An *Our Garden Gate* Special Report:
Fertilizer—*Food for Our Gardens & Crops*

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First, the problem: Abuse of Agricultural & Horticultural Chemicals*:*

Our modern farming and gardening culture has, for the most part, accepted the use of literally hundreds—perhaps *thousands*—of artificially produced, concocted and assembled chemicals in the production of food, food animals, and virtually anything else that derives from or via the soil. Industry gurus would have the world within their media grasp believe there are no solutions other than chemical. Television commercials, newspaper and magazine ads, and *tons* of junk mail depict "professional" and "successful" gardeners happily applying one or the other plant food, fertilizer or pesticide...chemicals, all. Particularly disturbing to growing numbers of organically-inclined gardeners are the ads with the clever approach: *"I don't know what's in it or why it works. All I know is that it gets the job done...so I buy it!"* Spring, especially, brings on a veritable blitz of advertisements which announce the easy gardening life...if we'd only purchase and apply their products. They rarely, however, tell us of the many hazards involved—short of a fine print caution to avoid breathing the dust or fumes, wash our hands and properly dispose of empty containers. All red flags if I ever saw them!

A particularly galling television advertising campaign, in my opinion, is the oft-repeated contrivance of a perfectly gorgeous spread of flowers, trees, shrubs and perennials "planted" amidst a spectacular lawn complete inviting to small children and household pets. The sun is shining brightly. Flowers so thick there's hardly a leaf showing. And, incredibly (that means lacking credibility) the "gardener" (totally misinformed actor, it seems) is blithely sprinkling gallons of miracle-working "blue water" (liquefied chemical fertilizer) on and over literally everything in sight!

The elaborate and misleading contrivance is so full of holes, it's almost laughable, yet the gardening public laps it up seemingly without question. Take, for example, the impossible density of flowering plants in this faux garden display. Ornamental plants simply do not grow and prosper that close together...except on nursery and greenhouse benches and in carefully arranged displays at spring garden shows. The obvious conclusion can only be that they're either still in their (cleverly concealed) nursery containers (a clear deception), or were removed from those containers, wedged together and manicured specifically for the commercial shoot (also a clear deception).

Worse, the hired actor stands there—in bright sunshine—splattering everything in sight with chemicals that under real-world circumstances would quickly burn most of those flowers into oblivion. Any experienced real-world gardener with half an ounce of sense knows you don't sprinkle flowers in bright sunshine...least of all with fertilizer.

And the gods only know what toxic soups those toddlers and fur-licking pets are being exposed to. Toxic ingredients that will probably be absorbed and stored in deep tissue and bone marrow or will drain off the land to become additions in nearby streams, wells or water supplies.

But the ads continue on, unrestrained. It is, after all, all about the money...profit.

Most folks, upon suspecting a pest or nutrition problem in their gardens or lawns, head immediately for the chemical displays at the local box store or farm 'n garden shop. There, they are apt to encounter a salesperson who, because of his or her implied status as an agricultural "professional," or because that sales clerk places a high value on his or her job, makes the convincing argument that the only way to deal with such an agricultural or horticultural trial is to purchase one or more of the numerous bottles, bags or boxes of dangerous pesticides or fertilizers they have for sale. So a steady stream of well-meaning—yet largely uninformed—gardeners return to their lawns and gardens with bags full of the deadly stuff to make their garden grow and to foil the next onslaught of bugs and weeds.

Focusing on fertilizer: Before you race off down the road, checkbook in hand, here are a few things to consider about fertilizer—information, perhaps, that some of the big chemical manufacturers, suppliers and more than a few retailers would prefer you not be too familiar with.

- **Nitrogen,** especially the kind found in the retail chemical world, is very highly soluble. It seems almost to have the uncanny ability to flow through what looks like solid rock. In most soils, an excessive application of nitrogen fertilizer, unless restrained by high humus (organic matter—compost or decayed animal waste) content in the soil, *zips* past roots in what might seem a frenzied rush toward the nearest aquifer or well. John Jemison, a water quality specialist for the University of Maine Cooperative Extension, published the following *chilling* paragraphs in the Summer, 1993, issue of *Streamlines* (a quarterly newsletter for residents of the Royal River Watershed):

"Nitrate is a chemical compound that occurs naturally from microbial activity or is produced synthetically during fertilizer manufacture. Problems occur because it is mobile (leachable) in soils. High levels of nitrate in groundwater could indicate the potential for other harmful organisms or chemicals in your water supply.

"Nitrate is regulated in water primarily because short-term exposure to excessive nitrate in water or formula can cause methemoglobinemia, or blue baby disease. Infants are particularly susceptible to nitrate because they lack the level of enzymes to prevent the conversion of nitr**a**te *to* nitr**i**te *that adults have. Therefore, nitrate builds up in the blood. This causes blood to carry less oxygen. Cases of fatality are rare, but brain damage is possible if not corrected in time.*

Jemison went on to recommend that people with private water supplies have that supply tested—a very inexpensive investment available through both certified private and state laboratories.

- **Phosphorus,** already found in sufficient quantities for plant needs in most improved soils, is locked up or "bound" by acidic soil conditions, thereby limiting or preventing access by plants in the attempted production of fruit and seeds. A common error made by many small farmers and even long-time accomplished gardeners is to assume that because their crops or plants fail to produce or bloom as well as they expect, their soil *must* be deficient in phosphorus. More often than not, the deficiency lies in the fact that either they've never had their soil pH tested or, if testing was done, they've neglected to make necessary adjustments. (The overwhelmingly-common response to the question, "What's your soil pH?" is: "I dunno." Then inevitable result: stores sell *tons* of chemical phosphates that too often end up in our lakes, streams and ground water.) For a brief explanation of the relationship of nutrient availability and soil pH, click here.

