Bulletin #1

# A Guide for Making Recommendations for Garden Soils

*The comments written in italics are a summary of soil test results, from the University of Arizona, 1965-1984, for Yavapai County.*

**pH** -- This measurement is important because of its relationship to the availability of plant nutrients. The elements zinc and iron are less available at high pH; aluminum and manganese may be present in toxic amounts at low pH. Most Arizona soils are between pH 7 and pH 8; the average pH of Yavapai County soils was 7.5. This number indicates, on a scale of 0 to 14, the acidity/alkalinity of a solution. If the pH is 7, it is neutral. A number above 7 is alkaline; a number below 7 is acidic. The optimal pH range for the growth of most crops is 6.5 to 7.5.

*53% of soils sampled in Yavapai County had a pH of 7.5 to 7.9; 34% had a pH of 6.5 to 7.4; 13% had a pH of 8.0 to 8.5. The average pH of Yavapai County soils was 7.5.*

**Salts (ECe)** *(ECe is the Electrical Conductivity of solution extracted from a water-saturated soil paste)* The concentration of soluble salts in soil solution is directly related to availability of soil water for plant uptake. The higher the salt content the lower the availability of water to the plant. The electrical conductivity (ECe) of soil is measured as a means to estimate total soluble salt content. ECe measures salinity or total salt content; the more salt in the water, the better conductor it becomes. This measurement does not differentiate the forms of soluble salts that are present. Seventy-six percent of Yavapai County soils, sampled from 1965 to 1984, had an ECe value of 2.0 or less. Values between 2.0 and 4.0 mmhos/cm (millimhos per centimeter) may cause problems for salt-sensitive plants. Many vegetable crops are affected if ECe is greater than 3.0. Serious problems may occur on fruit crops if ECe is greater than 4.0; fig and olive are more tolerant than apple and peach. If values are between 3.0 and 4.0, the soils should be heavily irrigated at first to move the salts below the root zone. If salts are above 4.0, pre-irrigate before planting according to the following table. Localized salt concentrations may occur in surface soils that cause problems on germinating seeds and small seedlings. Soluble salts (parts per million or ppm) is another measure of salinity. A value above 2500 ppm will result in poor growth.

| SALT READNG | WATER TO APPLY (INCHES) |
|---|---|
| 4.0—6.0 | 6 |
| 6.1—8.0 | 8 |
| 8.1—10.0 | 10 |
| 10.1-15.0 | 12 |
| 15.1—20.0 | 24—questionable garden location |
| 20.1 + | Choose a different location |

*42% of soils sampled in Yavapai County had an ECe of less than 1.0; 34% had an ECe of 1.0 to 2.0; 13% had an ECe of 2.1 to 4.0; 11% had an ECe of greater than 4.0.*

**ESP (Exchangeable Sodium Percentage)** -- In addition to salinity, excess exchangeable sodium (Na) is the other major limitation in the use of desert soils for growing plants. This measurement tells how many sodium ions can be exchanged for other cations, such as calcium, magnesium, or potassium. The most serious problem associated with high exchangeable sodium levels is a deterioration of the physical properties of the soil. A soil with a large amount of Na has poor physical characteristics for plant growth, becomes impervious to water when wet and forms hard clods when dry. At exchangeable sodium levels above 10 to 15 percent, the soil particles become progressively more dispersed, resulting in surface sealing, crusting, low water penetration, poor seedling emergence and difficulties in tilling the soil. An ESP of 2.0 or less is suitable; an ESP of 0.65 is good.

*The average ESP in Yavapai County soils was 1.5%.*

**SAR** -- The Sodium Adsorption Ratio is another measure of sodium salts in the soil. Gypsum (calcium sulfate) is recommended to correct sodium problems according to the following table. *Note that sodium problems are rarely found in Yavapai County soils.*

| SAR | LBS. GYPSUM PER 1,000 SQUARE FEET |
|---|---|
| 12 - 20 | 50 |
| 20 - 30 | 100 |
| 30 - 40 | 150 |

After adding gypsum, the soil should be leached in accordance with its salt reading.

**Organic matter** -- Any time organic matter (OM) is below 1.0 percent, incorporate four bushels of OM per 1,000 square feet.

