WHAT DO WE MEAN BY SOIL FERTILITY?

By: Dr. Ieuan R. Evans

We keep hearing about poor soils, clay soils, good soils, peaty soils, ruined soils, degraded soils, sandy soils and so on. These names are actually meaningless and very subjective. In order to grow from seeds, bulbs, cuttings or tubers plants need water, air (carbon dioxide and oxygen) and plant essential mineral nutrients often erroneously called plant food. Soil is a storage house of water and mineral nutrients which can vary from a total mineral sandy desert to a very wet fully organic peat bog.

1. Sand soils are really just coarse pieces of broken down rock from pinhead size and finer. Sand soils are easy to dig and poor at holding water and plant nutrients.

2. Clay soils are very fine particles of rock too small to really see that they can be suspended in water. When they dry out, clay soils become very hard and compacted but they hold water very well.

3. Silt soils are ground rock particles intermediate in size between clays and sand. Silt particles are rounded and generally found in old river bottom soils since the finer clay particles are washed away.

What is considered a good loamy soil is usually equal parts sand, clay and silt, i.e. one third each. Unfortunately, soils vary dramatically, some may be virtually 90% clay, heavy silty soils or very sandy perhaps 80% sand. Surprisingly a cubic foot of sandy soil will weigh more than a cubic foot of clay. Peat soils would weigh a lot less. Of prime importance in all temperate climate soils is the organic content. Typically, on this continent good productive soil would be as much as 10% organic matter with drier prairie soils down to 2 – 5% organic matter. Cultivation and crop production has reduced most of these soils to around 50% of their former organic content. The organic content is a storehouse of fertility.

Sandy soils can hold up to 1 – 1.5 inches of water per foot of depth, silty soils perhaps 2 inches and clay soils up to 3 inches per foot of depth. Plant roots are 90% or better in the top 1 foot of soil where most available nutrients are but they can draw water down to 10 feet or more. Water vapour moves in the soil upwards from a wetter to dryer area the opposite of heavy rainwater, which moves down into the soil profile.

How much does an acre of soil weigh on average to a depth of 6 inches? The most fertile part – 2 million pounds. So, if you apply 10 actual pounds of nitrogen (urea fertilizer is 46% nitrogen by weight) you will have 5 parts per million (ppm) of nitrogen in the top 6 inches per acre to get this 5 ppm or 10 lbs. of nitrogen per acre you would have to apply about 210 lbs. of urea. This is how fertilizer rates are calculated. Add two pounds of actual zinc (from zinc sulphate) will give you 1 ppm of zinc per acre.

What about the organic soil fraction? If a soil is 1% organic (most cultivated soils are 1 – 10% organic) then by weight this organic fraction (humus) per acre is made up of 10,000 lbs of carbon (complex carbon) 1,000 lbs of nitrogen 100 lbs of sulphur and 1 lb of boron. If a typical soil is 3% organic and you work it up in a temperate climate you will release perhaps 60 lbs of nitrogen in a year in a Southern U.S. climate but only 25 – 30 lbs in a Northern Canadian climate from this 3% organic faction. If you never add fertilizer and cultivate your soil annually that 3% over time (like, a 100 years of farming or gardening) will drop to less than 1% and the soil becomes non-productive, i.e. you have exhausted the mobile nutrients primarily nitrogen, sulphur and boron. The mineral part of the soil contains the bulk of the potash K, phosphate P, calcium Ca, magnesium Mg and the plant essential micronutrients such as copper, zinc, manganese, iron, chloride, molybdenum and boron. Occasionally some plants need micro amounts of nickel and cobalt.

Most North American soils contain enough nutrients (fertilizer) to grow ornamental plants, shrubs and trees. In sandy soils you may have to add such micronutrients as copper and zinc since they could be in short supply and copper to peaty soils since they tie up (or sequestered) this element. To classify copper, zinc and manganese as heavy metals is sheer nonsense when we know them to be bio-essential micronutrients. Point of fact, the blood of slugs, snails, shell fish, squids and octopus are copper based and not iron based.

Typical garden soils in North America may be low in potash and phosphate – particularly sandy soils but most frequently they are very low in nitrates (N) and sulphur (S) since both are easily leached into the subsoil by rain or removed by vegetables. Clay and loamy soils are generally high in potash.

By far the best fertilizer for most home gardens is not these overpriced small packages of 20:20:20, unless you are growing very few plants, is ammonium phosphate which is 16:20:0:14; 16% nitrogen (N), 20% phosphate (P), 0 potash (K), and 14% sulphur by weight. A funny quirk is that many people will tell you that they get a good response in plant growth to Epsom salts. Epsom salts is magnesium sulphate. I can bet that very few soils are short of magnesium but many are short of the very essential sulphur. It's the sulphur not the magnesium that makes plants grow better. Phosphate, potash and micronutrients except boron are not easily leached from soil but nitrogen, sulphur and boron can easily be washed away into the subsoil or drainage water. Nitrogen and sulphur are the two key elements in protein formation.

