



University of Nevada  
Cooperative Extension

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# **How to Read A Soil Analysis Report**

Angela O'Callaghan, Ph.D.  
Area Extension Specialist  
Social Horticulture

When people send soil samples to laboratories for analysis, the reports may be confusing to read. Different laboratories report their results differently, so it is important to understand the information that will appear on most lab reports. This publication is meant to be a simple guide for those who are new to this kind of report.

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## Introduction

When starting a new garden, it is a good idea to learn about the soil, the source of most of the nutrients and water plants need. Plants in existing gardens can fail for a number of reasons best determined by examining the soil. Soil problems such as nutrient deficiencies and salt excess can interfere with plant health, and even cause death. These can be diagnosed by soil analyses.

While home stores and nurseries will often sell test kits for home use, they are only meant to give a rough estimate of the nutrients nitrogen, phosphorus and potassium, and pH (a measure of acidity or alkalinity). The first three are usually only given as “high, medium or low” and the pH results are rarely accurate above a level of 7.2, too low for many desert soils. These kits do not provide detailed information on other important factors, nor are they able to predict whether the soil will meet any proposed use.

When more in-depth information is required, it is necessary to send a sample to an analytical laboratory. Usually, these laboratories are either university-based or certified commercial laboratories. Certified laboratories can recommend soil additions to make it more suitable for different purposes.

*University of Nevada Cooperative Extension does not have a certified lab for soil analyses.*

The customer has a number of choices to make before sending a sample to either a university or a certified commercial laboratory. It is generally better to choose a laboratory that is familiar with local soils. Selecting the

right tests will depend on how the information will ultimately be used.

Although the information contained in soil reports is generally similar, results are reported differently from lab to lab. It can be useful to have a guide as to what various reports contain.

Many analysis reports are designed to prescribe the fertilizer requirements for specific plants to produce in the sampled soil. For home gardens, the information can help to determine how to improve the soil, especially some western soils which are infertile, salty and alkaline.

## What is in a test?

Plants have nutrient requirements just as animals do. These requirements include nitrogen, phosphorus, potassium, calcium, magnesium, manganese, zinc, iron, boron and sulfur, copper, nickel, chlorine and molybdenum, as well as carbon, hydrogen and oxygen (from the air).

While different laboratories can provide many different services, there are a few standard tests that can guide home gardeners. The order form each laboratory uses will ask what exactly the customer needs. Basic analyses usually analyze for: salinity (all salts) and sodium, pH, and several of the essential nutrients listed above.

Two results that are not always reported are the percentage of organic matter in the soil and the soil texture. If these are not part of the standard test, gardeners should request them. More tests are generally available for a fee, but may not be interesting to the home gardener.

## Requesting an analysis

Although laboratories can test for the same elements and soil properties, they may not use exactly the same methods. For this reason, there can be some differences among lab results.

The application form for an analysis will often ask what crop is being grown, and may ask what fertilizer treatments have already been applied. This can be important information, for if a high dose of compost or other fertilizer was recently added, it will have an impact on test results.

When asked what crop will be grown in the soil, it is usually enough to state that it will be a "vegetable garden" or turf grass, or "ornamental (shrubs, trees)

garden" on the form. When possible, ask the lab for recommendations as well as the existing concentrations of nutrients. If the site has not had a garden before, some labs appreciate information on what, if anything, had been growing there previously.

The following is a mock-up of a standard soil analysis form. Every laboratory is different, but forms generally will list prices for different tests and occasionally will provide directions for obtaining and handling samples.

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### Soil Analysis Form

### SAMPLE ONLY

Complete form and include payment with samples. Mark each sample bag with your sample identifier.

