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Plant Nutrients and Fertilizers for the Non-Farmer[1]

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This publication is designed for persons who are not professional farmers but who nonetheless want to better understand plant nutritional needs and fertilizers. It should be particularly helpful to home gardeners who care for lawns, shrubs, trees, and vegetable and flower gardens.

My purpose is to give you a better appreciation of the need for fertilization, the materials available, and alternatives to purchased fertilizers. With this information you will be able to make better fertilizer management decisions. The following are some of the topics we discuss:

- When and why you may need to fertilize
- Fertilizer materials
- How to shop for fertilizers
- Efficient use of fertilizer resources

Why Do We Fertilize Plants?

For centuries plants grew without any help from human beings, and many are doing so today. Thus, it is obvious that they can do so by themselves, especially in environments to which they are adapted. However, as humans cultivated plants it was learned that the addition of certain materials to the soil sometimes caused plants to respond with characteristics which were considered to be desirable (e.g., more fruit, faster growth, better color, more attractive flowers). Early in recorded history we find accounts of applications of animal manures, wood ashes, and lime to enhance plant performance. Thus was born the practice of fertilization and soil amendment.

We should note here that the plant responses we get from applying fertilizer and other soil amendments are not inherently "good" or "bad." These terms are subjective and reflect personal judgment as to what is "desirable." For example, a greater quantity of fruit which is too small for market is not a characteristic desired by a peach farmer. Faster growth is usually not a desirable effect for someone growing bonsai plants. Rank vegetative growth is not desirable in an already-lush lawn nor are profusely-blooming squash plants that are not setting fruit. Thus, a "good" response to fertilization under one set of circumstances may be a "bad" response under another set. It depends on what response the person wants from the plant.

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So, why do we apply fertilizer to the soil? Because we want to obtain some desired plant response. We want our plants to "do better." As we set out to fertilize our plants we should keep in mind how we want them to do better (grow faster, produce better flowers or fruit, etc.) - and we should also know if fertilization will contribute to that improvement.

When Should I Apply Fertilizer?

Stated simply, you need to fertilize whenever you expect to get a desired plant response. However, the difficulty is in predicting. You usually want to know in advance if there will be a response to added fertilizer so that you can avoid growing plants under nutrient-deficient conditions. Since predicting plant responses is difficult, many people apply fertilizer as insurance against nutrient deficiencies. The result: over fertilization in the United States is now as prevalent a problem as under fertilization.

A suggested approach to fertilization involves the following steps:

- Recognize what plant response you are seeking;
- Determine from observation or consultation if fertilizer application is likely to give you the response you want;
- Apply fertilizer only if your desired response is likely;
- Apply only the amount of fertilizer necessary to give the desired response.

What Nutrients Do My Plants Need?

The best way of knowing what your plants need is by observing plant performance and understanding the multiple factors affecting such performance (e.g., light, water, temperature, pests, nutrition).

There is no magical way of knowing which nutrient may be in limited supply in the soil. Soil testing helps predict the need for some of the nutrients, but testing is only one of the tools in plant nutrient management. If you recycle organic matter such as grass clippings (don't use a bag on your mower) and leaves, you will be returning to the soil the nutrients those plants had absorbed. It is the easiest, least expensive, and most environmentally sound way to fertilize. You may still have to supplement, but you will then apply fewer nutrients—and a lot less fertilizer. Plants need 18 elements for proper growth and reproduction. Under many conditions, plants obtain enough of these elements from the soil, water, and air. It is only in certain environments and growing conditions that one or more of the nutrients are deficient.

The most-commonly applied nutrients are nitrogen (N), phosphorus (P), and potassium (K). Responses to all three elements were fairly widespread in the past, and it became customary to apply the three together. As a result of habit, all three are still applied even though there are now many situations, especially in gardens and landscapes, where plants do not respond to one or more of these fertilizer nutrients.

Other plant-essential nutrients used in fairly large quantities are calcium (Ca), magnesium (Mg), and sulfur (S). However, fertilization with these nutrients is not usually necessary because the Ca and Mg contents of soil are generally sufficient for most plant species. Also, large quantities of Ca and Mg are supplied when acidic soil is limed with dolomite. Sulfur is usually present in sufficient quantities from the slow decomposition of soil organic matter, an important reason for not throwing out grass clippings and leaves.