THE SOIL MINERAL COMPONTENT

What makes up this finely crushed rock that makes up the mineral component of the soil? Sandy soils may be 99% mineral and organic type soils 10 – 90% mineral.

What are these minerals? First of all, on average 50% of the volume of soil – let's say a cubic foot is made up of air when dry and water when waterlogged. When plants grow in soil the roots take in water vapour and air. Plants die in water logged soils unless they are water plants, mangroves or swamp cypress. The mineral component of soil on average is 50% by weigh oxygen in the form of oxides such as silicon dioxide or iron oxide. Silicon makes up 25% by weight, aluminum 7% and iron 5% of average soils. That's on average including the oxides, 87% of a typical component of a mineral soil. This other 13% consists of potassium, phosphorus, calcium (1 - 10% or more), magnesium and trace essential elements such as zinc, copper, boron, molybdenum, manganese, chloride, nickel and cobalt. Animals such as us also require specific trace elements like selenium, fluorine, iodine, sodium, tin and chromium. Not forgetting that in parts per million or billion all soils contain lead, antimony, arsenic, mercury, gold, silver, cadmium and so on. All of these elements, toxic or otherwise, exist in trace levels in sea water probably below any harmful levels.

THE SOIL ORGANIC COMPONENT

As previously discussed, the organic component generally ranges from 1 – 10% and is basically made up of carbon, nitrogen, sulphur and boron. Organic factions of the soil may also contain phosphates. This soil organic faction which has taken hundreds, if not thousands of years to form is very district from compost which can vary considerably in its nutrient content. Cow manure for example contains little in the way of nutrients and on average every 100 lbs of dry cow manure will contain about 0.7 % phosphate, 0.7 % potash and 0.7 % nitrogen, almost exactly the same nutrient levels as acidic brown peat moss. Compost made from poultry manure has about 7 times the nutrients N, P and K of cow manure. Most cow and horse nutrients are peed out in the urine whereas chickens do not urinate and the nutrients are in the manure. Garden composts can vary from being peat moss like to perhaps double the nutrients of peat moss.

Most information on the internet on fertilizers, excepting the University, Government sites and Wikipedia, an be classified as “Fake News”. Just lots of outrageous claims and misinformation. No doubt we have all heard about organic versus chemical fertilizers, the problems with pesticides and GMO’s (genetically modified organism). Logically and practically speaking most of this information is nonsense. There are those amongst us those who believe that the earth is flat and that the 1969 moon landing was faked. You are of course entitled to your beliefs but they are not hard facts. All the elements that make up basic plant fertility the macronutrients such as nitrogen, phosphorus, sulphur and potassium as well as all the micronutrients have not been modified in any way – JUST RECYCLED. Is there any difference in the nitrogen that is fixed by a lightning strike forming ammonia to the industrial electric arcs (Haber process) that make ammonia? Lightening storms by the way provide about a seventh of the earth’s nitrogen supply. Phosphate, potash and sulphur deposits that are presently mined are all from long past biological accumulations that took place millions of years ago on earth. Oil by the way is the end result of composting the oceans organic debris. Mother nature made oil. Whether the garden nutrients coming from the rear end of chickens or a fertilizer bag growing plants they do not make any distinction since there is absolutely no difference biologically.

GROWING LILIES

Now that we have the basic principles of fertility covered we will look to growing the best possible lilies. You are told to have your soil tested? What does it mean?

A full soil test will tell you how much nitrogen, phosphate, potash, sulphur, calcium, magnesium and micronutrients are in your soil. The soil test should also tell you what kind of soil you have – sandy – clay – loamy – including the organic content as well as the pH. The pH is very important for some lilies, such as Orientals that do best in pH soils below 6 but most lilies thrive at pH 6 – 7. Above 7.5 pH and below pH 5.5 you may need to modify your soil. Lime or crushed limestone to raise the pH if below 5.5 and elemental sulphur prills to lower soils with a pH, above 7.5. both are available at farm supply outlets.

How do you take the soil for this test in your garden? To take proper soil samples you need only dig down to 6 inches (15 cms), since 80% of plant roots and nutrients are generally in this zone. If your garden is, let’s say a half acre, you need to take around 10 widely spaced samples with a spade down to 6 inches (15 cms) so that each sample is about 1 lb (500 gms). About 5 samples for smaller gardens. All samples should only be taken from where you grow bulbs and herbaceous plants. Do not sample around buildings or walkways where you do not intend to grow lilies. Soil sampling under trees is fine for martagon lilies. All the samples that you take in your garden down to 6 inches should be combined in a wheel barrow or bucket and thoroughly mixed. From this mixture take about 1 – 2 lbs and allow to air dry indoors. This dry sample should then be placed in a sealed poly bag boxed and forwarded to your nearest soil testing laboratory. You should specify that you want the 1) soil type, 2) pH, 3) macro and micronutrients, along with any deficiencies that they might detect, i.e. zinc deficiency on sandy soil or very low phosphate levels.