Name \_\_\_\_\_ Phone \_\_\_\_\_  
Address \_\_\_\_\_ email \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_  
Payment (DO NOT SEND CASH)      Check      Money Order      Credit Card—  
Amount Paid \$ \_\_\_\_\_  
Make Checks Payable to: \_\_\_\_\_ (Lab name)

#### ANALYSES (Circle the desired test or tests)

1. Basic Analysis - \$\_\_ per sample (pH, NO<sub>3</sub>-N, P, K, Ca, Mg, Na, SO<sub>4</sub>, SAR and EC)
2. Basic Analysis + Micronutrients \$\_\_ per sample (Zn, Fe, Cu, B and Mn)
9. Basic Analysis+ Organic Matter \$\_\_ per sample
11. Basic Analysis + Micronutrients + Organic Matter \$\_\_ per sample

For additional analyses, please call the laboratory.

Give your sample an identifier \_\_\_\_\_

#### PLANT MATERIAL BEING GROWN

<u>Garden</u>	<u>Turfgrass</u>	<u>Trees / Woody Ornamentals</u>
variety _____	variety _____	variety _____

Give your sample an identifier: \_\_\_\_\_

What problem have you observed that you want to correct? \_\_\_\_\_

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## Some laboratories will also give instructions on obtaining soil samples:

### To collect and prepare a soil sample,

1. Scrape away plant material from the soil surface.
  2. Cut a section 4 inches to 6 inches deep into the soil and place in a clean container. Repeat this step several times in different spots in the lawn or garden you wish to test.
  3. Mix the collected soil thoroughly. Remove roots or other plant materials.
  4. Allow the soil to air-dry if it feels wet to the touch.
  5. Place 2-3 cups of the soil in a plastic bag. Seal bag.
  6. Label bag with permanent marker. Use the sample identifier you gave it before.
  7. Mail sample, form and check to listed address.
- 

## What do responses mean for the desert Southwest?

Deserts are, by definition, dry. This lack of water has multiple effects: fewer plants, microorganisms and dry material, resulting in less organic matter added to the soil (low fertility). There is low rainfall to wash out elements from the soil, resulting in high concentrations of calcium and other salts.

## How are results reported?

Most elements are reported as ppm, or parts per million. Another way that concentrations can be represented is mg/kg. This is equivalent to ppm. Occasionally, some results are reported as meq/l (milliequivalents per liter). This is generally used in a more technical setting. It measures the concentration of a substance in terms of its molecular weight and charge.

In general, labs will not only report quantities, but also whether this amount is sufficient for plant growth.

Fertilizer recommendations are often given in pounds per acre or pounds per 1,000 square feet. Look closely at this. An acre is 43,560 square feet, so this would be quite different! If, for instance, the recommendation were 20 lbs. /acre, that

would be equivalent to less than one half pound per 1000 sq. ft.

## What is measured in the report?

There are a number of items that might be reported in a soil analysis. All of these have different effects on plants, from their ability to take up water to their ability to create proteins for growth. The following are among the most commonly reported.

Organic matter (OM) – this reports the amount of compost present. OM improves the tilth (workability) of the soil, and is a good source of nutrients, particularly nitrogen. It is reported as %, meaning as a percent of the weight of the sample. Good garden soils are generally at least 5% OM, but desert soils are frequently less than 1%.

SAR (sodium adsorption ratio) measures the amount of sodium (which causes the soil to lose structure) in relation to the amounts of elements that improve soil structure (calcium and magnesium). High SAR can impede water movement in the soil and lower its tilth (workability). A level higher than about 10 can restrict growth of many plants.

Electrical conductivity of the soil extract (EC) – measures soil salinity. Higher EC means a higher level of salts in the soil.

The units are dS/m (deciSiemens per meter). Plants vary in sensitivity to salinity. Yields of sensitive vegetables (e.g. carrots, peas, beans, onions) decrease at levels higher than 1 to 2 dS/m. Moderately sensitive vegetables (sweet corn, tomato, lettuce) have reduced yields when EC is higher than 3 dS/m. Artichoke, beet and zucchini produce normally until levels are 4 to 6 dS/m. Very few vegetables are productive when EC exceeds ~8 dS/m. Besides decreased yield, salinity damage causes smaller leaves, abnormally dark foliage, and reduced growth rate.

pH – measures acidity or alkalinity. Its range is from 0, as acidic as any solution can be, for instance concentrated hydrochloric acid, to 14, as alkaline (basic) as any solution, such as concentrated sodium hydroxide (lye) can be. pH = 7 is neutral. Every pH unit represents a tenfold change; a substance with pH = 7 is 10 times more acidic than one with pH = 8 and 100 times more acidic than pH = 9.

