**Soil: A Gardener’s Perspective**

**Presented by JoAnn Weaver, University of MN Extension, Master Gardener in Crow Wing County**

**This presentation is intended to help you understand the key components of different soil types and the challenges that each type can present. Information will be provided on improving soil quality by means of soil conditioning, incorporating compost, and fertilizing for the best result.**

**Ideally, “good horticultural soil” contains 50% solid material and 50% pore space. At any given time, the pore space is occupied by both air and water. Particles of clay fit tightly together and have very little pore space while sand can have a large amount of pore space that drains too quickly. Soil can vary from part of your land to another.**

**The physical and chemical functions of soil are to provide:**

* **Mechanical support for plant roots**
* **Essential nutritional elements**
* **Access to water and oxygen**
* **Insulate plant roots from drastic fluctuations in temperature**

**Physical properties:**

* **All plant roots are found in soil and most in topsoil**
* **Soil particles are called soil separates: sand (the largest), silt, and clay (the smallest)**
* **Sand feels gritty and is not moldable or sticky**
* **Dry silt has a floury or talcum-powder feel, only somewhat moldable and sticky when wet, and dry clods are hard to crush**
* **Clay is very moldable when wet and dry clods are difficult to crush**
* **Soil texture is the relative proportion of sand, silt, and clay mineral particles**
* **“Friable” refers to a moist soil that with gentle pressure is easily crushed but which holds together when pressed. Great for plant growth and cultivation**
* **“Tilth” refers to the physical condition of the soil as related to tillage and it’s reaction to seed emergence and root penetration**
* **A soil with good tilth and friability makes for a very good garden**
* **Garden plants require both water and air at their roots**
* **Mechanical manipulation of soil loosens the soil, and promotes aeration, porosity and water-holding capacity. Don’t overtill with a mechanical tiller or consistently walk on an area to be planted as this can cause compaction which resists water movement and the spread of plant roots. It can take years to get over the damage caused by overtilling**
* **Direct effects of compaction: reduced growth, tip dieback, root rot, and dehydration**

**Life in the soil:**

* **A productive soil is an ecosystem alive with small (micro) and large (macro) plant (flora) and animal (fauna) organisms**
* **Microorganisms are responsible for organic matter decomposition, nutrient cycling, and other effects on plant growth**
* **Macrofauna includes nematodes, snails, slugs, earthworms, woodlice, millipedes, termites, beetles, ants, spiders and mites and are involved with the initial breakdown of surface organic residue**
* **Microfauna not very numerous. Protozoa an example**
* **Macroflora includes plant roots as the most common example**
* **Microflora are the most influential and includes bacteria, fungi, algae, and viruses**

**Soil pH:**

* **A measure of relative acidity or alkalinity**
* **Influences numerous chemical reactions that occur in the soil, including the availability of the 17 nutrient elements essential for plant growth and development. Of these 17, three are taken from air and water (carbon, hydrogen, and oxygen), and the other 14 (divided into “primary,” “secondary,” and “micronutrients”) are absorbed from the soil by plant roots**
* **A pH of 7.0 means that alkalinity and acidity are equally balanced in the soil**
* **Most crops do best when the pH is slightly acidic to neutral (pH of 5.5 to 7.5).**
* **Soil pH should only be managed in response to a soil test. Repeat every three years**
* **Soil testing:** [**http://soiltest.cfans.umn.edu/**](http://soiltest.cfans.umn.edu/)

**Fertilizer and plant nutrition:**

* **Garden and landscape soils are rarely fertile enough to supply all of the nutrients of plants**
* **Too little fertilization results in poor plant growth and appearance. Too much fertilization is unnecessarily expensive and may cause injury and pollution**
* **N-P-K The first number indicates nitrogen, the second number phosphorus, and the third number potassium. On a 100 pound bag of fertilizer, 12-12-12 indicates 12 pounds of nitrogen, 12 pounds of phosphorus, and 12 pounds of potassium. The remaining 64 pounds is filler which facilitates even spreading of the fertilizer**
* **Fertilizers affect plant growth by improving the supply of available nutrients in the soil.**
* **Organic or inorganic forms of fertilization require that the nutrients be changed into chemical form.**
* **Organic fertilizers are defined as materials derived from either plant or animal products containing one or more nutrients other than carbon, hydrogen, and oxygen. Inorganic fertilizers, sometimes called synthetic or chemical, are man-made chemical compounds that provide combinations of plant-essential nutrients**
* **Organic fertilizers often cost more per unit, vary widely in nutrient content, and may be slow-released. Limitations include availability, bulk, odor, potential salt and weed seed hazards, and expense per pound of nutrient**
* **Inorganic fertilizers are characteristically fast-acting and relatively low in cost per pound in actual nutrient but; if over applied, may burn crops and contaminate the environment through run-off**
* **WHAT HAPPENS IN THE GARDEN SHOULD STAY IN THE GARDEN! Some research has shown that gardeners have been known to use 4 X as much fertilizer as farmers!!**