Acidic soils below pH 5.5 (unless you are growing acid loving lilies, azaleas or blueberries) can be brought up to pH 6 -7 with about 2 – 3 lbs of crushed limestone or more per square yard (metre). Alkaline soils above pH 7.5 can be made more acidic with a quarter to half pound of elemental sulphur (sold as prills or pellets). The slaked lime (white powder) or crushed limestone is mainly calcium carbonate with varying amounts of magnesium carbonate. If the magnesium makes up almost 30% of the lime it’s called dolomitic lime. Both the calcium and magnesium carbonates will neutralize the soil acids and raise the pH to a maximum of pH 7.3 no matter how much lime is added. Both the lime or crushed limestone and elemental sulphur pellets should be well worked into the top 4 – 6 inches (10 – 15 cms) of your garden soil. The sulphur prills break down to fine sulphur in the soil and are slowly oxidized in the soil by bacteria (Thiophylic bacteria) to sulphate. This sulphate takes out the alkali calcium forming neutral (non-alkali) calcium sulphate. This process may take 3 – 6 years to use up the ¼ to ½ lb of sulphur that was applied to each square yard. This is changed over time and the soil will stay at ph 5.5 or 6.5 indefinitely since the alkaline calcium has been neutralized.

When your soil test results are returned to you remember that the that the amounts present in the soil may be in that form of pounds per acre or parts per million (your multiply parts per million by 2 to get pounds per acre). Some soil laboratories will also include graphs which will tell you that your nitrogen (N) or magnesium (Mg) level is good but your phosphate (P) level is very low. Your answer is to use a high phosphate fertilizer such as ammonium phosphate 16 – 20 – 0 – 14 (NPKS) and apply at the recommended rate which is usually about 2 ounces (60 gms) per square metre (yard).

If you intend to use composts of peat moss as your source of soil fertility remember that organic amendments do the soil (any type of soil) a world of good since you are feeding the soil microflora and micro fauna (fungi and bugs) but the nutrient levels may be very low. Bone meal, for example, is virtually useless in soils above a pH of 7 since the calcium phosphate is the meal will not break down. It will be of use in soils below pH 5.5 with a slow breakdown. Animal bones last for thousands of years in alkali soils but get dissolved in acidic peat bogs over time.

High organic amendments are poultry manure but not cattle, sheep or horse manure. Soil amendment such as alfalfa pellets, high in nutrients attract rabbits, mice and deer.

Whether you use organic or so called chemical amendments just practice common sense since most of those wonder minerals or glacial soils, humates are generally way over priced, useless and a waste of money. Any kind of fertilizer or soil amendment that you buy please read the label carefully since many internet seed catalogues and some garden and farm magazines soil amendment products are loaded with plain old snake oil treatments that are virtually worthless to growing plants.

IMPROVING YOUR SOIL

Manures, peats and composts dug into your garden will do the following for all soils:

1. Improves water and aids exchange capacity.
2. Helps root growth and nutrient exchange.
3. Provides buffering for the soil.
4. Retains moisture in dry and sandy soils.
5. Reduces fertilizer leaching.
6. Keeps soil from hardening.
7. Provides some plant nutrients.
8. Peat comes in convenient packages.
9. Lightens up and aerates heavy dry soils.
10. Provides the carbon energy food for the soil microflora and worms.

Contrary to what some writers having stated that compost or peat is not good for soils many wild lilies grow well in high organic and leafy compost soils. I multiply all of my lily scales to bulbets in plain acidic moist peat and they do very well. The acidic peats reduce bacterial rots.

If you strictly believe in organic concepts then plant any vacant soil to peas (buy them in bulk from the grocery store) and plant them as soon as the soil can be worked and allow them to form the first unfilled pods. Now dig or rototill in the pea vines and you will have raised your soil nutrient levels considerably, especially the nitrogen if your peas have nodulated. Inoculant is normally present in most soils.

If your soil is saline (salty) with a high pH (above 8) then it may have to be amended with gypsum (i.e. calcium sulphate used for gyprock or plaster casts). The calcium sulphate applied at 2 – 3 lbs per square yard will amend the soil and remove the alkaline salts over the course of a few years. White Sands New Mexico is almost pure gypsum. If you cannot find gypsum then old crushed gyprock from renovated house walls will be a good substitute.

Technically speaking, you can manipulate your garden soil with mineral or organic soil amendments, provide shade for some lilies, especially martagons and use raised beds for improved drainage if you have moisture problems. You can create your own optimum lily growing environment.

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