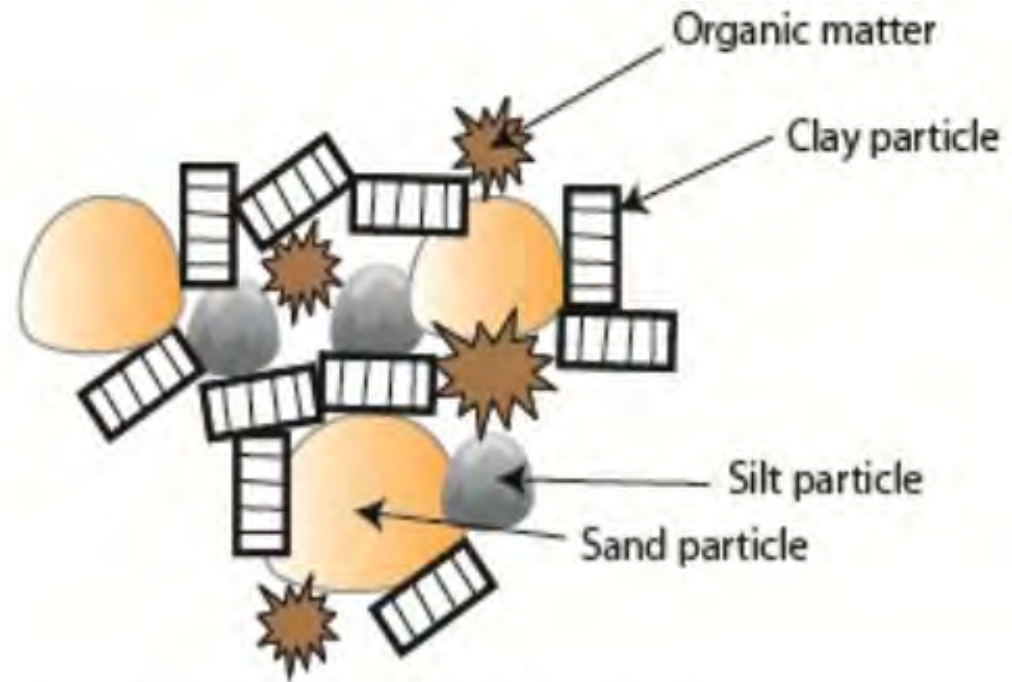
We may or may not be experts or “masters” at any or all horticulture topics, but we are trained to help you find science- and research-based information.

The Master Gardener provides educational leadership in home gardening, landscaping, and irrigation.

County-specific and local. Each county extension office has their own program. Maricopa and Pinal Counties focus on our conditions in the low desert.

Soil Properties - Structure

Soil structure refers to the way soil particles group together to form aggregates, which vary in size and shape from small crumbs through to large blocks.