**Nitrogen** -- Nitrogen (ppm) is reported either as N (nitrogen) or nitrate. To convert N to nitrate, multiply by 4.4. Nitrogen is the nutrient most commonly deficient in Yavapai County soils. Because nitrate moves in soil water, take soil samples for nitrate test just before an irrigation. Nitrate-N soil test values are considered deficient at less than 5 ppm; 5 - 20 ppm nitrate is rated medium; 20 - 40 ppm nitrate is considered high; and excessive at greater than 50 ppm.

The organic matter content is taken into consideration in making this recommendation as follows:

| SOIL TEST VALUE | PERCENT ORGANIC MATTER | | |
|---|---|---|---|
| nitrate -N ppm | 0 - 1.0 | 1.1 - 2.0 | 2.1 - 3.0 |
| | lbs. N to add per 1,000 square feet | | |
| 0 - 6.0 | 3 | 2 | 1 |
| 6.1 - 12.0 | 2 | 2 | 1 |
| 12.1 - 18.0 | 2 | 2 | 1 |
| 18.1 - 24.0 | 1 | 1 | 0 |
| 24.1 - 30.0 | 1 | 0 | 0 |
| over 30.0 | 0 | 0 | 0 |

If recommendation is for 2 or 3 lbs., apply one-half before planting and the other half July 1. Note that 1 lb. N may be obtained from 7 lbs. dried blood meal, 150 lbs. wet cattle manure or 40 lbs. dried cattle manure.

*33% of soils sampled in Yavapai County had a nitrate-nitrogen level (ppm) of 10.0 - 20.0; 28% had 1.0 - 5.0 ppm; 20% had 5.0 - 10.0 ppm; 13% had 20.1 - 50 ppm; 8% had greater than 50 ppm.*

**Phosphorus** -- Arizona soils have large reserve of phosphorus (P), but it is mostly insoluble. The average ppm P in Yavapai County soils was 6.9. A phosphate test determines the amount that is available to plants. Phosphorus is highly immobile in our soils and is removed primarily through crop uptake and harvest. Apply P according to the following table.

| SOIL TEST VALUE (ppm P) | | | |
|---|---|---|---|
| 0 - 7.0 | 7.1 - 14.0 | 14.1 - 21.0 | 21.- 28.0 |
| *4* | *3* | *2* | *1* |

Lbs. Phosphoric acid to add per 1,000 square feet

Note that 1 lb. phosphoric acid may be obtained from 6 lbs. of bone meal.

*The average ppm P was 6.9. 35% of soils sampled in Yavapai County had 2.1 - 5.0 ppm p; 20% had 5.1 - 10.0 ppm p; 18% had less than 1 ppm P; 10% had 1.0 - 2.0 ppm P; 10% had 10.1 - 20.0 ppm P; 8% had greater than 20.0 ppm P.*

**Potassium** -- If soil test value, in ppm potassium (K), is 0 - 60, apply 2 lbs. potassium oxide per 1,000 square feet. If soil test value is 61 - 120 ppm K, apply 1 lb. potassium oxide per 1,000 square feet. Note that 1 lb. potassium oxide may be obtained from 200 lbs. wet cattle manure or 50 lbs. dried cattle manure.

**Zinc** -- If zinc reads less than 1.0 ppm, apply one lb. zinc sulfate per 1,000 square feet.

**Iron** -- If soil test read 0 - 4.0 ppm iron (Fe), apply 2 lbs. iron chelate per 1,000 square feet. If soil test reads 4.1 - 8.0 ppm Fe, apply 1 lb. iron chelate per 1,000 square feet. Additionally, apply 4 bushels of manure per year per 1,000 square feet to garden.

**Manganese** -- Manganese (Mn) is not usually determined in a soil test. The critical level is 1.0. If the soil test reads below 1.0 and the pH is below 7.0, apply 1/8 lb. of actual Mn per 1,000 square feet and if the pH is above 7.0, apply 1/4 lb.

**Copper** -- If the reading is below 0.2 ppm, apply 1/8 lb. of actual copper per 1,000 square feet.

Note that all minor elements may be obtained from manure using an annual application of 4 bushels per year per 1,000 square feet.

Updated August 1, 2007 (Original prepared in 1995 by Deborah Young, reviewed by Tom Doerge)
http://cals.arizona.edu/yavapai