Micronutrients are those elements essential for plant growth which are needed in only very small (micro) quantities . These elements are sometimes called minor elements or trace elements, but use of the term micronutrient is encouraged by the American Society of Agronomy and the Soil Science Society of America. The micronutrients are iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo), Cobalt (Co), Nickel (Ni), and chlorine (Cl). If one of your plant species has a micronutrient deficiency, apply the recommended rate of the deficient nutrient. Recycling organic matter such as grass clippings and tree leaves is an excellent means of providing micronutrients (as well as macronutrients) to growing plants.

What About Organic Matter as a Source of Nutrients?

Organic matter (such as grass clippings, tree leaves, shrubbery and tree trimmings) is an excellent source of plant nutrients. The plants which produced that organic material accumulated all the essential nutrients for their own growth needs. Upon decomposition, those nutrients in the organic material become available for reuse. When you recycle "homegrown" organic matter such as grass clippings, leaves, and shrubbery trimmings you are practicing an excellent method of fertilizing your landscape. You are keeping valuable materials on site and are also greatly reducing the municipal solid wastes placed at curb side. Other organic materials, such as animal manures, biosolids (processed sewage sludge), or various composted materials, are also alternative sources of plant nutrients.

How Do I Shop for Fertilizer?

- Know what nutrients you need to buy.
- Be informed when reading fertilizer advertisements.
- Read the fertilizer label before buying.
- Consider all costs.

Buy nutrients, not "fertilizer." When you go to buy "fertilizer," know what nutrients you really need. Many fertilizers contain a whole suite of plant nutrients, but you may need only one or two. Buying such mixtures results in your paying for nutrients which you really do not need.

Nitrogen is the nutrient which is almost always needed as a fertilizer. Plants use large quantities of N, and most mineral soils simply can not supply enough to give satisfactory plant performance. N is also the element which gives the visual "green-up" responses most often associated with landscape fertilization. Proper use of N fertilizer in the landscape is vital for proper plant performance concurrent with environmental-quality protection.

Phosphorus and potassium are also often needed. However, in many landscaping situations sufficient P and K is supplied by the soil-recycled organic matter and from residual (build-up) fertilizer so that additional application is not necessary. When your soil test for either P or K is rated "high" or "very high," there is no need to include that nutrient in the fertilizer. The soil will supply all that your plants need. **Buy a fertilizer which contains only the nutrients you need**.

Micronutrients are often used to sell fertilizers. While there are numerous instances of deficiencies of one or more micronutrients in specific plant-growth settings, most micronutrients in fertilizer are included as a prophylactic and do not give a plant response. Buy and apply only those nutrients which you have reason to believe will be needed by your plants.

What Information Can I Get From the Fertilizer Label?

Labeling laws have been enacted to aid the consumer in evaluating the many fertilizer products on the market. Such laws make it possible for informed consumers to distinguish legitimate fertilizers from those of questionable value. Following are some things to look for on the label (Figure 1). (For more information, refer to UF/IFAS Fact Sheet SL-3, "The Florida Fertilizer Label" available from county Extension offices or on the web at http://edis.ifas.ufl.edu/ss170).

Reading the label. Two items of major interest are the guaranteed percentages of nutrients claimed by the manufacturer (the "guaranteed analysis") and the materials from which the fertilizer is made ("derived from"). The first tells the percentage of each nutrient in the fertilizer, while the second lets you know the source of the nutrients.

In the **guaranteed analysis** section of the label, the total N content is broken down to distinguish the different forms of N in the fertilizer. Unfortunately, legal and technical terminology sometimes get in the way of simple, straightforward definitions, so the information on the tag can be confusing. The distinction between nitrate and ammoniacal N is of little practical significance since ammoniacal N is quickly converted to nitrate N under most Florida landscape conditions. "Other Water Soluble Nitrogen and/or Urea Nitrogen" is almost always urea N, a good, legitimate source of N. "Water Insoluble

Florida License No. Fxx

BRAND NAME
XX-XX-XX (grade)
Name and Address of Registrant
Net Weight
GUARANTEED ANALYSIS

**Total Nitrogen..______%
___% Nitrate Nitrogen
___% Ammoniacal Nitrogen
___% Other Water Soluble Nitrogen (and/or Urea Nitrogen)
___% Water Insoluble Nitrogen
Available Phosphorus (P_2O_5)..................................______%
Soluble Potassium (K_2O)...______%
Chlorine, not more than...______%
Total Magnesium as Mg..______%
___% Water soluble Magnesium (Mg)
Total Manganese as Mn...______%
___% Soluble Manganese (Mn)
Total Copper as Cu...______%
___% Soluble Copper (Cu)
Total Sulfur as S..______%
___% Combined Sulfur (S)
___% Free Sulfur (S)

Derived from: (Actual source materials and forms used in the fertilizer mixture, e.g. urea, concentrated superphosphate, potassium chloride, biosolids, manganese sulfate, copper sulfate, etc.)

