



## I. Understanding Plant Nutrition



Nineteen elements are considered essential for plant growth. Carbon, hydrogen, and oxygen are primarily supplied by air and water. Plant roots absorb the remaining 16 elements from the surrounding soil. These elements are divided into three groups based on their relative abundance in plants: Primary Nutrients (or Major Nutrients), Secondary Nutrients (or Minor Nutrients), and Trace Nutrients (or Micronutrients). Although the Major Nutrients are needed in the greatest quantities, a deficiency of any one nutrient can prevent plant growth, or reduce it to unsatisfactory levels. Even though some soils may already contain these nutrients, they may not be in a form available for plant growth. The best way to ensure that all of the nutrients are available in the soil is through regular applications of plant foods. Table 1 provides more information on each nutrient, its deficiency symptoms, and possible plant foods to cure the deficiency.

# Plant Food Fundamentals

## T I P S H E E T

Primary Nutrients	Function	Deficiency Symptoms	Solutions
Nitrogen	Vigorous growth & dark green color	Light green leaves; stunted growth	Dried Blood, Garden Manure, Cottonseed Meal, Ammonium Sulfate, Urea
Phosphorus	Root development & flowering	Smaller yields of seeds & fruit; purplish leaves, stems & branches;	Rock Phosphate, Bone Meal, Single Super Phosphate, Triple Super Phosphate
Potassium	Overall hardiness & disease resistance	Reduced yields; Spotted or curled leaves; Weak root system	Sulfate of Potash, Sulfate of Potash Magnesia, Muriate of Potash, Greensand
Secondary Nutrients	Function	Deficiency Symptoms	Solutions
Calcium	Plant vigor; Aids in uptake of nutrients	Deformed terminal leaves; Poor root growth	Garden Lime, Garden Gypsum
Magnesium	Essential part of chlorophyll	Yellowing of older leaves	Garden Lime, Sulfate of Potash Magnesia
Sulfur	Dark green color; Seed production	Yellow leaves; Stunted, spindly plants	Garden Sulfur, Sulfate of Potash, Gypsum
Trace Nutrients	Function	Deficiency Symptoms	Solutions
Boron	Increases flowering & fruit development	Terminal buds die; Less flowers & fruit develop	Garden Manure, Bone Meal
Chlorine	Helps control water loss & moisture stress	Plants wilt; yellow leaves	Muriate of Potash, Garden Manure, Greensand
Cobalt	Improves growth & transpiration	Reduced growth and yellowing of foliage	Greensand, Kelp, Cottonseed Meal
Copper	Helps produce chlorophyll	Yellow, wilted leaves; Lack of flowering	Garden Manure, Greensand
Iron	Promotes dark green leaves	Yellow leaves	Greensand, Garden Manure, Cottonseed Meal
Manganese	Helps produce chlorophyll	Intervenous chlorosis in younger leaves	Garden Manure, Greensand
Molybdenum	Essential in some enzyme systems	Pale green, rolled or cupped leaves	Greensand, Lime (makes it more available)
Nickel	Enzyme Production	Yellow Leaves	Greensand
Sodium	Aids water regulation & photosynthesis	Plants wilt	Kelp, Garden Manure, Bone Meal, Greensand
Zinc	Enzyme & growth hormone production	Yellow leaves, Rosetted (clustered) leaves	Garden Manure, Greensand, Cottonseed Meal

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## II. Reading & Comparing Plant Food Labels

Plant foods sold in the United States generally have a label with information on the following: Grade, Net Weight, Guaranteed Analysis, Sources of Nutrients. Each of these components is explained below. When shopping for plant foods, this section is indispensable for making comparisons between seemingly similar products.

20 lb. Net Weight	
<b>XYZ</b>	<b>5-10-5</b>
<b>Brand</b>	<b>Guaranteed Analysis</b>
<b>Nitrogen</b> .....	<b>5%</b>
<b>Phosphate</b> .....	<b>10%</b>
<b>Potash</b> .....	<b>5%</b>
Nutrients derived from ammonium sulfate, triple super phosphate, and potash.	