Another little-advertised fact is that *super* phosphate, a highly soluble form of chemical fertilizer, is artificially produced by treating naturally-occurring *rock* phosphate with sulfuric acid... something that Nature *never* does. Thus chemically-altered—and combined with the *low-pH-pour-on-the-phosphorus syndrome* and most gardener's bad habit of sprinkling fertilizer granules on the surface without cultivating them in, *and* the next heavy rain— sends the now-dissolved chemical downhill into the nearest body of water. *Body of water* is defined as a well, aquifer, pond, stream, lake or bay. By now we all know what happens when phosphates build up in lakes and streams.

Chemical phosphorus isn't the only source of water contamination*...not by a* long *shot! One of the most disturbing—and wasteful—practices I know of is the spreading of thousands of gallons of fresh (mostly liquefied and sloppy wet) farm animal manure on top of snow...over frozen ground in the dead and depth of solid-frozen winter. The practice is particularly worrisome when it occurs on land that slopes toward a body of water——too frequently the case. The theory goes, if memory serves, that as the snow melts, nutrients will dissolve and slowly incorporate into the soil. In plain fact—seemingly ignored or forgotten by practitioners of this wasteful and offensive method—is that virtually* all *of the available nitrogen which might have done a world of good if applied properly then immediately tilled in is lost to the atmosphere as ammonia gas. In plain fact—also ignored—is that very little of available phosphorus ever soaks into the soil but rather joins the down-hill rush of spring run-off—into the nearest lake or stream.*

True, a fair amount of the actual organic matter part of this spread agricultural waste does, finally, end up on top of the field's soil. But the vast majority of any nutrition (nitrogen, phosphorus and a lengthy list of trace elements) which might have benefited the farmed earth

has been swept away by wind, rain, runoff...and misinformation.

Another worrisome practice is the wholesale spreading of unimaginable amounts of the by-product of thousands of community waste water "treatment" facilities all across the country—and world. Commonly called "sewage sludge," it is claimed by government agencies to be safe when spread on vast tracts of production agricultural land. And, while it is theoretically sterile—having been chemically pre-treated with chlorine or peroxide, a great many very knowledgeable and responsible people reject government claims that the toxic heavy metals it inevitably contains are harmless to humans. Is it possible that lead, cadmium, zinc, mercury, arsenic and a long list of other equally dangerous substances—even in small amounts—can actually be "safe" for human exposure and consumption? As for me and my family, I won't have the toxic stuff on my property...and I certainly *wouldn't* consider *it safe to apply on or in soil dedicated to the production of either human or animal food!*

Yes...yes...I know that some cultures thrive on the application of individual or family human waste in rice paddies and small vegetable plots. There's a vast *difference, however, between the daily emptying of a thunder-mug (chamber pot) or two into a small farm or personal garden...and the accumulation of billions of tons of incredibly toxic materials illegally or irresponsibly dumped into multiple millions of public sewers where it's collected, pumped into treatment plants, concentrated, then re-dumped onto fields where fruits, nuts and vegetables are grown for you and I and our babies to eat!*

- **Potassium,** the third number in the standard fertilizer formula, is essential—*vital*—for strong plants, winter hardiness, disease resistance and strong, healthy root systems. Old-time vegetable farmers will tell you that to get the best, most tender and most flavorful beets, mix some wood ashes into their underground environment. The part of the beet which most of us eat is the root. Get the point? Broadleaf wood ashes are the best natural source of potash. Care must be taken to avoid overdoing the ash thing, however—ashes also alter the pH of the soil, shifting pH past neutral and into an alkaline range. While a few plants we grow prefer alkaline (sweet) conditions, most would prefer something closer to neutral or a little below.

Potash contained in packaged commercial chemical fertilizers is obtained mostly from the immense potassium deposits in the southwestern desert states. The common perception (which chemical manufacturers *don't* go out of their way to correct in the public eye) is that these potassium chloride salt "reserves" are perfectly natural. So they're scooped up by the thousands of tons, blended with other chemicals, packaged and sold in huge quantities to be spread all over the country's gardens and farm land.

But just because an element is found in nature *today* doesn't necessarily prove that it's the best thing for our gardens. In fact, those salts of potassium chloride (also called muriate of potash) were left behind when oceans abandoned what we now see as "desert." In fact, the chemical has a great deal in common with salty oceans—*but very little in common with healthy and productive soils.* Leaving measurable residues of chlorine in the soil, muriate of potash is a highly concentrated salt and is among the chief causes of the tragic loss of seemingly endless tracts of once-healthy and productive soils in the southwestern corner of the U.S. Prime example: the now nearly useless farm land—now, for all practical purposes: *desert*—of San Fernando Valley in southern California. Multiple hundreds of acres of useless, dusty-white *dirt* that can't even support decent weeds is the inevitable result of ill-advised wholesale reliance on chemicals and heavy irrigation.

Fact...the desert southwest is a prime source of the chemical potassium chloride (muriate of potash), a concentrated salt commonly found in popular—and heavily advertised—garden fertilizers...

Fact...the desert southwest is a desert *with salty "soils" incapable of supporting much more than scrub, cactus and a few lizards, really tough birds, and a declining population of very lean jackrabbits...claims of certain religionists that someday the desert will blossom as the rose notwithstanding...*

Surely I can't be the only person willing or capable of seeing the connection!

Is that *what we want for our healthy garden soils....to set up and encourage the same conditions that have devastated and desertized vast tracts of once-productive farmlands?*

There are a number of perfectly viable and inexpensive sources of more natural—certainly more preferable—forms of potassium. Materials, it must be stated, that are *infinitely* better for the health of our soils...and the health of the farmer's or gardener's family as well. Later in this report you'll find a list of some of the more acceptable and readily available sources of primary and trace nutritional elements required by plants of various types.

Now let's take a little closer look at some other common home and garden chemicals found on the shelves of most big box stores, garden centers and neighborhood farm 'n garden shops.

