



# Soil Fertility and Soil Testing Guideline for Arizona Cotton

According to all available evidence, there are 20 total nutrients necessary for complete plant growth and development. Not all are required for all plants, but all have been found to be essential to some. Three of the 20 (C, H, and O) and are derived from CO<sub>2</sub> and H<sub>2</sub>O and are not usually considered in terms of managing a soil fertility program. The remaining 17 are commonly referred to as mineral nutrients (N, P, K, Mg, Ca, S, Fe, Mn, Mo, Cu, B, Zn, Cl, Na, Co, V, and Si). Of the 17 mineral nutrients N, P, and K are considered to be the macronutrients; Mg, Ca, and S are secondary nutrients; and Fe, Mn, Mo, Cu, B, Zn, Cl, Na, Co, V, and Si are referred to as micronutrients. The terms macro-, secondary, or micronutrients do not refer to any level of importance but rather to relative amounts required by plants.

The amount of a given nutrient found in a plant will depend on a number of factors, governed in general by a broad range of plant and environmental interactions. Therefore, the percentage composition can vary tremendously among species and locations. With cotton, considerable information has been developed regarding nutrient content for various stages of growth and different growing regions. This information is helpful in understanding the nutrient requirements for a crop like cotton. However, based on the fact that all of the mineral nutrition is provided to the plant by nutrient uptake from the soil through the root system, an understanding of the soil conditions and the effects on plant nutrition are very important. A fundamental point to consider is that there is usually a rather poor relationship between the total amount of a given nutrient found in the soil (i.e. P or K) and the amount actually available to the plant for uptake and utilization. This is very true in Arizona where our agricultural soils are commonly rather young (geologically) alluvial soils with a high native fertility level. Soil tests are commonly used in an effort to establish a relationship between an estimated level of a "plant-available" form of a given nutrient and its sufficiency, deficiency, or toxicity for the crop in question. The relationships between a soil test and actual crop nutrient needs are usually specific for a crop and region (set of common soil conditions).

To develop recommendations for the proper fertilization program for a given field of cotton in Arizona, it is important to have an established relationship among three variables: 1) soil test levels, 2) the rate of a fertilizer nutrient to be applied, and 3) (very importantly) an expected yield response. To determine a soil test level for any nutrient, the method of testing the soil for that nutrient is very important, particularly in relation to the three factors mentioned previously. For cotton production systems in Arizona, the University of Arizona offers a set of guidelines for developing fertilizer recommendations based upon a set of standard (and common) soil test procedures offered by many commercial soil testing laboratories in the region. Developing a sound fertilization program begins with a good understanding of actual soil conditions. The collection and analyses of a good set of soil samples and then relating that information to established guidelines is the first step toward developing a strong soil fertility and plant nutritional management program for cotton. This is important for agronomic efficiency (providing the appropriate nutrients for crop growth), as well as both economic and environmental efficiency.

Table 1 outlines the information currently available regarding cotton nutrient requirements in Arizona. The critical levels can be used as approximate lines

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[ag.arizona.edu/pubs/crops/az1215.pdf](http://ag.arizona.edu/pubs/crops/az1215.pdf)

separating sufficient and deficient levels of a given nutrient. Soil test levels above the critical concentrations indicate a low probability of crop response to fertilizer applications of that nutrient. One notable exception is for the critical level for  $\text{NO}_3^-$ -N, which pertains only to pre-season soil tests and pre-season applications of N, due to the mobile nature of  $\text{NO}_3^-$ -N in the soil and many important soil N reactions that can affect available N concentrations over time. If greater than 10 ppm  $\text{NO}_3^-$ -N is found in a pre-season soil test, this would simply indicate a sufficient level of soil N for crop establishment. Additions of N fertilizer will commonly be required with split, in-season applications depending on actual crop conditions. For the other nutrients listed, the critical levels can serve as general indicators of season-long crop nutrient needs.

For soils that have nutrient concentrations below the critical levels, additional amounts of that nutrient provided to the crop through fertilization is recommended. Actual amounts of fertilizer forms of the nutrients needed will depend on several factors including the degree of deficiency detected, the form of fertilizer being used, and other factors such as nutrient concentrations in the irrigation water (requires water analysis). In cases where the nutrient levels in the soil are close to the critical levels, crop response may be positive to fertilization. For most of the nutrients listed in Table 1 recent information is available and the critical levels are considered to be up to date. Field testing is the best way to evaluate these critical levels and establish better relationships between soil test levels and expected crop response to fertilization.

Table 1. Soil fertility and soil testing guidelines for Arizona cotton.

Nutrient	Soil Test Method	Critical Level (ppm)
N	1:1 soil solution (ISE)	10 ( $\text{NO}_3^-$ -N)
P	Sodium Bicarbonate	5
K	Ammonium Acetate	150
Zn	DTPA	0.6
Fe	DTPA	5.0
Mn	DTPA	1.0
B	Hot Water	0.5

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