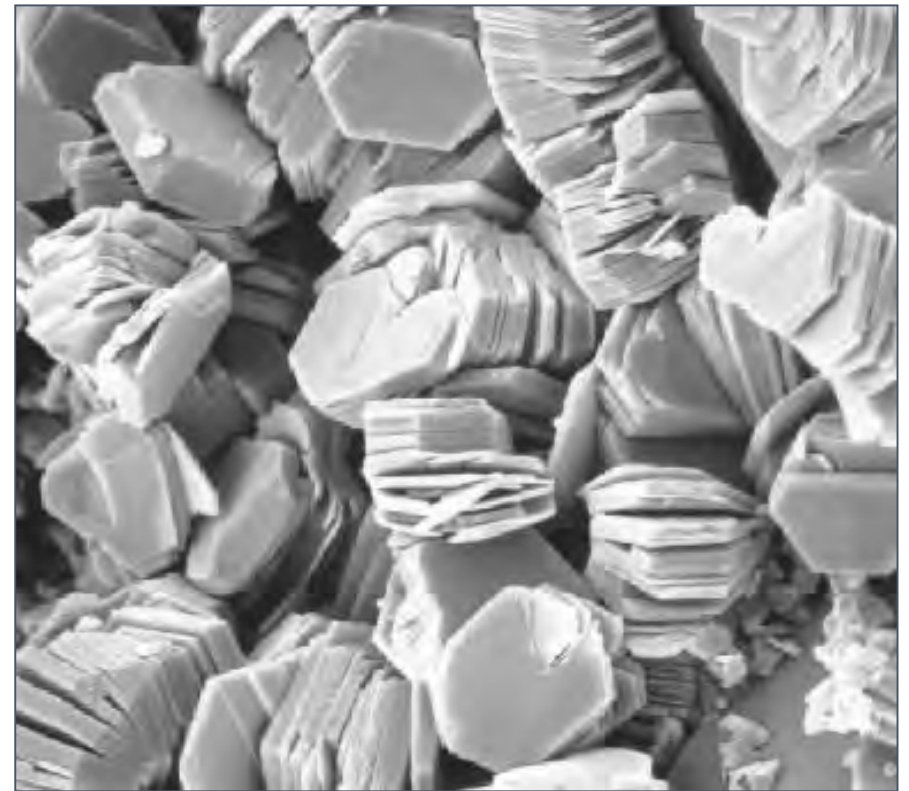


How soil particles may be arranged

Particles are not to scale

Soil Properties - Structure

- A good loamy soil structure has air pockets and micropores that provide space for air, water, microbes and roots.
- Heavy clay tends to stick together and become compacted, providing poor drainage, low oxygen and few happy microbes.



Clay under an electron microscope

Structure

- Initially, a new bed will need to be tilled or worked well to incorporate amendments and loosen soil
- Once a good structure has been obtained and gardening begins, plant roots and microbes will continue to improve soil structure.
- When removing plants, leave the roots in the soil to compost and maintain the pores.
- Avoid further tilling; it damages soil structure
- Use designated pathways to prevent compaction

Soil Properties - Texture

- Non-organic materials in our soil consist of sand, silt and clay.
- A good balance of sand, silt and clay is called Loam. Loam is the best structure mix for a soil.
- Soil often contains humus (organic matter) but it may be as low as 1-2% naturally in the desert.
- Our soils are eroded mountains, the product of eons of mineral-rich erosion

What's Your Soil Texture?

Do the jar test

Bag of 2 cups of soil from your yard (dried and free of stones, roots, etc.)

Use a Mason jar or other see-through container with lid (quart size)

A few drops to 1 tsp of non-foaming liquid soap, shake well and let settle for 2-3 days