- **Herbicides.** Here again, advertising agencies hired by the highly profitable chemical industry have done a *superb* job of convincing the vast majority of gardening public that the use of questionable chemical formulations instead of muscle to control weeds is perfectly acceptable...and safe...and easy...and you don't even need to know what's in the stuff or how it works. Simply squirt a little here and a little there and, *presto!* you have a nice, clean garden where the kiddies and Bowser can play. **Don't you believe it!**

Many concerned professional gardeners find it inconceivable that state and federal agencies continue and allow—and, likely as not, encourage or subsidize—the manufacture, distribution and advertising of powerful chemicals which are either known or strongly suspected human toxins. (To refresh your memory, toxins are *poisons* which can kill or disable people, their domestic animals, and can often cause irreparable damage to the environment.) These same professional gardeners are often appalled at the advertising suggestion that it isn't necessary to inform yourself about the contents of a produce...or the potentially harmful—if not *lethal*—side effects. According to the implication of mass-advertising, just run right down to the store, grab a bottle or can off the shelves, then run right back home and spray the unwanted plants or bugs. Never mind what the stuff is made of! Never mind how many beneficial insects and other organisms are destroyed! Never mind about the as-yet-not-comprehended or appreciated damage to our fragile environment! Never mind the profound upsets or changes in the delicate balance of Nature!

Rubbish! If you wonder just how dangerous some of these products are, thoughtfully read the label. Notice things like *"keep out of reach of children," — "do not apply to or near lakes, streams or ponds," — "do not contaminate water by cleaning of equipment or disposal of wastes," — "apply only when air is calm to prevent drift," — "do not use on or around edible food or food crops," — "do not allow this product to come in contact with the skin," — "wear protective clothing,"* and the revealing *"buyer assumes all responsibility for safety and use."*

Having said all that, there may be times when a particular undesirable plant problem is simply too difficult to handle by hoe, tiller or string trimmer. There are more natural products on the market which can get the job done. It may take a little longer but, when compared with a drifting cloud of toxic chemicals, a few days more or less is easily worth it. Certain "weed oils" and a product called Sharpshooter may be be purchased from dealers who lean in the direction of organic control, and therefore sell more appropriate products.

But all chemical herbicides aside, by far the best and safest weed control method is the one which muddies trouser knees and dirties fingernails. And by far the best time to get on your knees is *before* weeds produce seeds or send invasive runners toward the distant horizon and taproots to China.

Note: It is *strongly* recommended that you never purchase or use any weed control formulation containing arsenic or any form of 2,4-D or 2,4,5-T. These potent chemicals have been conclusively linked to serious hazards to the health of humans *and the environment*.

- **Other Chemicals.** As if the widespread application of powerful chemical fertilizers and herbicides isn't enough, add to the list the many other substances that are sprayed, dusted or poured out on our agricultural and horticultural lands and the foods or other plants grown in them. Growth regulators, hormones, pheromones, repellants, rodenticides—and who can only *guess* what else—comprise a startlingly substantial list of substances we've created to control our own personal little patches of the environment. Little wonder we cough and wheeze, swell up and turn red, itch, and are gradually—*insidiously*—encouraging new generations of sickness and debility.

Clearly, the time for sensible adjustment in our gardening and farming philosophy is at hand. We can no longer afford to continue practices which threaten the health of our world, our animals, *and us*.

Now, let's take a closer look at the three primary nutrients: **nitrogen, phosphorus** and **potassium**, and the 50+ other lesser (minor or trace) elements that plants need for healthy growth and prosperity.

Straight Talk About Fertilizers

Just as humans cannot survive on the intake of water alone, neither can your plants. We need proteins, various kinds of sugars and some of the right kinds of fat. In addition, our very complex human system must have a ready supply of fiber, vitamins and minerals to prosper. Without these elements, sickness, disease and physical weakness quickly move in to replace good and vibrant health. It should not, therefore, be too difficult for us to understand that our plants also require a consistent and readily available supply of not only water, but essential nutrients as well.

Here comes an important little tidbit of knowledge, one which every truly successful gardener knows and respects: just as predatory animals almost always seek out the young, vulnerable, injured or weak as their prey, so also do harmful insects and diseases attack plants which are stressed and weakened by major deficiencies of essential nutrients.

Where do these nutrients for plants come from? Some gardeners obtain theirs from a bag purchased at the store or garden center; others from a bottle or bag of one of the many brands of liquid and granular concentrate. Still others reject the use of man-made artificial or chemical substances altogether and derive nutrition from more-or-less natural sources like animal manure, urine, fully-organic composts, ground bones, dried blood and perhaps even ground shoe leather or pulverized rocks.

Generally, rather than choosing to place myself squarely on one side or other of the chemical/natural debate, I've selected a "middle-ground," recommending heavy reliance upon compost, bonemeal and thoroughly decomposed animal wastes and, for the flower garden, the modest and judicious use of a complete commercial fertilizers. Flowers, of course, will do just fine on an all-natural diet, just as fruits and vegetables grow and appear perfectly healthy on a strict chemical diet. I do not, however, recommend using any more chemicals on plants grown for food than is absolutely necessary. . .if any at all. Common sense, sensitivity and practicality rule here. If you find the thought of using man-made fertilizer products in your garden repulsive, then by all means don't use them. As for me, I wouldn't want too many of these chemicals leaching into my well (or my neighbor's) either, so I use them only when necessary, applying just enough to satisfy the plant's needs without excess.

Some Basics

Three primary nutrients are required by most plants: nitrogen **(N)**, phosphorus **(P)**, and potassium, also known as potash **(K)**. They are represented in the 3-number formulas printed on fertilizer containers and always appear in that order. So 10-10-10, for instance, means there are ten parts of nitrogen, ten of phosphorus and ten of potassium (plus a significant amount of "filler" material for bulk and weight). Other required lesser nutrients are occasionally contained in trace amounts in some blended (and generally more expensive) "complete" fertilizers.

Here, in a nutshell, is what the three primary nutrients do for your plants: **Nitrogen** is for foliage - lush, dark green *(and tender)* foliage. **Phosphorus** insures strong stems, abundant flowers and viable seeds. **Potassium** is for strength, winter survivability, resistance to disease and healthy root systems.

Nitrogen

This element, the first component in the standard three-number fertilizer formula and represented by the letter "N," put very simply, is for foliage - *leaves.*

Focusing primarily on the perennial garden for a moment, normally we're interested in masses of flowers, strong stems and big healthy crowns, roots, bulbs and rhizomes, but not a lot of soft, green leaves. So, knowing nitrogen is for soft, green foliage, it doesn't make sense to spread large amounts of nitrogen in a flower garden.

