Plant Nutrition Part 2 – Organic vs Chemical Fertilizers & Crop-Specific Fertilizers

Remember this table from last month's article?

Element	Uptake Form	Source	Element	Uptake Form	Source
CARBON	CO_2	Air & Water	boron	H_3BO_3, $H_2BO_3^-$, HBO_3^{2-}	Soil
HYDROGEN	H_2O	Air & Water	chlorine	Cl^-	Soil
OXYGEN	H_2O	Air & Water	copper	Cu^{2+}	Soil
NITROGEN	NO_3^-, NH_4^+	Soil	iron	Fe^{2+}	Soil
PHOSPHORUS	$H_2PO_4^-$, HPO_4^{2-}, PO_4^{3-}	Soil	manganese	Mn^{2+}	Soil
POTASSIUM	K^+	Soil	zinc	Zn^{2+}	Soil
Sulfur	SO_4^{2-}	Soil	molybdenum	MoO_4^{2-}	Soil
Calcium	Ca^{2+}	Soil	nickel, silicon	Ni^+, Si^+	Soil
Magnesium	Mg^{2+}	Soil	sodium, cobalt	Na^+, Co^{2+}	Soil
			vanadium	V_2O_5	Soil

Table 1: Essential plant nutrients, their uptake form and their usual source.

This lists the essential plant nutrients and the chemical form the element must be in for plant uptake. Looking at this table, you can see that there is no distinction between the uptake form whether the nutrient is from organic or synthetic chemical fertilizers. It's like when my body needs calcium for bone development. I don't care if it's from milk, ice cream, yogurt, spinach, okra, or kale. Calcium will enter the biochemical pathways and be utilized for bone building in the same ionic form no matter what the original source. For example, plants can only take up nitrogen as either nitrate or ammonium. It doesn't matter whether the nitrogen comes from blood meal, alfalfa meal, urea, ammonium nitrate, or chicken manure.

In summary, plants take up required nutrients in specific chemical forms. No matter where the nutrient comes from, it must be converted to that specific chemical form in order for a plant to import it and utilize it in metabolism. Organic or synthetic, a plant doesn't really care. From a strictly chemical nutrient point of view organic is not better, nor is it worse than synthetic. It is exactly the same.

So, what's the difference between organic and synthetic fertilizers? Let's compare and contrast the two.

Nutrient Availability

With synthetic chemical fertilizers, all the nutrients are in the chemical form that plants can take up. Therefore, 100% of the nutrients are immediately available to the plant. If you use 100 lbs. of 13-13-13 fertilizer, all 13 lbs. of the nitrogen, phosphate, and potassium are available for the plants as soon as you apply it. There is no need for microbial activity or chemical conversion to make the nutrients available. This is not totally true because most chemical fertilizers use urea (CH_4N_2O) as a source of nitrogen. In the presence of water and urease (an enzyme found in plants, bacteria, fungi, and some invertebrates), urea is digested to yield ammonium (NH_4^+) and carbon dioxide (CO_2). Plants can take up urea which is then broken down within the plant. Urea is also broken down in the soil by soil microorganisms.

Organic fertilizers contain plant- or animal-based materials that are either a byproduct or end product of naturally occurring processes, such as animal manure and composted organic materials. With organic fertilizers, the majority of the nutrients are bound up in complex macromolecules that require microbial activity to break down the complex molecules and convert them to the form that plants can take up. The amount of immediately available nutrient is 3-5% of the total. If you use 100 lbs. of blood meal (16-0-0), only 0.5 to 0.8 lbs. of nitrogen is immediately available for plant uptake. The rest is released over time with the rate of release being influenced by moisture, temperature and microbial population. Organic fertilizers are actually a form of slow-release fertilizer.

Nutrient Concentration

The difference between 13-13-13 chemical fertilizer and 8-8-8 is the amount of filler that is used in preparing the fertilizer. Simply, 8-8-8 is more dilute than 13-13-13. Chemical fertilizers can be formulated to almost any ratio; it just requires adding the chemicals at the desired ratio along with carrier materials. Some of the highest nutrient content can be found in these fertilizers: urea (46-0-0), triple superphosphate (0-46-0) and muriate of potash (0-0-60). I've seen balanced fertilizers as high as 30-30-30 available.

Organic fertilizers, on the other hand, are based on specific organic components. Table 2 is a listing of some common organic fertilizers or soil amendments and their NPK value. Many, especially manures and composts, vary greatly in NPK value depending on the source.