Clay layer – water clears

Silt layer – 2 hours

Sand layers – 1 minute

*Photo: Colorado State University Extension,
Colorado Master Gardener Program*

Soil Texture

8. Measure the heights of each individual layer in centimeters and write those down.

Height of sand layer (bottom) _____

Height of silt layer (middle) _____

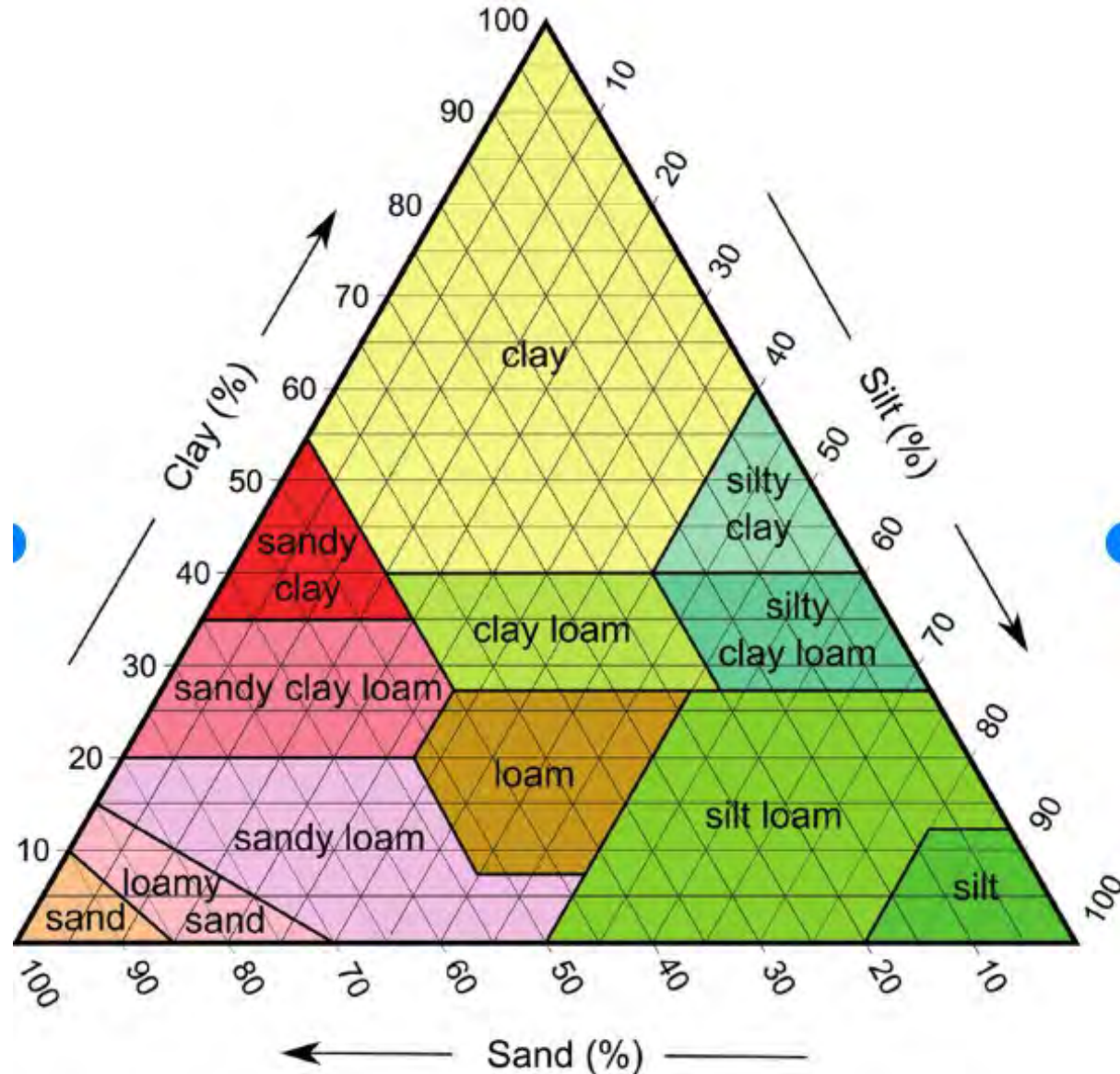
Height of clay layer (top) _____

Divide the height of each layer by the total soil height and multiply the result by 100. Write the results below.

$(\text{sand height} / \text{total height}) \times 100 =$
_____ %

$(\text{silt height} / \text{total height}) \times 100 =$
_____ %

$(\text{clay height} / \text{total height}) \times 100 =$
_____ %



Low Desert Soils

- Sandy soils are found in some areas. Sand comes from former washes and basins. Sand drains well and promotes healthy root growth, but dries out quickly. Nutrients leach out very quickly.
- Clay holds moisture and nutrients but often becomes so compacted that plants don't receive oxygen. It is also harder to wet, as water runs off.
- Loam -- the Holy Grail mixture of sand, silt and loam -
- drains well, while holding nutrients and moisture.

Ah, Clay...

- Clay tends to get compacted without adequate sand, silt or organic based components.
- Once clay gets wet it retains water. While this means less irrigation is necessary, soils can remain too damp if overwatered
- Clay is a very beneficial medium in a well balanced loamy texture.

Drainage Test

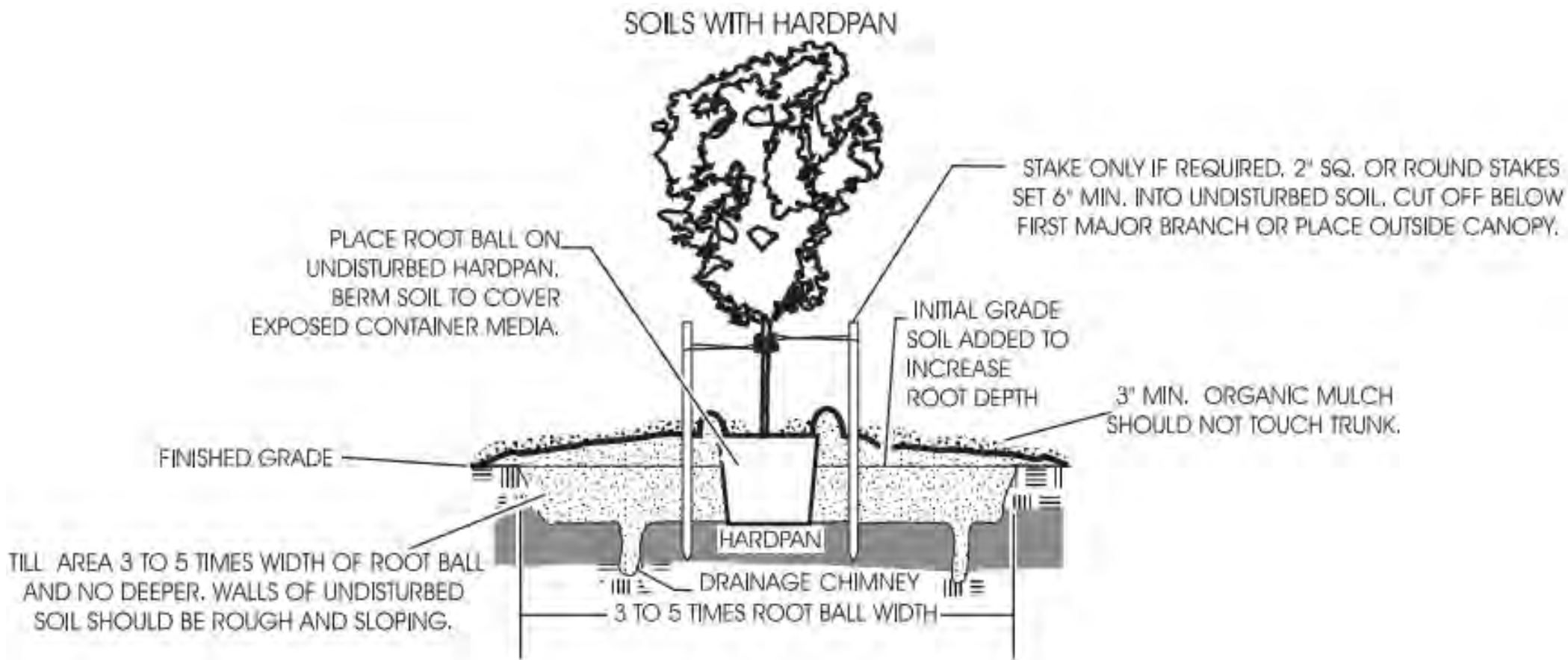
- Test soil drainage by digging a hole approximately one foot deep in dry soil. Fill hole completely, allow to drain, and fill again immediately. Monitor the drainage.
- Drainage is poor if any water is still standing 24 hours after the second filling.
- Do the test in the planting hole as it moistens the planting area to prevent dry soil absorbing water out of the root ball.