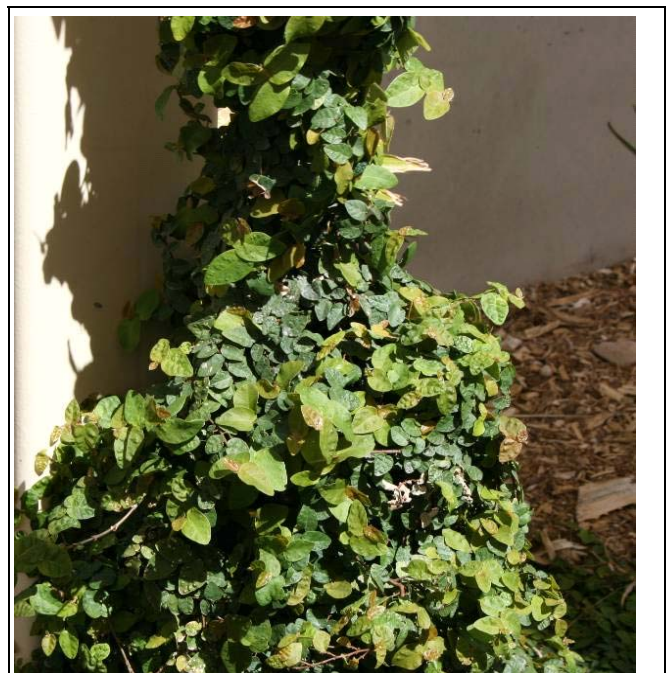
pH of a few common items													
← Increasing acidity					neutral		→ Increasing alkalinity						
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Stomach acid	Lemon juice			Rainwater		Pure water		Baking soda		Ammonia	Bleach		lye

Most edible plants grow best between pH 5.5 – 7. Many regions are concerned with acidic soils, but in the Southwest, soil pH is high enough to make several nutrients unavailable to plants. For this reason, lime is rarely recommended for desert Southwest soils. To lower pH, add soil sulfur or use sulfate fertilizers. The amount to apply depends on soil texture (sand, silt or clay) and the necessary pH

change. N.B. gypsum is **not** soil sulfur and does not lower pH.

The following are essential nutrients that are almost always part of a soil analysis.

Nitrogen (N) – is critical for proteins and many functions of plants such as photosynthesis. It is important for leaf tissue, many color compounds, and most physiological processes. It is present in fertilizers but also in compost, so % organic matter is an indicator of nitrogen that can become available to plants. Nitrogen comes in several forms, but is usually reported as nitrate (NO<sub>3</sub><sup>-</sup>). Turf grass and leafy green vegetables need fairly high levels of nitrogen throughout their growing cycles. Yellow older leaves often indicate nitrogen deficiency.



**Figure 1.** Older leaves showing yellow N deficiency symptoms. Photo: A. O’Callaghan

Phosphorus (P) – is involved in root production, plant reproduction, and many other reactions necessary for growth. The

best laboratory test for P on high pH soils is the Olsen (sodium bicarbonate) assay. Phosphorus is listed as  $P_2O_5$  on many fertilizers and recommendations. New plantings, from shrubs to bulbs, will often require phosphorus to be added at planting, since it moves slowly through the soil when it is added later, and may not be available to roots. In very high or low pH soils, the phosphorus may be in an unavailable form. As a result, plants growing in these soils often show leaf discoloration: a pink or bronze tinge, indicating phosphorus deficiency.