If you use chemical fertilizers, and you aren't particularly anxious for an abundance of soft foliage, start with one that has a low first number in the NPK formula. In our two-and-one-half acres of gardens where the beds, borders and growing areas are surrounded by large trees which quickly gobble up every fragment of nutrition and drop of water, we supplement the heavy use of compost (our soils are maintained at 55% to 75% or more organic matter) by lightly feeding with **10**-10-10 at the first sign of growth in the spring and once again during the first week of July.

If you garden organically and are not forced to sacrifice the lion's share of nutrition to a forest canopy, compost and well-rotted manure should provide most of the nitrogen you need, so, in this case, avoid the use of natural materials which contain large amounts of nitrogen in your flower beds. Bloodmeal, for instance, contains a *lot* of nitrogen (15)

so it wouldn't be wise to apply it too heavily if you hope for gardens full of flowers, fruits or non-leafy vegetables. I'll expand on the subject of organic fertilizers a little later.

Natural sources of nitrogen

Here is a short list of materials that contain varying amounts of organic nitrogen. The figures are approximate since there are so many variables, and just about every book will give different percentages. Remember, you'll be looking at the first set of numbers (N). We'll talk about the others and their purposes in the next two sections.

Material	N - P - K
-animal tankage	8 20 0
-blood meal	15 1 0
-fresh cow manure	12 3 9
-cotton seed	3 1 1
-cotton seed meal	7 2 1
-dried blood	12 3 0
-ground feathers	12 0 0
-fish scraps	8 13 4
-guano	12 8 3
-hoof/horn dust	12 2 0
-fresh horse man.	14 5 11
-ground leather	12 0 0
-fresh chick. man.	20 16 9
-fresh rabbit man.	2 0 0
-seaweed	2 1 5
-fresh sheep man.	19 7 20
-fresh pig manure	10 7 8
-fresh lawn clippings are quite high in nitrogen--the quantity varies widely.	

Here are three more reasons for not using too much nitrogen: 1. chemical nitrogen is "hot" and highly volatile and you can burn plants in a hurry with even just a little too much; 2. because it is *so* soluble, it leaches out of the soil rapidly. Indeed, it almost seems to flow right through solid rock and will head straight for your well or nearby lakes or streams; 3. nitrogen may make the plant's leaves look great, but it also makes them *soft*. Soft growth experiences difficulty surviving a harsh winter, like those considered normal in northern tier states.

A common error of uninformed cold-climate perennial gardeners is fertilizing through summer and right up to—and sometimes beyond—frost. The poor plants are so soft and tender that winter knocks 'em right out! Plenty of nursery owners, when trying to calm an irate customer whose purchases failed to survive a difficult winter, have heard, *"Well (!), I fed them every week with* [*product "X"* or some other miracle-working formula probably high in nitrogen] *right up 'til frost...they* ***should*** *have been healthy enough to live through a little snow!"*

Imagine yourself spending the entire summer relaxing in the shady lap of luxury, sipping sweetened iced tea and plumping-up on prime rib, butter and bonbons. Then at winter's sudden arrival, you're left outdoors without even a light jacket. Your "hardy" perennial plants would freeze to death, too! Just as you need time to adjust to changes in temperature, and probably a good pair of long-johns too, so also do your plants require several weeks to "harden-off" (toughen-up) and make themselves ready for freezing temperatures.

In my experience, no nitrogen should be applied after about July 4 in USDA Zone 4, July 15 in Zone 5, August 1 in Zone 6, August 15 in Zone 7, and September 1 in Zone 8. Of course there are always exceptions to general rules such as these. Micro-climates, unusual periodic weather patterns and a few other variable circumstances have a

way of creeping upon all gardeners, everywhere. Probably the best source of naturally occurring nitrogen is fresh, properly made, rich, chocolaty-brown compost. If you still haven't started a compost pile, then you're probably wasting one of our most valuable resources: organic matter that becomes nutrient and water-holding humus in your soil. The subject of compost and compost*ing* is detailed at length in Chapter 9 of my *Keys to the Garden Gate*, a free, downloadable, full-length book that every person inclined toward responsible gardening and resource stewardship should read. (www.HillGardens.com)

If you rely heavily upon compost in your garden, as we do in ours, then you'll need to select a fertilizer blend with minimal nitrogen. If you don't use compost (and every caring gardener should), more frequent applications of nitrogen will be required. In either case, it's always wisest to send a soil sample every spring through your state's Cooperative Extension Service for testing in your university system's soil testing facility. That way you'll know for certain what you do *or do not have* in your soil. Along with a complete breakdown of nutrients, pH and organic matter content, you'll be told how to fix many problems. The cost is minimal for the basic test ($10 to $15 in most states - good insurance against failure), and a great investment.

> *There are those who will balk at the suggestion of having their soil tested...like the grumpy/grumbly old-timer who came to me with a problem that* clearly *was nutritional. When I asked if he'd had his garden soil tested, he scowled and spat, "I don't need no soil test, young fella. I been gardening for more years than you been alive. I* know *what's in my dirt...leave your soil test to someone who don't know what they're doin!" Sadly, I wasn't able to penetrate and soften that attitude and, likely as not, he's still wondering why he has all leaves and no tomatoes.*

You'll probably find the term "water insoluble nitrogen" on the fertilizer bag (often abbreviated *WIN*) followed by a percent number. A *WIN* of less than 15% means it's fast acting, and a *WIN* over 30% indicates it releases nitrogen more slowly. Since fully soluble nitrogen rapidly leaches out of your soil, a "slow-release"—slower-acting— *WIN* would be best. Remember to observe the last-application dates mentioned above and be careful about applying slow-release nitrogen-bearing fertilizer beyond about mid-summer. You don't want any soft, tender, unprepared growth in your garden when snow flies! A good, fresh compost, which releases adequate levels of nitrogen slowly, serves the same purpose and is less likely to contaminate your well (or your neighbor's) with nitrates. As you might have guessed, I *do* like compost(!), partly because when it's done right and made with manure, plant material, kitchen vegetable scraps and a little wood ash and bonemeal, it will finish out at about pH 6.5. That's perfect for most perennials, while avoiding the need for powerful, manmade chemicals.