Caliche

- Soil can be amended, but removing caliche can be a very labor intensive process
- Caliche can be several inches to several feet deep
- Caliche varies – it is not likely the same thickness or at the same depth everywhere in the yard.

Managing Caliche

See AZ Pub 1281: Managing Caliche in the Home Yard



Nutrients and Minerals

- Consider a soil test by a laboratory to determine if there are deficiencies in your soil
- Saves money on amendments by determining exactly what is needed.
- Helpful Extension publications:
 - AZ1412: Soil Sampling and Analysis
 - AZ1111: Laboratories Conducting Soil, Plant, Feed or Water Testing

Nutrients and Minerals

- A 'standard' or 'routine' soil test varies by laboratory, but generally includes soil pH, available phosphorus (P) and potassium (K).
- Sometimes includes available calcium (Ca) and magnesium (Mg), salinity, and often include an analysis of organic matter content and soil texture.
- Most laboratories offer nitrogen (N), sulfur (S), and micronutrient analyses for additional cost.

Soil Sampling

- Collect samples with stainless steel or chrome-plated tools. Using brass, bronze, or galvanized materials could contaminate the sample.
- Collect soil in a clean plastic bucket.
- Avoid taking samples from areas that are obviously different from the norm
- Remove large pieces of organic material and stones



IAS Laboratories

2515 East University Drive
Phoenix, Arizona 85034
(602) 273-7248

Grower Raised Beds
Submitted By Kim Baker
Send To Kimberly Baker
Report Number 6656641
Date Received 07/11/2017

Soil Analysis Report

VL = Very Low
L = Low
M = Medium
H = High
VH = Very High

Sender	Lab	pH	Calcium (Ca) ppm	Magnesium (Mg) ppm	Sodium (Na) ppm	Potash (K) ppm	Iron (Fe) ppm	Zinc (Zn) ppm	Manganese (Mn) ppm	Copper (Cu) ppm	Salinity (EC x 2) dS/m	Nitrate (NO3-N) ppm	Phosphate (PO4-P) ppm	Computed %Sodium (esp)	Sulfur (SO4-S) ppm	Boron (B) ppm	Free Lime Level	Molybdenum (Mo) ppm
Raised Beds	279	6.43	8800 VH	1100 VH	850 VH	900 VH	170.0 VH	27.00 H	33.0 H	6.10 VH	6.9	62.0 VH	360.0 VH	6.2	3300.0 VH	5.80 VH	High	0.25

This potting mix is nutrient rich. As a result you may see a reduction in seed germination, stunting, and yellowing. Here are some goals to keep in mind (I don't typically write it out but I believe this will help you since you are trying to learn as much information as you can):