Potassium (K) – controls the circulation of water and sugars through a plant, and helps plant to conserve or remove water. Clay soils often have good concentrations of potassium unless they have been used extensively in agricultural production or have experienced leaching. Potassium should be added when new plantings are being established unless it already has high levels of K. Fertilizers and recommendations often list potassium as  $K_2O$ . When a plant is deficient in this element, the perimeter of older leaves will have turned brown.

Calcium (C) – is important for developing plant cell walls and membranes, fruits, and storage roots. In areas with low precipitation such as the desert Southwest, there is generally enough calcium for plant health. In fact, the high levels of calcium compounds in the soil keep the pH too high (see pH information above). Deficiency often appears as browning of leaf tips or blossom end rot.

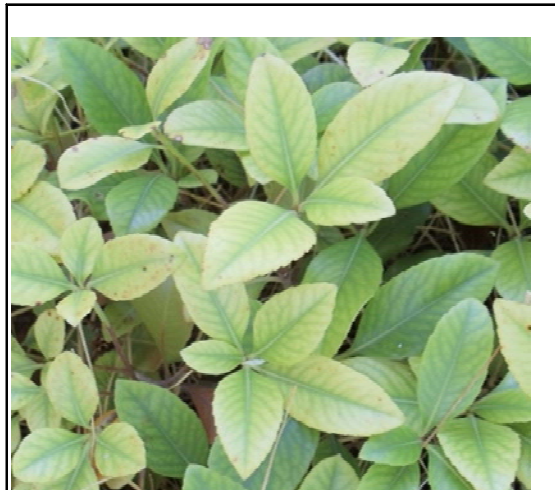
Magnesium (Mg) – is important for several functions, including protein synthesis and photosynthesis. A plant with insufficient Mg may show pale leaves with green veins.

Copper (Cu) – is a part of several plant proteins and functions. It is necessary for water movement from roots to leaves.

Iron (Fe) – is not only a key factor in photosynthesis and proper leaf color but also in root growth. High soil pH can lead to deficiency of this critical element in the plant, whether or not there is enough in the soil. (See Figure 2.)

Zinc (Zn) – is critical for production of the plant hormone that is required for development of leaves and for proper attachment of leaves to stems. This element is also necessary for photosynthesis and may be deficient at high pH. (See Figure 2.)

Manganese (Mn) – is another element that is important in the process of photosynthesis that can be deficient at high pH. It is necessary for proper protein activity and root growth. See Figure 2.)



**Figure 2.** *Plants in high pH soils show pale leaves with green veins: symptoms of iron, magnesium, manganese or zinc deficiencies. These can look very similar. Photo: A. O'Callaghan*

Boron (B) – is needed in only very small quantities but it is greatly important in

seed production, root development, and the movement of sugars throughout the plant. Many parts of the Southwest have excessively high levels of boron, which can lead to toxicity symptoms, including deformed leaves and bronzing of leaf margins. Few plants need more than ~ 1 ppm B, and very few can tolerate more than ~ 2 ppm.

Sulfate S – is a form of the element sulfur, which is critical for several amino acids, the building blocks of proteins. It is important in the formation of chlorophyll, the core compound of photosynthesis, as well as in nitrogen fixation and seed formation.

Other measures that can be useful when looking at soils, either to plan for future uses or to diagnose problems:

Soil texture –labs are often able to analyze the relative amounts of sand, silt and clay in a soil. Sandy soils tend to drain very quickly and need more soil amendments, while clay soils might be high in nutrients but have very slow infiltration and percolation rates. This information can help the gardener or landscaper to find out likely problems a particular soil might have. They may also report the USDA classification of soil type, which might be less useful. One common problem in desert soils is that heavy clay soils become water logged, which interferes with root activity. Over watering can cause plant death.

## **Types of Reports**

Various laboratories present their findings differently. All will report the levels of nutrients numerically, but they can expand their usefulness by putting the data into a chart form. Graphic

presentations can be helpful in getting a better sense of the balance of nutrients in the sample. Some labs only provide graphic reports when specifically requested. Different labs will routinely present their data both in text and graphically, but others do not give the option of graphic representation. Some labs routinely give fertilizer recommendations; others require specific requests. Usually additional tests cost more.