Deficiencies of Nitrogen

A lack of nitrogen causes leaves of plants to lose their rich, dark green color and turn varying shades of yellow. That's called "chlorosis," and it usually shows up on lower leaves first. Plants that are starved for nitrogen are usually short, spindly, very slow-growing and yellowed. The more deficient in N, the more yellow leaves become. If the problem is not corrected, but worsens, lower leaves turn brown and die while upper foliage turns light green. Withholding nitrogen would effectively tell a plant that you don't want any more leaves, so it is apt to think it's time to make seeds—to bloom or "bolt."

Without adequate levels of nitrogen, grasses like those in lawns grow slowly and try *desperately* to set seeds. A healthy lawn with ample nitrogen grows thick and doesn't feel such an urgent need to produce seeds. Annuals that lack sufficient nitrogen grow slowly and look "stunted", pitiful little wretches, languishing in near-starvation. Lettuce that puts on a few feeble leaves and sends up a flower spike without even trying to form a head is starved for, among other things, nitrogen. Rhubarb that flowers far too soon is telling you that, while it may have ample phosphorus and other nutrients, there is much less nitrogen in the soil than it would prefer.

> *Even soils that appear rich in organic matter can be seriously lacking in essential nutrients. Last seasons' cow manure added to garden soils, for example, does indeed contain a small amount of nitrogen (one source claims 12 while others say it's much less) but is very quickly exhausted after application by leaching, "evaporating" into the air, robbery by weeds and by the normal action of decomposition. Very often gardeners will say, "Well, I added a* lot *of peat moss, isn't that enough?" or "I mixed in several inches of sawdust (or shredded bark), so I thought I'd have a wonderful garden!" The problem: peat moss (nutritionally and biologically* dead*), sawdust, shavings, even shredded, dry leaves have precious little—if any—nitrogen of their own. Fact is, they use up virtually all of what little nitrogen already in nearby soil during their own process of breaking down...leaving nothing but very deficient humus.*

One final point about nitrogen before we move on: you should know that it is common practice in many nurseries to fertilize high-value container-grown plants (including perennials, shrubs and small trees) with a sustained-release fertilizer product. It's a pelleted material - little yellowish beads about the size of small BBs - the most common of which gradually releases 14 nitrogen, 14 phosphorus and 14 potash over the space of two to three months. (There are a number of other formulas, some lasting eight to nine months, frequently used on container shrubs.) A thin and slightly porous polymer/resin outer membrane allows tiny amounts of water-soluble chemical to more or less continuously diffuse through the coating. It is correctly used on houseplants and, if applied early enough in the spring (mid-April or early May in the north), is a good source of food for plants left trapped in dark-colored pots in the hot sun until purchased. The material is more expensive than other forms of fertilization (injection proportioners or hose-end applicators of liquid types, for example) but significantly less labor-intensive. Labor savings insure that this procedure is preferred in many large nurseries.

Trouble is, if the plant hasn't sold by mid-July and the nursery operator sees that it's beginning to look a little (sometimes *a lot*) stressed-out, he or she often gives it *another* dose of the same 14-14-14 formula. It doesn't take a master-mathematician to figure out that the pellets (which can last three to four months) will be kicking out 14% nitrogen at the end of October or beyond, far too late for newly-encouraged foliage to harden-off for a severe northern tier winter.

Some would argue that the slow-release of nitrogen diminishes as soil temperature begins its descent during early Fall. That's very true in the garden or field. I have seen tender new growth on container-grown stock begin anew, however, during a period which most of us know as "Indian Summer" (an oftentimes multiple-week period of unseasonable warmth following the first damaging frost of the season). That vulnerable new growth could only have been stimulated by the presence of a fresh application (or release) of nitrogen. Complicating the issue even further is the oft-forgotten factor of container temperature. Remember: nursery containers are almost always dark colored and are even more likely sitting in sunshine. Actual container temperatures can be considerably higher than ambient *seasonal* temperatures, further encouraging untimely release of nitrogen from these little pellets. The poor plants become so confused...tops in the frigid air, roots in a 90-degree pot; fertilizer pellets pumping out nutrients, tops not knowing what to do with it.

Of course, if the plant *still* doesn't sell, plant merchants will be forced to go to what some folks might call extraordinary lengths (some might even say *heroics*) to help it survive the long winter months so it can be displayed for sale *next* season. Protection by Styrofoam or other insulating material, or burying under several inches of mulch and plastic are not things a home gardener cares to spend time or money on.

To complicate plant survival problems even further (after all that fattening "food"), towards the end of the nursery retail season when the so-called *Fall-Is-For-Planting* sales promotion occurs, customers race in to take advantage of presumed "bargains." Many of those plants may have been weakened by abuse and neglect, root bound and perhaps even choked with weeds, or fat on too much fertilizer. Some bargain! Many really good bargains, however, await the patient late-summer plant shopper, *if* he or she knows what to look for.

Accumulations of this pelleted fertilizer are readily apparent on the surface of containers and, in my opinion, should be scraped or poured off immediately after purchase in mid- to late summer in order to halt the release of too much nitrogen at an inappropriate time.

Now, however, comes a new product: a glued-together tablet of much longer-lasting, pelleted material that some nurseries push below the soil surface (and out of sight). So the customer who might know the facts about the pellets—but doesn't see any—has no way of knowing that a dose of long-acting, sustained-release fertilizer (now lasting eight or nine months) lies out of sight stimulating soft, new growth well past the time for a plant to prepare for cold weather. Yes, the plant may look great but, in many cases, is ill prepared to face a tough northern winter. Sadly, it's a "buyer-beware" situation. My advice is to be very cautious during early- to mid-fall about any plant which looks exceptionally good after spending all spring and summer in a nursery container, or which sports lush, new growth near the approach of fall. Making your serious and expensive purchases earlier in the season gives *you* control over the amount of nutrition and quality of care your plants receive.