- Sodium: <300 ppm
- Potassium: <900 ppm
- Salinity: <3 dS/m
- Zinc: <30 ppm
- Manganese: <50 ppm (40 is my comfort zone)
- Copper: <10 ppm (Copper is used as a herbicide and will kill plants)
- Nitrate: <80 ppm
- Sulfur: <300 ppm
- Boron: <4 ppm
- Calcium to Magnesium: 10:1 to 20:1
- Iron to Copper: 10:1
- Phosphorus to Zinc: 18:1



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There are two ways to go:

(1) Dilute the raised beds with another organic material such as perlite, vermiculite, or pumas. Depending upon the material you wish to dilute the potting mix with I would start by cutting the material by 1 third; possibly 2/3 potting mix and 1/3 something else because of the very high magnesium and potassium. As the organic material in the potting mix breaks down more nutrients will be released and the concentrations will increase. Then irrigate (flood) with extra water to flush the salts out of the root zone. This leaching process may need to occur a couple times a week for a couple of weeks until the white crust around the irrigation and bottom of the planter is gone. The white residue is a sign of high salts.

(2) Mix 1/4 cup of lime (calcium carbonate) per garden bed to raise the soil pH. This will reduce the availability of the all the nutrients. Then over the next few years as your garden needs the nutrients you can slowly lower the soil pH. After everything is mixed and placed into containers flood the heck out of them with water to flush the excess potassium, sulfur, magnesium, and sodium out of the soil. This leaching process will need to occur once a day for 3-4 days and then once every other week for several months. As the organic matter breaks down more nutrients and salts will become more available to the plants.

In about six weeks apply 0.1 lbs of nitrogen per 100 sqft to replenish the nitrogen that was consumed and leached away. If you use an organic source of nitrogen that contains 10% nitrogen, you will need to use 1 lbs of that product to obtain 0.1 lbs of nitrogen.

Also your garden is placed between the side of your home and a brick wall. This area may trap a great deal of heat, which will be great for the winter but you may be limited on what you can grow in the summer. This location may also create a great deal of shade. If your vegetables are tall and thin, they are reaching for the sunlight. Crops that can handle low sunlight are carrots, onions, and potatoes (maybe tomatoes).