Organic Fertilizer/Amendment	Nitrogen	Phosphorus	Potassium
Alfalfa Meal	2	1	2
Bat Guano	10	6	2
Blood Meal	16	0	0
Bone Meal	3	15	0
Coffee Grounds	2	0.3	0.3
Compost (variable)	0.5-4.5	0.5-1.0	0.8-1.0
Cottonseed Meal	6.6	2.5	1.5
Cow Manure (variable)	0.6-2.1	0.7-1.1	0.5-3.6
Crab Meal	5	2	0
Eggshell	1	0.4	0.1
Feather Meal	12	0	0
Fish Emulsion	5	2	2
Fish Meal	9	4	1
Greensand	0	0	3
Hair	15	0	0
Kelp Meal	1	0	1.2
Pig Manure (variable)	0.6	0.4	0.3
Pine Needles	0.5	0.1	0
Poultry Manure (variable)	2.5-4.5	2.5-5.0	1.5-3.0
Rabbit Manure	2.4	1.4	0.6
Rock Phosphate	0	33	0
Spanish Moss	0.6	0.1	0.6
Worm Castings	1	0	0

Table 2: NPK values of selected organic fertilizers and soil amendments. NPK values for most organics can vary. These numbers are based on figures gathered from multiple sources.

As you can see by the table, many organic products are so low in NPK that they cannot be considered fertilizers at all but rather soil amendments.

Effect on Soil Microbiota

In their enthusiasm for organic gardening and organic products, many proponents make a statement similar to this one: "Using synthetic chemical fertilizers is bad because it kills soil microorganisms." Is this a true statement? There have been many scientific studies looking at the effect of adding fertilizers to soil on the soil microorganisms. By comparing populations of soil bacteria and fungi in soils with no additions, soils with added chemical fertilizer, and soils with added organic fertilizer, researchers came to the following conclusions. Adding synthetic fertilizer resulted in no change in the number of bacteria and an increase in the number of fungi. Organic treatment increased both fungi and bacteria. Proper use of synthetic fertilizer does not kill soil microorganisms.

Soil microbiota need nutrients to carry out metabolic functions just like plants. Therefore, adding these nutrients in either organic or synthetic form will be providing nutrients to both plants and existing soil microbiota. Either way you are benefiting soil microorganisms so it's easy to understand why adding either leads to an increase in population.

The real benefit of most organic fertilizers/amendments is that it builds soil structure and provides a slow continual release of nutrients needed by soil microorganisms. Soils high in organic matter also have a greater diversity of microorganisms.

What About Crop Specific Fertilizers?

What do I mean by crop specific fertilizers? Just walk into any garden center or garden section of a store and you will know immediately what I mean. You'll see fertilizers made specifically for citrus or tomatoes or flowering plants or palms or vegetables. These are crop specific fertilizers; fertilizers formulated by the company to optimize plant growth and production. Figure 1 points out one of the fallacies with most crop specific fertilizers.

Figure 1: Commercially available fertilizers formulated specifically for citrus.

These are all fertilizers formulated to give your citrus trees the optimal supply of nutrients they need. Using this fertilizer formulated by plant nutrient specialists should lead to optimal plant growth and fruit production. But look closely at the labels. They all contain different amounts of nitrogen, phosphorus and potassium and they all have different ratios of NPK. The experts don't agree. So, which one is truly the best for your citrus trees?

Figure 2 shows the same comparison of vegetable specific fertilizers.

Figure 2: Commercially available fertilizers formulated specifically for vegetables.

These fertilizers have different nutrient content and different NPK ratios. Once again, the experts don't agree. They can't even agree on the best NPK ratio for optimal vegetable production.

I show these to make a point. Plants in general all need the same basic nutrients and in the same basic ratios for health and vigor. What additional nutrients they need is a function of the soil conditions and what is already available in the soil. That's why doing soil tests is so important. This analysis helps you see what nutrients might be a limiting factor to optimal plant growth and advises what you need to add to the soil to eliminate the nutrient deficiency.

In general, crop specific fertilizers also end up being more expensive per nutrient unit than general purpose complete fertilizers. Doing a soil test and amending the soil with the specific nutrients needed is a much better way to garden. Crop specific fertilizers usually optimize a company's profits more than optimizing plant growth.

There are a few caveats to this: 1) excess nitrogen does lead to increased vegetative growth and reduced flower and fruit production. That is one reason that most lawn fertilizers have a high nitrogen ratio. 2) Plants that do best at low soil pH (e.g., blueberry, gardenia, hydrangea) benefit from fertilizers formulated for acid-loving plants. Components of these fertilizers have a tendency to lower soil pH and they are recommended when growing acid-loving plants.

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