Cation Exchange Capacity (CEC) – measures the ability of a soil to adsorb and exchange positively charged ions such as the nutrients calcium, magnesium, potassium, etc. As soil releases nutrients, they become available to plants.

## **Conclusions**

Plant health depends on the right soil conditions. Gardeners and landscapers need to know what is happening in the neighborhood of the roots. This includes information on the nutritional levels in the soil, as well as soil pH and salinity. Knowing the relative amounts of sand, silt and clay can also be helpful, particularly if drainage is a problem.

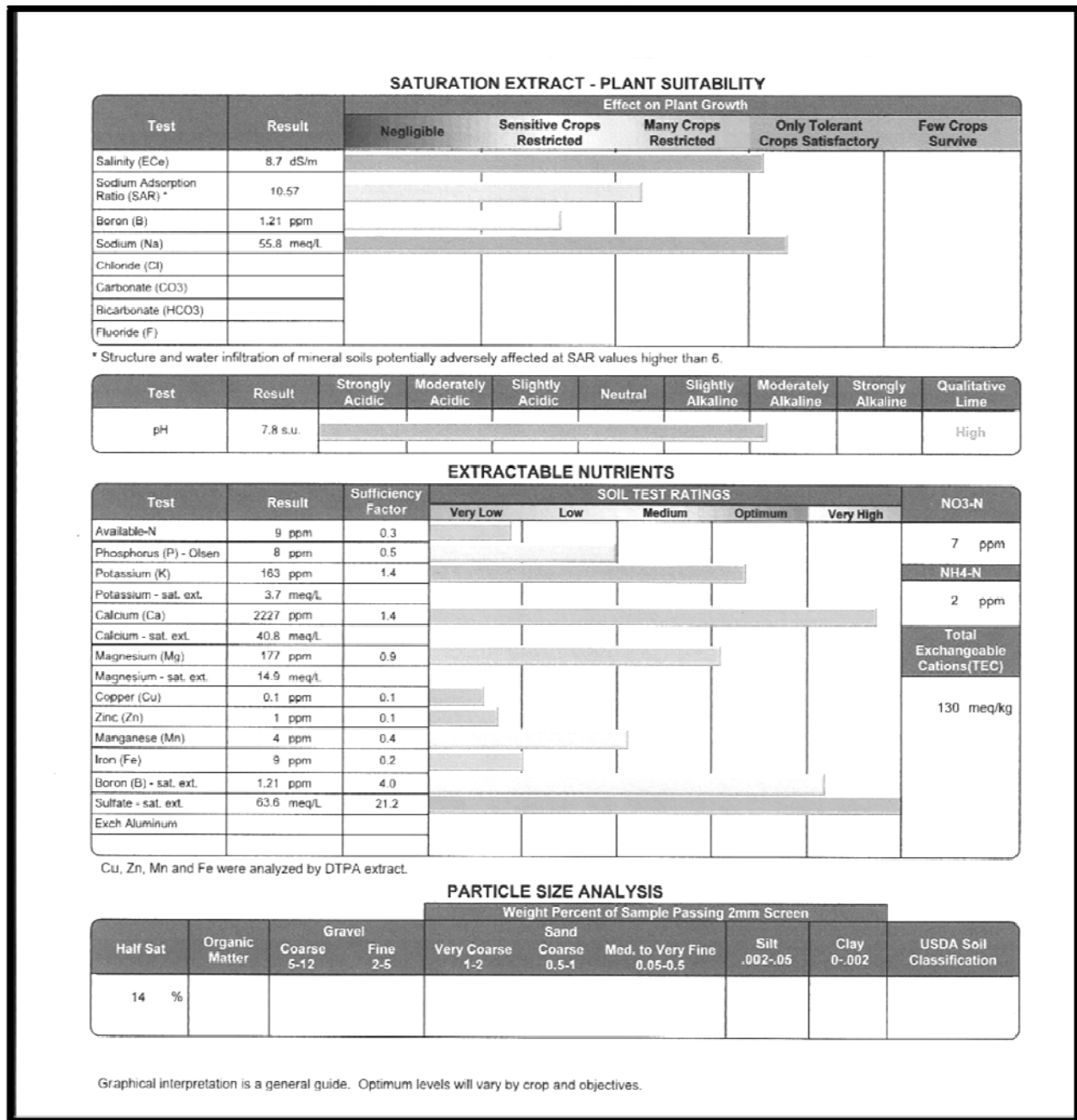
Understanding what is contained in a soil analysis will help horticulturists (both amateur and professionals) to make the best choices for their plantings. For more information, contact the local Cooperative Extension office.