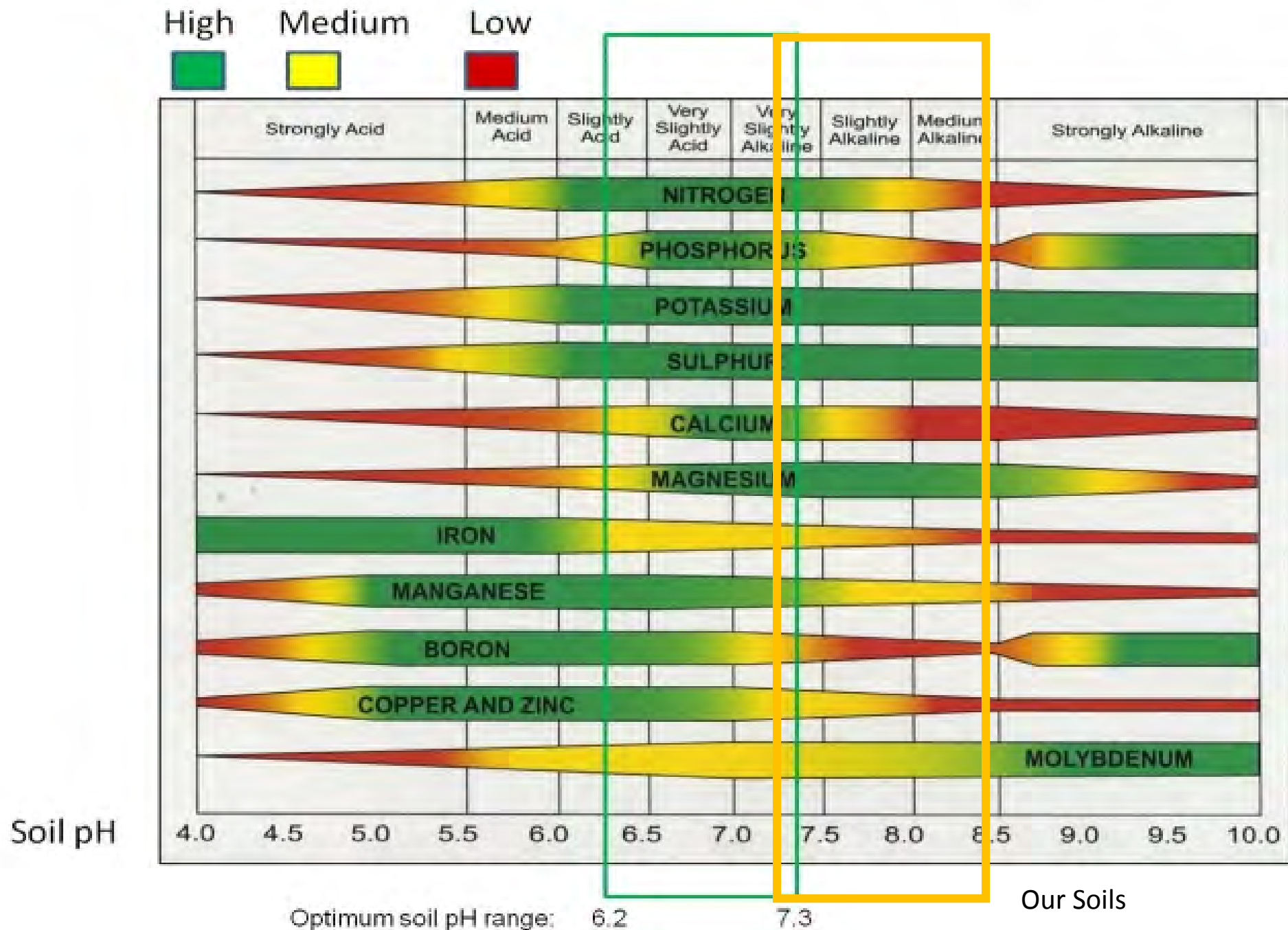
Fertilizers

- Macro nutrients: N-P-K
 - Nitrogen – for green and leafy.
 - Phosphorous - flowers, roots
 - Potassium - fruits, flowers, stems
- Store in a cool, dry place, sealed and labeled, use quickly. It is **volatile!** It gets lost to the atmosphere over time.
- Synthetic or organic versions

Why Fertilize?

- To supplement nutrients in short supply or depleted
- To provide extra nutrients when plants require them
- To make nutrients more available in our alkaline soils
- To compensate for climatic conditions which inhibit nutrient absorption

How soil pH affects availability of plant nutrients



Importance of Nitrogen

- Nitrogen is the most common element in the earth's atmosphere, and is required by all living creatures
- Nitrogen is found in soils
- In plants, nitrogen is the nutrient required in the largest amounts. It is a key component of as amino acids, nucleic acids, and proteins.

Fertilizer: Guaranteed Analysis

- NPK is arithmetically described:
 - 21-3-0, 16-20-5



Organic Options

Animal or vegetative based

- Urea
- Blood meal
- Bone meal
- Worm castings
- Seaweed/kelp
- Fish-based
- Compost



It often require significantly more organic fertilizer than synthetic, to obtain the same NPK and other nutrients.

Micronutrients: 17 Elements

- Valley soils test well for most micronutrients
- If soil is lacking specific micronutrients, apply and work into soils

Herbicides and Pesticides

- As needed, personal choice
- Need to be fresh due to short shelf life
- Buy in smaller amounts
- Keep in a clearly labeled, sealed container
- Store under lock and key
- Read and follow ALL directions for use
- These are toxic; they mean to kill something after all!

Various Soil Amendments

- Compost
- Manures
- Minerals
- Fertilizers
- Inoculants
- Living organisms
 - Single celled
 - Worms
 - insects

Compost

- The primary role of compost is to “feed the soil” for healthy soil texture and structure.
- Living organisms in the compost and soil provide a very healthy living “soil web” for roots to thrive
- It is also a fertilizer, but very low in NPK (typically a max of 2-2-2).

Role of Living Organisms

- Continue the decomposition process
 - Improve nutrient availability
 - Keep soil aerated
 - Are engaged in symbiotic relationships with plants.
- *New soil delivered from commercial source may not have these little helpers

Compost

- Decomposing organic material
 - Vegetative matter
 - Anything that was once living with roots, leaves and stems; not faces
 - Can be home made or purchased



Herbivore Manures

- Digestion is a composting process
- Different animal manures have different properties and nutrient values
- Some can be applied directly to the garden
- Can be composted on it own
- Can be added to a compost pile
- Manure is ***not*** necessary for a garden or a compost pile to have success

Herbivore Manures

- Horse
 - Often contains weed seed and may be high in salt. Horses often eat Bermuda grass hay...
 - Can be added to garden or composted
- Goat, Sheep and Rabbit
 - Not super high in nitrogen
 - Can be applied directly to garden without composting

Dairy or Steer Manure



- Available in bags or at farm sources
- Urea or nitrogen content is secondary to organic components without a guaranteed analysis
- If obtained fresh from a farm, compost first