**This produce contains ___% of slow or controlled release nitrogen from sulfur coated urea.

Figure 1. Example of a Florida fertilizer label.

Nitrogen" may be N in natural organic forms as would be found in biosolids and manure or it many be in controlled release N materials such as urea-formaldehyde. When fertilizers contain controlled release materials, the guaranteed percentage of the controlled release nutrient is shown in a footnote

Phosphorus and potassium contents are expressed as oxide equivalents, a relic persisting from and related to historical methods of analysis. Do not worry about this convention since fertilizer recommendations are expressed in terms of P_2O_5 and K_2O, the same as used on the tag. Other nutrient contents are expressed as percentages of the element.

In the **derived from** section are listed the actual materials used in formulating the fertilizer. Knowing what a fertilizer is made of, and the characteristics of its components, helps you to better evaluate its value and its appropriateness for your particular fertilization situation.

How Do I Know Which Fertilizer Advertising Claims to Believe?

Marketing in the consumer sector generally depends on a large volume of material being sold. Thus, advertisement of low prices "per bag" or the presence of extras such as micronutrients or control release forms of the nutrients, influence greatly what is sold. Be an informed consumer.

Price per bag can be deceptive because **bag weights differ** (a 28-lb bag contains 30% less material than a 40-lb bag), and the concentration of nutrients in a bag can also be very different. One way to comparison shop for fertilizer is to compare the cost per pound of primary nutrients in the various products. Add the N, P_2O_5 , and K_2O percentages; and multiply by the net weight of the package to approximate the pounds of nutrients contained. Then divide the cost of the package by the pounds of N + P_2O_5 + K_2O in the package to obtain the per pound cost. For example, a 40 lb bag of 20-3-7 fertilizer would contain 12 pounds of nutrients (i.e., 30% N + P_2O_5 + K_2O multiplied by 40 pounds). If the bag of fertilizer costs $6.00, the average cost of the nutrients would be $0.50 per pound. While this method has shortcomings (e.g., nutrients other than N, P, and K aren't considered; also, nutrients have different values, N costing about twice what K does), it allows quick comparisons between products.

Micronutrients are often used as an incentive to buy one fertilizer instead of another. Fear of micronutrient deficiencies and the feeling that somehow micronutrients make the fertilizer "better" are each motives exploited in fertilizer sales promotions. However, as a rule, lawns and gardens exposed to reasonable recycling of organic matter seldom need the small amounts of micronutrients contained in general fertilizer mixes. If a serious micronutrient deficiency does exist, the small quantities of micronutrients present in popular fertilizer mixes would usually not be sufficient to correct the problem.

Control release fertilizers, also called slow release fertilizers, help reduce nutrient leaching losses. These fertilizers have only a portion of the control release nutrient in soluble form at any one time. That portion which is not soluble is protected from loss when water moves through the soil and below the plant root zone. The original slow release fertilizers were manure and biosolids that released nutrients over time as the microbes decomposed the organic matter. Urea coated with sulfur was one of the original manufactured control release fertilizers. It took time for the sulfur coating on the urea granules to deteriorate so the urea was not all available right after application. Various types of plastic coated fertilizer are also now on the market. Additionally, there are manufactured materials that solubilize slowly such as urea-formaldehyde and magnesium ammonium phosphate. The cost of these materials is inevitably higher than that of readily soluble fertilizers. However, the benefits in terms of more even plant growth and reduced likelihood of water pollution make these materials a good investment in many situations.

What Fertilizers are Found in Stores?

There are literally hundreds of fertilizers on the market. Some fertilizers contain only **one nutrient**, whereas others contain **several nutrients**. Most of the multi-nutrient fertilizers are made by simply mixing single-nutrient fertilizers together in the proportions needed to give a desired nutrient analysis.

The **chemical form** of some materials automatically means that they contain more than one nutrient. For example, magnesium sulfate ($MgSO_4$) contains both Mg and S. Other materials, such as ammonium nitrate (NH_4NO_3), contain only a single nutrient. A mixture of magnesium sulfate and ammonium nitrate would contain the three nutrients N, Mg, and S.