Figure 1

### 1. The Grade

A shorthand representation of the minimum percentages guaranteed (by weight) for Total Nitrogen, Available Phosphate, and Soluble Potash, with each guarantee separated by a hyphen. In Figure 2, the grade for Plant-tone is 5-3-3, which means that it is guaranteed to contain 5% nitrogen, 3% phosphate, and 3% potash. Therefore, in a 40 lb. bag of Plant-tone, there would be 2 lbs. of nitrogen, 1.2 lbs. of available phosphate, and 1.2 lb. pack of soluble potash.

### 2. Net Weight

All fertilizers must be sold on the basis of net weight (not volume). When comparing products, it is often better to compare the price per pound rather than total price because the net weights often vary.

### 3. Guaranteed Analysis

States the minimum percentage by weight of plant nutrients claimed by the seller. If the manufacturer claims a given nutrient, it must be guaranteed in this section.

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### Plant-tone® 5-3-3

#### GUARANTEED ANALYSIS

Total Nitrogen .....	5.0%
0.4% . . . . Ammoniacal Nitrogen	
1.6% . . . . Water Soluble Nitrogen	
3.0% . . . . Water Insoluble Nitrogen	
Available Phosphate (P <sub>2</sub> O <sub>5</sub> ) .....	3.0%
Soluble Potash (K <sub>2</sub> O) .....	3.0%
Calcium (Ca) .....	3.0%
Magnesium (Mg) .....	1.0%
0.6% . . . . Water Soluble Magnesium	
Sulfur (S) .....	1.0%
Derived from: Hydrolyzed Feather Meal, Pasteurized Poultry Manure, Cocoa Meal, Bone Meal, Alfalfa Meal, Greensand, Humates, Sulfate of Potash, and Sulfate of Potash Magnesia.	
*Contains 3.0% Slow Release Nitrogen.	

#### Non Plant Food Ingredients:

Contains 3,804,705 colony forming units (CFU's) per lb. (253,647 CFU's per lb. of each of the following 15 species):

Acidovorax facilis	Marinibacillus marinus
Arthrobacter agilis	Paenibacillus lentimorbus
Bacillus licheniformis	Paenibacillus polymyxa
Bacillus megaterium	Pseudomonas alcaligenes
Bacillus oleronius	Pseudomonas chlororaphis
Bacillus pumilus	Pseudomonas putida
Bacillus subtilis	Rhodococcus rhodochorus
Bacillus thuringiensis	

While fertilizer materials have unlimited shelf life, the beneficial microbes in this product are best used within two years of the production date (see side panel for production date). After that time their numbers may be reduced.

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Figure 2

### 4. Derivation Statement

The derivation statement lists the sources for the nutrients guaranteed. Look to see how many ingredients are listed. The more ingredients, the more rates of release, the better the feed. Check also to see if there are any slow release ingredients, i.e. natural organic or controlled release ingredients.

### Tips for Comparing Grades:

*Bigger doesn't mean better.* Some consumers mistakenly believe that bigger numbers in the analysis means better plant food. However, high analysis plant foods are often wasted because the plant cannot utilize all of the nutrients immediately, and what it does not use leaches away from the soil. It is more important to look for slow release ingredients such as natural organic or controlled release that will slowly feed the plant and not leach away.

*Take weight into consideration.* Some consumers mistakenly believe that bigger analyses always mean more nutrients. However, because an analysis represents the percentage by weight of a given nutrient, it may not always be the case. In the table below, Espoma Organic provides more nitrogen per 1,000 square feet than two competitors products; one with a higher and one with a lower nitrogen analysis.

Figure 3

Brand	Analysis	Application Rate per 1,000 sq. ft.	Nitrogen per 1,000 sq. ft.
Espoma Organic	7-2-2	12 lbs.	0.84 lbs.
Espoma Lawn Food	18-0-3	4 lbs.	0.72 lbs.
Brand X (Natural)	3-1-5	10 lbs.	0.30 lbs.
Brand Z (Synthetic)	16-4-8	4 lbs.	0.64 lbs.

### Comparison Tips:

*Is there any slow release nitrogen?* To determine how much of the nitrogen is slow release, add the percentage of "Water Insoluble" Nitrogen to any other "Slowly Available" Nitrogen in the guaranteed analysis. In the Plant-tone label of Figure 1, 3% nitrogen (approximately 60% of the nitrogen guaranteed) is slow release. In the XYZ brand label in Figure 2, there is no water insoluble guarantee or any other slow release claim. Therefore, this is a water soluble product that will not last long in the soil.