Chicken/Poultry Manure

- High in nitrogen, can burn plants if directly applied without composting
- Do not use in the same volume as other manures
- Either compost it or allow soil to rest after incorporating
- A good addition to compost high in carbon material

Green “Manure”

A crop used specifically to:

- Break up heavy soil
- Increase nitrogen in soil
- Hold Moisture
- Prevent Erosion
- Control pests / disease
- Cultivated or turned under before the crop matures and allowed to decompose

Other Amendments

- Soil sulfur - to mitigate alkalinity
- Gypsum - counteract excessive salt build-up (Publication AZ1413)
- Inoculants for legumes
- Coconut coir

Do Not Use As Soil Amendments

- Peat moss
 - no nutrients
 - hard to re-wet
 - not sustainable
- Lime
 - A common east coast component NEVER recommended for desert soils
- Wood or BBQ ashes. Highly alkaline!

Do Not Use As Soil Amendments

- Sand
 - Some sources suggest sand to improve drainage, but adding sand to clay can result in adobe or compaction
 - Alternative is pumice - a volcanic rock that helps change physical soil structure

Initial Garden Preparation

- Add 3-6 inches of organic materials to native soil
- Add fertilizer as needed, per package instructions
- Add other minerals as needed
- Dig the garden to the depth of 16 inches to integrate all this
- Rake level, remove debris, irrigate, and plant

Rotate your Crops

- Remember this: “Roots-shoots-beans-fruits”
- Rotating prevents depletion of nutrients in the soil.
- Planting the same crop in one place multiple seasons greatly increases the possibility of disease, such as Verticillium Wilt or Fusarium
- Beans/legumes fix nitrogen in the soil, helping future crops.

IRRIGATION

“Gardening in the west is easy. All you have to do is make the soil, and make the water.”

Eleanor Welshom

Irrigation Information

- Books
- Arizona Municipal Water Users Association
 - Smartscape
- City water departments
- Cooperative Extension
 - Inspect several options in garden
- Desert Botanical Garden

Irrigation

- Drip, soaker hose or drip tape on a timer
 - Convenient and easy
- Spigot and a hose
 - use to water transplants, seedlings, special needs plants
 - washing insect pests
 - mixing liquid fertilizers
 - washing veggies, hands, tools, etc.

Irrigation: How Often

- 1 gal. of water wets 1 cubic foot of soil
- Plants use more water on long, hot, dry and/or, windy days
- Mature, bearing plants use more water than seedlings, but seeds and seedlings need more frequent water (to stay moist)

Irrigation

- Learn how long to run water to achieve desired depths, adjust frequency and not length of run time
- To keep down alkalinity and salts, use rainwater as much as possible. Our tap water is alkaline and high in Total Dissolved Solids (TDS) which includes salts
- Salts include not only sodium, but potassium, calcium, magnesium, chloride, sulphate, bicarbonate and carbonate

Mulch

- A mulch is something that is used to cover the soil between plants or rows
- Organic or inorganic
- Permanent, temporary
- Can be rock, carpet, compost, hay, straw, chips, newspaper, commercial compost and so on

The Importance of Mulch

Mulch provides three advantages. It builds the soil, it keeps the soil MUCH cooler, and slows evaporation.

Woody mulch works well as a soil builder. It breaks down over time. However it is carbon-based, so as it breaks down, the composting process may take some nitrogen from the soil.



The Importance of Mulch

“Living mulch” also works well. Sweet potatoes and cowpeas thrive in the heat.

Cowpeas are edible, and black-eyed peas are a type of cowpea. Peas also fix nitrogen in the soil.



Photo from Greg Peterson, Urban Farm

After the summer, work plants into soil to compost in place.

The Importance of Mulch

- For maximum results, use BOTH woody mulch and living mulch around the trees.
- After the summer, work the plants into soil to compost in place.
- Mulch at least 6 foot diameter around the trunk, more for larger trees (out to the drip line is optimal).