In all fairness to the many honest and reputable nursery operators, it must be said that their ranks are, thankfully, more heavily populated than the ranks of those who use what I consider questionable tactics to sell inferior products. One surefire method to be certain the plants you purchase are healthy and haven't been chemically abused is to buy from well-established local retailers you know and whose reputation you can trust. Additionally, you may enjoy more success if you make your purchases early in the season at nurseries whose stock remains in gardens or growing beds until the moment of purchase. And keep in mind that a thick layer of fresh (and active) pelleted fertilizer beads on the soil surface in nurseries is a very bright "red flag," warning you to be cautious when making your purchases.

You'll find more on the subject of Fall sales in greater detail in Chapter Six of my *Keys to the Garden Gate*, a free, downloadable, full-length book that every person inclined toward responsible gardening and resource stewardship should read. (www.HillGardens.com)

Phosphorus

Basically, phosphorus (always the middle number in the formula) is for flowers and strong stems, plays an important role in root and bulb development and does not stimulate soft, new growth. It is essential for cell division both in plants and humans. Without it there can be no growth. A common form of phosphate fertilizer is the man-made chemical *super*phosphate, a combination of ground phosphate rock treated with a strong acid, usually sulfuric, making the product *very* soluble and fast-acting. SuperPhos, as this souped-up, super-charged chemical is commonly called, gained early and firm acceptance by larger commercial farmers because of its immediate effect on plants. Its heavy use on farms in many US agricultural regions has caused the build-up of chemical salts, ultimately leading to loss of extensive tracts of once-valuable croplands.

Two widely available alternatives are ground up, untreated rock phosphate and bonemeal. Both are good sources of phosphorus, and both are slow-acting and long-lasting so they won't burn leaves or roots. Personally, I prefer bonemeal. It's routinely between 12% and 16% phosphorus, is about the consistency of cornmeal and lasts about three years in most soils. Perfect! That's about the right timing for digging and dividing plants, and rebuilding a garden's soil foundation!

The following is a brief list of some materials that contain varying amounts of organic (*natural*) phosphorus. It should be understood that figures can vary widely, depending on which book or authority you consult and where they got their information. Bonemeal, for example, is listed at 21 phosphorus in one book but most retail product in the local garden store is only 12, occasionally 16. Amounts shown are approximate.

- Activated sludge 3-6
- Fish waste (red snapper) 13
- Slaughterhouse waste 16-20
- Guano 8
- **Bonemeal 12-21**
- Trash ash 5
- Colloidal phosphate 18-24
- **Rock phosphate 28-32**
- Cottonseed hull ash 8-9
- Wood ash 1-2

Bonemeal, again, will not burn plants—*when used as directed*—and is best incorporated into the soil before any plants go in, but it can also be applied locally when planting just one or two new plants or bulbs (as in "filling in the gaps"). Bonemeal is liberally applied into our garden soil but we have learned that great care must be taken to avoid spilling *any* around the surface or even on the sides of the hole where you intend to place a new plant or bulb. If skunks, raccoons or a neighbor's little digger-dog smells it, by the next morning your garden will be turned up side down and in shambles!

The Relationship between nutrient availability...and soil pH*—A most important effect of pH is that role which it plays in the availability of nutrients, either those already in the soil, or nutrition in the form of fertilizer of one type or another applied by the gardener. Phosphorus, for example, is bound up and almost totally locked away from plants in moderately- to strongly-acid soil (below about pH 6). No matter how hard plants try, or how much of the nutrient you apply, they simply can't get at it. Additionally, phosphorus availability is somewhat restricted when pH is between about 7.8 and 8.5 (moderately alkaline). Molybdenum, one of nine "trace" elements important to plant growth (according to many authorities), is also blocked in soil which is too acidic but is unaffected by alkaline conditions. Other essential nutrients appear to be indifferent to reasonable shifts in pH. A good rule of thumb to insure that nutrients are always available to plants is: balance pH for optimum phosphorus availability (6.5 to 7.5) and all other elements generally fall into line.*

A Caution:

One of the most frequently-asked questions here at the nursery and during the discussion period at gardening lectures I deliver goes something like: *"My plants look great, all healthy and green, but they don't bloom!"* or *"How come all I get are leaves and branches but no tomatoes?"* So I ask a series of questions about soil and light conditions and what kind of fertilizer they use. Almost always, they say, *"Well, I use* [insert the name of one of the most widely advertised liquid fertilizers here]*!!!"* It only takes one more question to solve the problem: *"Which* ***formula*** *do you use?"* The all-too-common answer: *"I don't know . . . the one they advertise on TV!"* (A similar admission of benightedness comes when I ask the question, *"What was the pH of your soil the last time it was tested?"* Questioner: *"*[blush] *I don't think it's <u>ever</u> been tested"* or *"*[frown] *I don't need no expensive test . . . I know what's in my dirt!"*

Here's the problem: These supposedly wonder-working plant foods are available in a number of formulas for different uses or purposes, a bit of information not granted extensive coverage in the ads. Without careful observation, the natural assumption many viewers make from the splashy ad is that there's only one, and your purchase will bring rewards of beautiful lawns, trees, shrubs, and prize-winning flowers and healthy vegetables. After all, the fellow in the ad *appears* to be using just one formula on everything in sight (with the exception of rhododendrons and azaleas; a separate commercial advertises a strongly acidic formula for them).

As you might have already suspected I'd say, fertilizers don't work that way. When talking about heavily advertised soluble fertilizers, there's one formula for lawns, one for roses, one for tomatoes and some for other specific uses. Trouble is, folks just grab the first one they see in the store (or accept one handed them by an inexperienced clerk), without reading the label to determine the formula, or realizing it's probably *very* high in nitrogen. Remember that nitrogen is for foliage (like leafy houseplants, lawns and lettuce); fast, tender growth on just about any plant. It doesn't do a great deal for flowers or fruit. *Phosphorus* is for flowers and fruit.