Some **common fertilizer materials** are listed in Table 1. These materials are sold separately or are mixed in an almost infinite number of combinations to produce the fertilizers available on the market.

What Is In a Fertilizer Besides Its Nutrients?

Other elements of the chemical compounds used as fertilizers make up much of the weight of the materials shown in Table 1 . For example, the hydrogen (H) and oxygen (O) atoms in a molecule of ammonium nitrate (NH_4NO_3) contribute 67% to the weight of the molecule, while the N contributes the remaining 33%.

Non-fertilizer materials (fillers) are added to dilute the nutrient content in many mixed fertilizers. The amount can be large, especially in low-analysis fertilizers such as 6-6-6. For example, 100 pounds of a 6-6-6 fertilizer made with diammonium phosphate (18-46-0), ammonium nitrate (33-0-0), and muriate of potash (0-0-60) would contain 13.1 pounds of 18-46-0, 10.9 pounds of 33-0-0, 10.0 pounds of 0-0-60, and 66 pounds of filler. A 17-17-17 fertilizer made using the same three materials would contain only 4 pounds of filler. Fillers often remain visible on the soil surface long after the fertilizer has dissolved and moved into the soil.

Conditioners are sometimes added to keep the fertilizer in good physical condition for handling. Their content seldom exceeds 5% of the total weight.

Why Do We Use Low-Analysis Fertilizers?

It is harder to overdose with dilute materials than with concentrated ones. High analysis fertilizers must be applied at considerably lower rates than many people are accustomed to using. Also, many advisors prefer to recommend the more dilute fertilizer materials in order to minimize plant damage caused by overzealous fertilizer applicators. Hint: It takes only one fourth as much 33-0-0 as it does 8-8-8 to give the same dose of N. If you'd rather use your head than your back, calibrate your spreader carefully and then use high-analysis fertilizers!

Where Do I Find High-Analysis Fertilizers?

Any good lawn and garden center will stock a full range of fertilizers. However, often only the most popular materials are prominently displayed or featured as sale items. If you can not find what you want, ask store personnel for the desired material.

What About Fertilizer Costs?

The dollar value of fertilizer was addressed when we showed how to get an approximate **cost per pound of nutrient**. Since it is nutrients that you are buying in fertilizer, that approach is the most straight-forward means for approximating the cost. It gets you around the sales gimmicks of the fertilizer trade. In all fertilizer purchases, the goal of the responsible person is to buy only the nutrients the plants actually need.

The **societal cost** of fertilizer use is an issue which is now receiving increased attention. There is growing awareness that **resource depletion** and the potential for surface and groundwater **pollution** are consequences of excessive fertilization. The manufacture of N fertilizer requires considerable quantities of energy and also uses natural gas as a source of hydrogen. Phosphate reserves of the U.S. are estimated at only 80 years, given current rates of consumption. Most of the K fertilizer used in the United States today is imported from Canada. To use non-renewable fertilizer resources in situations where there is no likely response to the nutrients has a **long-term, societal cost** which must be considered.

Water pollution by fertilizers is not a serious problem if the materials are properly used. However, excessive lawn fertilization has polluted the water in nearby lakes and ponds, creating algae blooms. Runoff water carries fertilizer into **surface waters** where aquatic plants subsequently "respond" to the fertilization. The effects of excessive landscape fertilization on groundwater **aquifers** is much more difficult to evaluate and also much more expensive and difficult to correct. Apply only those nutrients that are needed and only in the amounts that are needed to avoid waste and pollution.

Summary

- Plants respond to individual nutrients.
- Observe plant responses and use only those nutrients which are giving you the response you desire.
- Buy nutrients, not "fertilizer."
- Study the fertilizer label before making your purchase.
- Get wise about fertilizers and fertilizer advertising.
- There are societal costs of fertilizer use.
- Responsible fertilizer use produces desired plant responses and does not waste resources or pollute the environment.

Table 1. Some common fertilizer materials.

Material	Usual Grade	Percent (%)		
		N	P_2O_5	K_2O
Ammonium nitrate	33-0-0	33	0	0
Urea	46-0-0	46	0	0
Ammonium sulfate	20-0-0	20	0	0
Diammonium phosphate	18-46-0	18	46	0
Concentrated superphosphate	0-46-0	0	46	0
Ordinary superphosphate	0-20-0	0	20	0
Potassium chloride (muriate)	0-0-60	0	0	60
Potassium sulfate	0-0-50	0	0	50
Potassium magnesium sulfate	0-0-22	0	0	22