**Soil amendments:**

* **Influence plant growth indirectly by improving the soil’s physical properties (e.g. soil tilth, water infiltration, water retention, nutrient-holding capacity, etc.)**
* **Compost is decomposed organic matter derived primarily from vegetable sources. Nutrient value depends on materials used**
* **Earth worm castings are a great soil conditioner very high in organic matter with no risk of burning plants**
* **Manure (horse, cow, rabbit, chicken, turkey, and sheep) can be both an amendment and/or a fertilizer. Nutrient content varies widely. The highest concentration of nutrients (and salts) is in fresh material. Best to compost first**
* **Bone meal is made up of bones, hoofs, and antlers of vertebrates, which have been softened by steam and ground up. High in phosphorus and slow release**
* **Blood meal is the collected blood of slaughtered animals, then dried and ground. Contains iron and many other trace elements. Encourages leaf growth**
* **Peat moss - plants that have been harvested and dried. Holds up to seven times its weight in water**
* **Lime or limestone – generic term for a wide range of agricultural materials defined as having a calcium and magnesium content that is in forms that are capable of reducing soil acidity. Provides large amounts of secondary nutrients**
* **Sawdust has low levels of nitrogen and potassium and is best mixed with compost before adding to soil**
* **Wood ashes are a fast acting, rich source of calcium that raises soil pH**
* **Additional choices include alfalfa meal, ammonium sulfate, chelated iron, coffee ground, dolomite, fish emulsion, greensand, gypsum, kelp meal, perlite, superphosphate, urea, vermiculite, etc...**

**Mulching:**

* **Mulch is a material that covers the soil**
* **Mulch affects soil temperature by insulating or transferring heat**
* **All mulches help soil retain moisture**
* **Mulches may also help reduce weed growth, prevent erosion, and affect insect/disease presence**
* **Drawbacks of mulch: slows down soil drying in spring and following a heavy rain; absorbs moisture from light showers before it reaches the soil; provides habitat for pests that need consistently moist conditions, like slugs; encourages fungal diseases of the roots and stalks**
* **Organic mulch provides indirect benefits to the soil as it decomposes**
* **Inorganic mulches such as stone or plastic sheet materials have little effect on nutrient levels and do not contribute organic matter to the soil**
* **Rule of thumb: apply two to three inches deep for the best result. The finer the mulch, the thinner the layer should be. Timing is everything!!**

**Soil and Water:**

* **Apply water according to the plants’ needs and how much water is already in the soil**
* **If water runs off the surface of the soil it’s not meeting the needs of the plants growing in that soil**
* **The addition of organic matter helps to build a soil structure that accepts and holds water**
* **Tips to reduce runoff: don’t work the soil too finely which promotes crusting, mulch, use a gentle spray rather than a stream when irrigating, and apply water slowly**
* **Apply enough water at one time to wet the entire root zone**
* **The right amount of water varies with the season. After planting, adequate moisture helps seeds germinate and transplants become established**

**Cover Crops and Green manure:**

* **Plants grown in a garden to improve a soil’s physical structure and fertility. Can be planted in the early spring or early fall to protect bare soil from raindrop impact and erosion, capture nutrients leaching through the root zone, compete with weeds, and, once incorporated, add organic matter to the soil**
* **Typically grains or grasses such as rye, oats, or annual ryegrass; legumes such as clovers vetches, cowpeas or fava bean; or a mixture of both. Avoid plants that are listed as invasive**
* **Plant winter-hardy crops at least four weeks before the expected date for the first hard frost**
* **In spring, turn the crop under three weeks before you want to plant to give the organic matter time to break up**

**Crop Rotation:**

* **One of agriculture’s oldest practices**
* **Used to reduce damage from insect pests, to limit the development of vegetable diseases, and to manage soil fertility**
* **Most effective if plants from the same plant family are rotated. Do not plant an area with vegetables from the same plant family more than once every three to four years:**

**Carrot Family *(Apiaceae)*:Carrot, celery, parsley, parsnip**

**Goosefoot Family *(Chenopodiaceae)*:Beet, spinach, Swiss chard**

**Gourd Family *(Cucurbitaceae)*: Cucumber, muskmelon, pumpkin, summer squash, watermelon, winter squash**

**Grass Family *(Poaceae)*: Ornamental corn, popcorn, sweet corn**

**Mallow Family *(Malvaceae)*: Okra**

**Mustard Family *(Brassicaceae)*: Broccoli, Brussels sprouts, cabbage, cauliflower, Chinese cabbage, collard, kale, kohlrabi, mustard greens, radish, rutabaga, turnip**

**Nightshade *(Solanaceae)*: Eggplant, pepper, potato, tomato**

**Onion Family *(Alliaceae)*: Chives, garlic leek, onion**

**Pea Family *(Fabaceae)*: Bush bean, kidney bean, lima bean, p0ea, pole bean, soybean**

**Sunflower Family *(Asteraceae)*: Endive, lettuce, sunflower**

**Steps to a great garden:**

* **Select and prepare the site**
* **Do a soil test**
* **Amend the soil as needed**
* **Choose your plants and consider their growing habits**
* **Rotate your crops**
* **Fertilize as needed**
* **Water wisely**
* **Clean up your garden in the fall**
* **Consider a winter cover crop**

**Questions:** [**www.extension.umn.edu/garden/yard-garden/**](http://www.extension.umn.edu/garden/yard-garden/)

**“We come from the earth, we return to the earth, and, in between, we garden.”**

**Anonymous**