A Wrinkle

Actually, you may not need as much supplemental phosphorus in your garden as you might think. You've probably have heard about phosphates contaminating lakes and streams. State and local authorities alike are deeply concerned about phosphorus and what it can do to a body of water. And with good cause! A bloom of an undesirable species of algae resulting from an overabundance of phosphorus, uses up available oxygen; fish and other water creatures suffocate; and the odor of rotting fish and a dying ecosystem is very dissatisfying.

Oddly enough, much of the phosphorus contamination in some lakes and ponds comes right from the soil in its watershed—the land immediately surrounding a body of water that slopes down to its level. A gentle rain soaks into soil and gradually finds its way into the water table where it becomes part of a valuable resource, water for drinking, irrigation and maintenance of lake levels. A tremendous, pounding storm, however, sends large droplets of rain slamming into the ground, dislodging phosphate-laden particles, forming muddy rivulets which merge to gouge out gullies, and the whole muddy mess ends up in the lake! Irresponsible irrigation or run-off control can result in a similar scenario.

To compound the problem, questionable management of some lakes and ponds has resulted in fluctuations of water levels frequently resulting in erosion of shore lands. Once again, resident phosphorus in the soil is dissolved and becomes mixed with lake water.

But that's not all! The common and highly-questionable practice of spreading large amounts of animal wastes, rich in nitrates and phosphates, on frozen or snow-covered fields adds to the contamination. When those offending contaminants run-off and end up in surface water before they have a chance to be tilled into the soil, phosphorus-driven algae blooms inevitably occur. Improperly installed or maintained septic systems are also a serious source of contamination.

Chemical fertilizers, too, can be a real problem if applied too heavily or if allowed to remain on the surface where rain or irrigation can flush them away before plants have a crack at them. The solution: heavy reliance on compost and other organic materials, and the careful and judicious use of *any* fertilizer product, an inescapable responsibility. You knew I was going to say that, didn't you?!

Deficiencies of Phosphorus

A phosphorus deficiency results in weakened stems and reduced plant size and, surprisingly, a deep green color with perhaps a purple tinge. Leaves of some plants will actually turn purple on their undersides, easily noticeable on seedlings. Fruits and vegetables fail to develop, or fall prematurely. The process: a shortage of phosphorus sets up conditions for the production of sugars in plant tissues; the substance **anthocyanin** is formed which manifests itself as a purple pigment in leaves. The problem: either insufficient phosphorus or (most likely) an inordinately low soil pH, probably combined with insufficient organic matter content. The solution is obvious: a soil test for pH and primary nutrients should quickly and decisively pinpoint the problem. It may be a simple matter of adding some finely ground phosphate rock to raise phosphorus levels. If a test proves the soil is too acidic, the problem may be resolved by adjusting soil pH with ground limestone (magnesium-containing lime supplies an important micronutrient that plants also require) and adding compost, aged manure or, if nothing better is available, peat, followed by thoroughly working these amendments into the soil. Remember that while peat moss is strongly acidic, it is nutritionally and biologically *dead*.

Potash

There is one more primary nutrient to consider, and it's just as important to plants as were the first two discussed. Potassium (K - always the third number in the fertilizer formula) is essential for growth and is usually needed in fairly large amounts by plants. Most soils normally contain adequate amounts of K, but a number of circumstances may cause its depletion in our gardens.

Potash is needed by the plant during the production and movement of carbohydrates (sugar is a common carbohydrate), and is involved in nitrogen metabolism. Sound a little confusing? To simplify things a bit, just think of potassium as being necessary for good strong roots and bulbs. Long-time vegetable gardeners, for example, know that putting wood ashes (which are high in potash) in soil used for growing beets makes for big, tasty beets. The part most of us eat is the root. Get the picture?

For an organic gardener, ashes are a great source of potash. Ash also contains some phosphorus, boron and other minor elements used by plants. A word of caution, however: use only *wood* ash. Coal ash can be very toxic in your garden. Toxicity problems may also occur after application of ashes derived from trash, garbage, and some older printed papers as well. Since ashes also serve much the same purpose as lime to alter soil pH, no more than 20 pounds of ash per 1000 square feet of garden space should ever be applied. Wood ash also serves to raise soil pH, with twice as much ash applied as limestone (by weight) for the same effect. Considering the problem of run-off over frozen ground during winter, it would be best to store the ash *dry* until it can be spread and immediately tilled into the soil.

Here is a short list of readily-available natural materials which contain varying amounts of potassium. Once again, remember that numbers may vary and are approximate.

- Alfalfa hay 2-3
- **Cottonseed hull ash 24**
- Granite dust 3-5
- **Greensand 5-6** (normally called "Jersey" greensand)
- Seaweed 5
- Wood ash 7

Deficiencies of Potassium

Most plants need and consume significant quantities of potash. When supplies are drastically reduced, plants grow slowly and are weak, having a poorly developed root system. Older leaves curl and appear *very* hungry, and develop a dark brown margin called "necrosis." As the deficiency becomes more severe, upper leaves gradually turn yellow and die within a short time. Characteristically, yellowing begins at the leaf edge and progresses toward the center, or yellow spots near the edge enlarge and connect. Properly made compost utilizing a good mix of green garden wastes and barnyard manure usually contains sufficient levels of potash. Use such compost liberally, working well

into soils. If the deficiency is severe (revealed by soil test), add wood ashes, granite dust or greensand (available at most garden centers and farm supplies). **Prevention:** periodic soil testing (recommended: annually) would quickly alert you to impending problems; heavy reliance on compost will go a long way to avoiding problems in the future.

Trace Elements & Micronutrients

In addition to the three primary nutrients detailed above, plants also require small—in some cases, tiny—amounts of a number of other elements. Commonly called "trace" elements, 13 additional substances (in a sense, chemicals) are recognized by soil experts as important to help plants grow and produce seed. In actual fact, approximately 57 lesser nutrients are required for *truly* healthy growth! More on this subject later.