Mulches in Summer

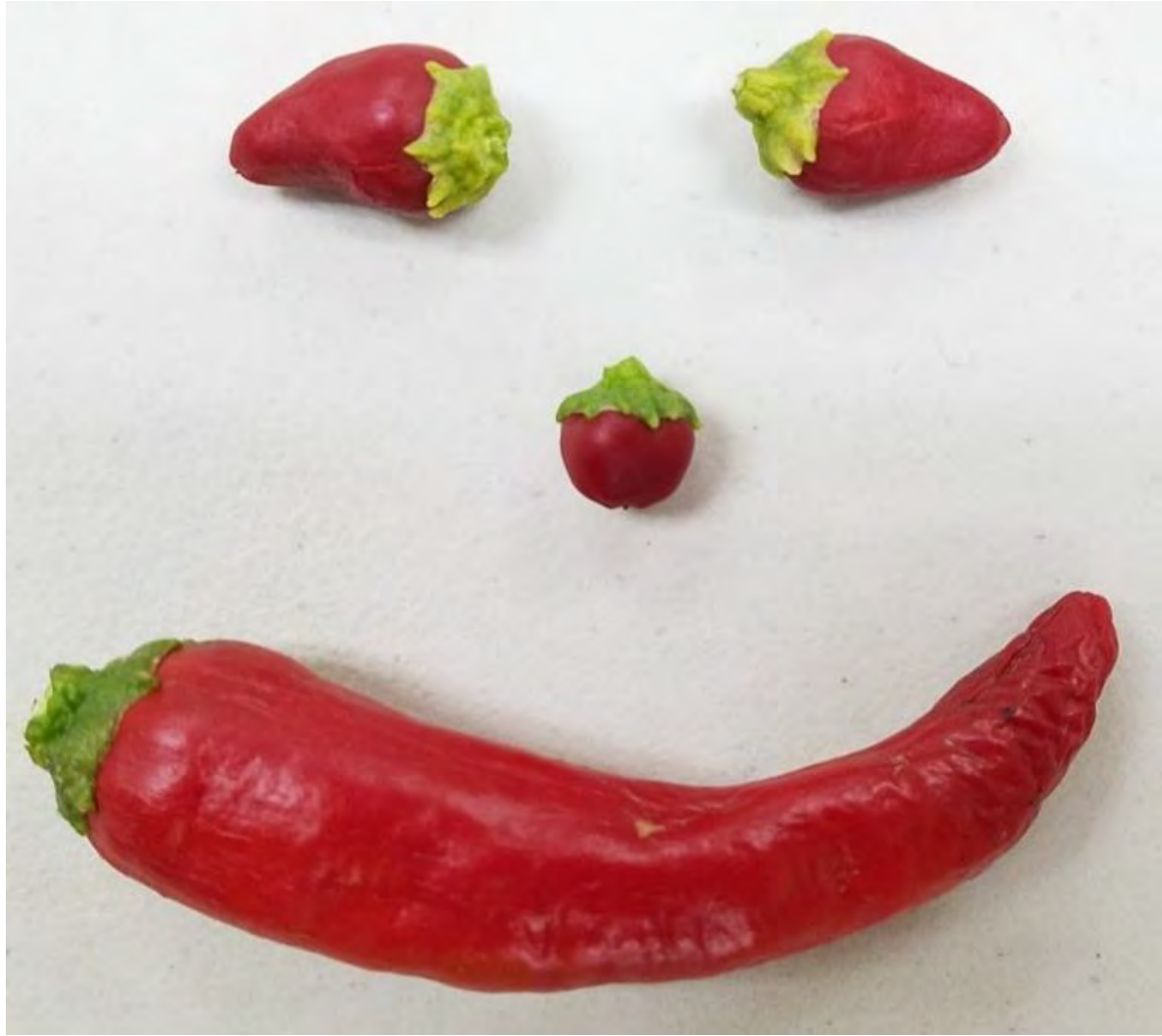
- Moderate the soil temperatures
- Help prevent evaporation
- Help to prevent a crust from forming on the soil surface
- Keep many weeds from germinating
- Can protect tender crops from insects, pests and rot.

Mulches in Winter

- Can slow soil warming as spring progresses
- Can hold heat in the soil on cold night when frost is expected
- May provide home for unwanted insect pests
- Prevent weeds from germinating

Which Mulch, Where?

- Use rough compost where you will want to dig it in after harvesting a crop
- Other organic materials such as wood chips will break down and add to soil nutrients
- Use straw/pine needles to protect melons and tomatoes from soil contact
- Use a more permanent type for paths chipper chips, rock, carpet...



Maricopa County Extension Master Gardener Plant Help Desk

- The Maricopa County Extension Plant Help Desk provides research-based information to assist you with plant and pest problems.
- Email: maricopacountyplanthotline@gmail.com. Responses will generally be within a week
- Visit: 4341 E. Broadway Rd Phoenix, AZ 85040. Bring in a plant or pest sample. Location is in Southeast Phoenix, near Tempe.
- If a master gardener cannot answer your question, they will refer the question to University expert staff members.

Resources

- University of Arizona Extension Publications
<https://extension.arizona.edu/pubs>
 - Many, many free gardening publications
- Contact me or view my presentations on my website:
Tenthgenerationfarm.com