# NURSERY FERTILIZATION

A Brief Overview

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The lifted crop of tree seedlings represents a significant drain on the nutrients from the nursery soil. Consequently, the nurseryman is in a never—ending struggle of trying to maintain soil fertility at a level which will provide for the growth of the seedling crops while neither building nutrient supplies to excessive levels nor letting them become depleted.

Maintaining soil fertility would be a reasonably simple task if our system were easy to analyze and if fertilization were completely efficient. In that case we would first determine the amounts of the various nutrients removed in the crop and then return those nutrients to the soil for the next crop.

Unfortunately, the soil, climate, and the seedlings all interfere with the functioning of a simple system. Various soils have different capacities to hold or lose specific nutrients. The climate, through the actions of rain, heat, and wind affect the loss of nutrients through leaching, the reduction in the availability of some nutrients, and the success in the establishment of the seedling crop which will eventually need the nutrients.

Additionally the nurseryman faces the challenge of taking soil samples for analysis that are truly representative of his fields. Non-representative samples, no matter how carefully analyzed are not likely to yield useful information.

In the laboratory, the soil samples are to be analyzed chemically, in a few minutes, to represent what the seedling crop will do, biologically, over

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an entire growing season. Various methods have been developed in order to make these fertlity estimates. Unless we know which methods have been used in the analyses, interpretation of the results is difficult or impossible.

Finally, assuming that we have representative samples, analysed by using known methods, and the history of previous years' fertilization schedule, we are still faced by three variables which can affect the nutrient needs of the next seedling crop. They are the actual seedbed density and distribution attained, whether the year will be unusually wet or dry, and warm or cool. These all affect the quantities of nutrients that will need to be applied to the next crop.

With all of these considerations in mind, we can now turn our attention to the actual development of an efficient nursery fertility management program. In the following paragraphs, we will only be able to address general conditions. Specific nursery soil fertility management is still required on a nursery—by—nursery basis.

## FACTORS AFFECTING NURSERY FERTILIZATION

### Species Being Grown

Loblolly and slash pines represent the principal species grown in the region, but they are far from the only species being grown. It is important to determine in advance which species will be grown in which fields.

We need to give particular attention to hardwoods. On a per acre basis they require more of all nutrients than pines and they have especially large needs for calcium (Ca). Then if one considers that hardwoods are grown at only 1/2 to 1/4 the seedbed density of pines, the nutrient needs per seedling become much greater.

Even within the conifers, there are differences in needs. For example, iron (Fe) deficiency in longleaf pine seedlings requires approximately four times as much chelated iron per acre as loblolly or slash pines to correct the chlorosis.

Organic Matter

The amount and condition of organic matter in the soil have very significant effects on the fate of some nutrients. A good level of well humified organic matter results in a favorable cation exchange capacity (CEC) of the soil. This results in cations being held effectively in the soil against leaching by rain and irrigation water. Such soils can receive larger, less frequent doses of cations than soils with less organic matter. The cations include nitrogen (N) *as* ammonium ($NH_4^+$); potassium ($K^+$); Ca++; magnesium ($Mg^{++}$); and the minor elements copper ($Cu^{++}$), iron ($Fe^{++}$ or $Fe^{+++}$), manganese ($Mn^{++}$), and zinc (Zn++).

In order for soil to have the desired level of humified organic matter, there must be periodic additions of fresh organic matter. While fresh organic matter is undergoing the necessary humification, certain nutrients are likely to be immobilized by the microbes that are involved in the humification. Although all nutrients may be affected to some degree, N, phosphorus (P) and sulfur (S) are the ones usually strongly affected, Thus when fresh organic matter is added to soil, we will likely need to increase our levels of fertilization with N, P, or S. That is particularly true when woody materials or bark are added to soil.

Nutrient and Time of Application

Certain nutrients move slowly or not at all in the soil. Thus in order for those nutrients to be where seedlings can get them, they need to be applied and mixed with the soil either before or during bed shaping. These nutrients include P, Ca, Mg, and fritted (slow—release) sources of minor elements.

Other nutrients move more readily into and through the soil. Thus we have more options in their application to the soil. Frequently, however, they are applied as topdressings which are timed to precede the seedlings' needs. These elements include N, K, S and soluble sources of the minor elements.

Finally, there are some nutrients which may be efficiently applied directly to the foliage for uptake. These include Fe, Mn, boron (B), and Zn. These nutrients can be applied to the soil rather than the foliage but the rate of application is usually required to be considerably higher in that case.

Time of year is also an important factor in determining nutrient needs. A major rain in June will leach certain nutrients from the soil (e.g., nitrate **N**, **K** and S) and require that they be replaced soon. A similar rain in October will not require any immediate action. The nutrients lost then will be realized in the soil tests conducted in advance of the next year's crops.

## Soil Acidity

Soil acidity has both direct and indirect effects on nursery fertilization. The direct effects are caused by the pH value. The availability of all nutrients is affected by acidity (Figure 1). Within the range of pH values that are satisfactory for tree seedling production, four of the minor elements (Cu, Fe, Mn, and Zn) increase in availability as the soil becomes more acidic. All other nutrients become progressively less available. It is interesting that pH 5.5 is about the acidity level at which the relative availability of most nutrients is about equal and this acidity level is near optimum for most seedling species of interest.