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### III. Choosing the Right Type of Plant Food

In general, plant foods fall into one of two categories: (1) Synthetic Plant Foods and (2) Natural Organic Plant Foods. Each type has its own advantages and disadvantages.

#### Synthetic Plant Foods

Synthetic plant foods are materials that are manufactured chemically as opposed to found ready made in nature. In general, synthetic plant foods fall into one of two categories: (1) Water soluble plant foods and (2) Controlled release plant foods.

**Water Soluble Plant Foods.** Water soluble plant foods completely dissolve in water and release their nutrients immediately thereafter. They are ideal when you need a quick solution to a problem and for nursery growers who have a drip irrigation system. The trade-off for rapid response is that the feeding is generally short lived, lasting approximately a few weeks. Frequent applications are required as well as mixing with water. Leaching can also be a problem, especially in sandy soils or under high moisture conditions. And burn (dehydration) potential is higher due to solubility and high salt index. Examples of water solubles include: urea, ammonium sulfate and ammonium phosphate.

**Controlled Release Plant Foods** contain a plant nutrient in a form that delays its availability for plant uptake significantly longer than a water soluble fertilizer. The delay occurs by one of two mechanisms: (1) Coating a water soluble source such as urea with molten sulfur, wax, or plastic. The thicker the coating, the slower the release. Examples include sulfur coated or polymer coated urea. (2) Chemically combining materials to form insoluble polymers, which release nutrients more slowly as the length and number of polymers increases. Ureaform is an example of this. While both types give plants a long lasting feeding, neither contains all of the advantages that you will find with natural organics.

# Plant Food Fundamentals

## T I P S H E E T

### Natural Organic Plant Foods

Although no universal definition exists for the term "natural organic", our guiding definition is any material derived from plant, animal or mineral origin that contains one or more essential nutrients for plant growth. While it is true that all plant foods ultimately feed nutrients to plants in the chemical form, it is the process by which they are delivered that makes natural organic plant foods superior to others.

**"Feed the soil that feeds the plants".** Plant growth is dependent on the health and vitality of the soil surrounding it. The process by which natural organic plant foods deliver their nutrients enhances the fertility and structure of the soil. Natural organic plant foods are digested by soil microorganisms, which then release the nutrients in a form available to plants. This process produces humus, a spongy material that improves soil structure. When you improve soil structure, the soil is better able to hold the proper balance of water, air and nutrients until they are required by plants. Plants respond by developing larger root systems. Larger roots support more vigorous top growth and make plants less susceptible to drought. And by stimulating a healthy population of beneficial microorganisms in the soil, plants become more resistant to insects and diseases.

**Slow, steady feeding, as the plants require it.** The nutrients in natural organic plant foods are not in a readily available form for plants to use until they are digested by beneficial microorganisms in the soil. This process is slow and largely dependent upon three factors: the microbial population in the soil, moisture, and soil temperature. A healthy population of microbes in the soil is necessary for the digestion process. Moisture is required to sustain microbial life as well as to keep nutrients flowing into the plants root zone. And soil temperature is critical because as it rises, plants require nutrients more rapidly. Fortunately, microbial activity mimics these requirements and also increases as soil temperature rises, so that plants can be fed the needed nutrients, as they require them.

**The safest choice for your plants and the environment.** Unlike synthetic plant foods, natural organic plant foods have an extremely low salt index, which means there is little to no risk of burning (dehydrating) plants in periods of extreme drought or when over-applying. Natural organic plant foods are generally very resistant to leaching out of the soil, so their nutrients stay in the root zone until the plants need them. And since most natural organic ingredients are byproducts from commercial farms and meat processing plants, the utilization of them for feeding plants is really a system of recycling much like composting.

**Soil and plants receive much more than just the primary nutrients.** With natural organic plant foods, they receive organic matter containing millions of beneficial microbes (bacteria, fungi and protozoa) that help improve soil structure for better moisture retention, nutrient retention, aeration and drainage. They receive secondary and trace nutrients as well as vitamins, minerals, and plant growth hormones that promote plant growth and improve resistance to insects, diseases and climate extremes.

Examples of natural organic ingredients include: bone meal, blood meal, kelp meal and greensand. It is for all of the above reasons that we have always used natural organics as the source of nutrition in our Tone line of products. It has established the Espoma Tones as the finest, safest, and most reliable plant foods available.

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