## **Appendices**

The following samples are based on reports from two separate laboratories.



**SAMPLE ONLY**



**Figure 3.** This sample report includes a graphic representation of data. The original request did not specify any plants other than “garden.” There are three graphs: one describes some results in terms of plant effects, here the saline soil will inhibit growth of salt-sensitive plants; the boron concentration is enough to limit certain plants as well. The second is a pH chart showing a moderately high level of alkalinity. The third chart gives concentrations of the various elements; note that nitrogen in the right hand column is listed as NO<sub>3</sub><sup>-</sup> (nitrate) N and NH<sub>4</sub><sup>+</sup> (ammonium) N. The sum is the available nitrogen reported. The low nitrogen levels could impair plant health; nitrogen fertilization will help this. Lowering soil pH with soil sulfur and adding compost for fertility will probably improve growing conditions. Soil type analysis was an option, but not requested.

<b>Date received:</b>				
<b>Date complete:</b>				
<b>Name:</b>		<b>Phone:</b>		
<b>Address:</b>		<b>County:</b>		
<b>Lab #</b>		<b>Grower's comments:</b>		
<b>Identification:</b>		Windmill Ln.		
<b>Crop to be grown</b>		Garden		
<b>Soil Test Results</b>		<b>Interpretations</b>		<b>Recommendations</b>
<b>Texture</b>		Sandy Clay Loam		
<b>pH</b>		8.17		
<b>Salinity – ECe</b>	<b>dS/m</b>	8.25	Very High	
<b>Phosphorus – P</b>	<b>mg/kg</b>	6.6	Very Low	3 lbs P2O5/1000 sq ft
<b>Potassium – K</b>	<b>mg/kg</b>	303	Adequate	0 lbs K2O/1000 sq ft
<b>Nitrate N</b>	<b>mg/kg</b>	4.31	0 – 1 lb N/sq ft	
<b>Zinc – Zn</b>	<b>mg/kg</b>	0.41	Very low	3 oz Zinc/1000 sq ft
<b>Iron – Fe</b>	<b>mg/kg</b>	3.71	Low	
<b>Copper – Cu</b>	<b>mg/kg</b>	0.3	Adequate	
<b>Manganese – Mn</b>	<b>mg/kg</b>	5.4	Adequate	
<b>Sulfate Sulfur S</b>	<b>mg/kg</b>	385	Adequate	0 lbs Sulfur/1000 sq ft
<b>Organic Matter</b>	<b>%</b>	1.1		
<b>SAR</b>				
<b>Boron</b>	<b>mg/kg</b>	1.46	High	

**Table 1.** This is based on an analysis from a university laboratory which does not offer graphic reports. It routinely provides information on soil texture (“Sandy Clay Loam”) as well as fertilizer recommendations. “Grower’s comments” would be the place to mention any soil amendments that had recently been applied. SAR (Sodium Adsorption Ratio) was not requested, although it was an option. The high salinity could be treated by using large amounts of irrigation water to flood the soil. Lowering the high pH with soil sulfur will ultimately increase the availability of iron and zinc, although micronutrients can also be applied to the soil.

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- Southern Area
- Western Area
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- |                                 |           |               |
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