The indirect effect of soil acidity occurs at pH values below 5.5. As soil acidity increases, a non—nutrient element, aluminum (Al) becomes increasingly available in the soil (Figure 1). This element interferes directly with the uptake of both P and Fe and also becomes toxic to the seedlings, especially to roots. The toxicity level varies with tree species. Fortunately, the Southern pines are relatively tolerant of Al in the soil.

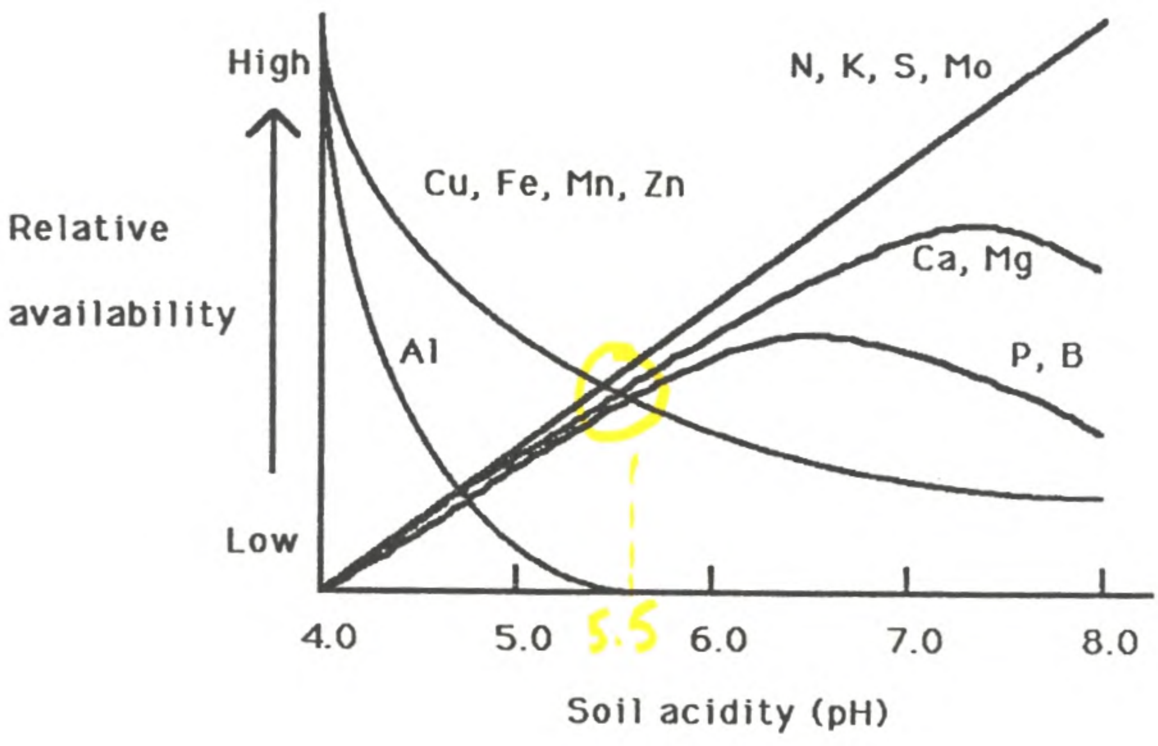


Figure 1. Effect of soil acidity (pH) on the relative availability of nutrient elements and aluminum.

If soil tests show pH values that are outside the desired range, we have several options. When the pH value needs to be raised, we will use dolomitic lime (dolomite) if both Ca and Mg are low. If only Ca is low, we may use calcitic lime (calcite) instead. When the pH value needs to be lowered, we may use ammonium sulfate as part or all of our nitrogen source or we may apply elemental sulfur (S) to the soil and mix it in thoroughly, before seedbeds are formed.

Irrigation Water

Irrigation water enters into our fertilization program because all water sources contain both nutrient and non—nutrient elements. Generally, water that is pH6 and lower is not a problem. From pH6 to pH8 we usually find increasing levels of Ca or Ca and Mg. If only Ca is present, it may eventually adversely affect the soil's Ca:Mg ratio and require the addition of Mg to re—establish a proper balance. Abouve pH 8.2, the non—nutrient element sodium (Na) becomes the dominant cation. This leads to soluble salt problems and excessive leaching of K from the soil. Such water can be, and has been, treated to make it useful. However, it is not an inexpensive process and alternative water sources or nursery sites should be considered when such water is found. In some areas, well water from certain depths is high in Na while surface water or well water from other depths is quite satisfactory.

## CONCLUSION

This brief overview of nursery fertilization elucidates the complexity of factors which influence our fertilization programs. The practical nurseryman will become familiar with those factors which affect him directly, develop an appreciation for the soil—to—soil variation that occurs, and not be intimidated by the subject. Our knowledge, while still imperfect, is adequate to handle most situations that we encounter.