All but three of these 13 "important" elements are provided to plants by the *healthy* soil in which they live. Those three, **oxygen**, **hydrogen** and **carbon** (in the form of carbon dioxide [CO2]), are present in great abundance in the air around our plants and us.

While only very tiny quantities of these trace elements are required, too much can create some serious complications for plants. Deficiency of trace elements is less likely in soils that have been treated with respect and maintained with an abundance of organic matter—*humus*—composed of composted plant residues and animal wastes.

Here is a list of the remaining ten trace elements commonly considered important and, briefly, how a deficiency manifests itself in plants:

- **Boron** - plants will "dwarf;" stems crack and may rot at the center.
- **Calcium** - blossom-end-rot in tomatoes; tips and margins of leaves turn pale.
- **Chlorine** - inadequate root growth and wilting or drooping of upper foliage.
- **Copper** - unexplained dieback; underdeveloped tomatoes; poor growth.
- **Iron** - shortages are most common in intensive agricultural areas of the country. Chlorosis (weak and sickly, yellowing foliage).
- **Magnesium** -unexplained markings (mottled-appearance) in leaves, blossoms and sometimes fruit.
- **Manganese** - sickly and yellow leaves and poor growth.
- **Molybdenum** - margins of leaves blacken (necrosis) and die.
- **Sulfur** - unexplained slowed growth; leaves turn brown or black (necrosis) and die.
- **Zinc** - unexplained dieback of plant parts; reduced yield.

Bear in mind that there are many more minor nutrients than contained in this abbreviated list which plants—and those who eat them—require to be truly healthy. In actual fact, plants require about 60 total; human physiology requires something near 90 for optimum health! Given the documented nutritionally poor condition of twentieth-century production soils, it is highly unlikely that anyone, with the possible exception of those on an intensive vitamin/mineral supplement program, is getting a full load of all 90 elements.

Let me repeat, yet again, that if your soil is rich and deep, and you rely heavily on compost and other organic materials for plant nutrition, it is unlikely that you'll ever see a significant deficiency of trace elements in the home garden. Those who have incredibly poor soil, devoid of humus, choked with weeds and littered with stones, and who pour in nothing but chemical fertilizers containing only three "nutrients," are the ones most likely to have trouble. The way to prevent that kind of woe and anguish should be obvious by now!

Some Common Problems

Quite frequently, gardeners say they fertilize *"Like the book* [or salesperson at the store] *says,"* but it never seems to do any good! Plants *still* have yellow foliage and very few flowers, and those they have are perched atop spindly, weak stems. I love playing a sort of modern, garden-detective Sherlock Holmes, and so I ask my standard series of questions. It is usually revealed that they sprinkle their fertilizer on top and never till it in. Nitrogen, being both very soluble and highly volatile, is either quickly lost to the air or dissolves and washes right through soil with low humus content, and the roots grab only a little as it goes by. Naturally occuring forms of phosphorus and potassium, on the

other hand, are largely stationary, remaining very near where applied. But plant roots are not supposed to be on the surface. In most cases, feeder roots are several inches below the surface. Scattering fertilizer granules around plants and not cultivating them in, forces roots to gradually move *up* to get part of their dinner. As you might expect, such circumstances leave them highly vulnerable to drought and later cultivation damage. The solution: cultivate fertilizer to a depth of at least two or three inches—that's where the roots are—being careful, of course, not to do any serious damage to delicate feeder roots.

Consider also that most chemical fertilizers are salts. Water always flows *toward* a salt in an effort to dilute or balance it. Heavy application of fertilizer near plants not only pulls moisture away from soil near roots, but may also draw water from roots themselves. Most folks call that burning, and I guess we've all seen it. For those who feel they must use chemicals, the solution is threefold: 1. Always apply the correct amount of fertilizer and cultivate it in; 2. Always water it in well; and 3. Never apply a dry fertilizer on dry ground, *especially* near a wilted plant.

A SOIL TEST - ANSWER TO MANY PROBLEMS!

Picture in your mind a carpenter, just beginning to build a house. Most good carpenters know their materials, and work from a precise plan called a blueprint. But *our* carpenter has never received any formal training in home building and hasn't the faintest notion of how to read a blueprint. Fact is, he doesn't even *have* one! How totally frustrating his job will be! What a *funny-looking* building he'll erect! Wires and pipes all over the place; windows and doors crooked; roof leaking. And, likely as not, the structure will come crashing down during the next heavy rain or burn to the ground soon after the first match is struck in the fireplace or the first toaster is plugged in, or light switch flipped.

How very much like more than a few gardens we've all seen. No plan, no foundation (soil preparation); no order; no charm and, most importantly, no clue as to existing soil nutrition or pH! Just dump in some "loam" (properly pronounced, by the way, *low-um...*not *lume*) and a little cheap super-fertilizer, then hope for the best. It, like the poorly-built house, is problem-cluttered, frustrating, weed-choked, and "funny-looking," destined to come crashing down.

I've often posed the question, *"If you woke up at 4 a.m. and decided to read a good book, got your milk and cookies, propped yourself up on pillows, put on your glasses, opened to the first page but, with clenched teeth and intractable resolve, refused to turn on the light*, *how much reading would be accomplished?"* Reading in the dark is not very satisfying. *Gardening* in the darkness of diminished information (or in the presence of *mis*information) isn't remarkably satisfying either!

Please forgive the repetition. . .but this is *really* an important 'key'! You have a tremendous resource at your immediate disposal. It is no longer necessary to garden in the "dark." You don't have to wonder what your pH or soil nutrition is. For a small fee and a couple of stamps you can send a sample of your garden soil to the university-based and supported soil testing laboratory for complete analysis of pH, humus and primary nutrients. Then you'll *know* what you've got so there'll be no doubt about how much lime, fertilizer or organic matter to add.

It's like turning on a light in the dark, or working from a plan. *Everything* just seems to come into focus and shift into perspective. Problems almost seem to solve themselves! Your Cooperative Extension Service can help you with forms, mailing boxes and counsel. What an opportunity!

Here's the official site with a complete list of Cooperative Extension Service offices...and contact information.