Canadian Organic Growers

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Canadian Organic Growers Inc is Canada's national membership-based education and networking organization representing farmers, gardeners and consumers in all provinces.

COG Reference Series

#13,Improving Soil Fertility and Organic Amendments

In order to understand this subject we have to distinguish between natural fertility without human interference and fertility created by soil management, which includes the effects of manure, fertilizers, tillage, crops, weeds, drainage, leaching and erosion.

Nature's Way

Let us first examine how nature supplies plants with nutrients. We all know that native vegetation has adapted itself to soil, climate and water table. Dead plants and animals decompose with the help of micro-organisms and the nutrients that had supported their growth are returned to the soil. There are, however, losses from leaching and erosion, as well as evaporation of nitrogen compounds, the lost nutrients of which are replenished by natural processes.

The mineral nutrients, phosphorus (P), potash (K), calcium (Ca), magnesium (Mg) and the many trace elements, originate from rock formations. These are very slowly broken down by the process of "weathering" from water, temperature changes, and weak acids formed by the decomposition of organic matter originating from dead micro-organisms, vegetation and animals.

Nitrogen (N) is the only non-mineral nutrient. As an atmospheric gas it cannot be used directly by plants. However, certain soil bacteria can take N from the air for their cell structure and when they die this N becomes available for plant growth. Earthworms, springtails, centipedes and other organisms are part of this nitrogen cycle. Other species of bacteria living in symbiosis with leguminous plants (clovers, beans, peas, etc.) fix N from the air in nodules in their roots; this N is released when they decompose. This process is most active where N is lacking. When N fertilizer is applied nitrogen fixation slows down.

Organic Matter

Micro-organisms are the key to soil fertility; their essential function is to make organic matter, mineral soil particles and natural nutrients in the air, available to plants. They in turn need organic matter to sustain their life and multiply. As organic matter breaks down it must be replenished. Organic matter has other functions. It has the capacity to hold or bind by electric negative charge those nutrient elements that have a positive charge. In general the latter group consists of all the essential elements or compounds, including the ammonium form of nitrogen but not the nitrate form. This sounds complicated, but, in short it means that soluble nutrients leach out from the soil if there is little organic matter. Clay particles also have this binding power but to a lesser extent.

Organic matter improves soil structure giving better drainage and aeration of heavy soils and increasing the moisture-holding capacity of light sandy soils. In the soil, oxygen is needed for root growth and for beneficial soil organisms. A good soil structure allows plants to extend their root system to reach more moisture and nutrients.

Improving Soil

So far we have discussed soil conditions as we would like to see them in our fields or gardens. However, if the soil is low in organic matter and nutrients and has a poor structure, what can be done to improve it? Organic matter has to be supplied and giving compost is one way to do it. If home-made compost is insufficient there are other sources. Large quantities of compost are available from municipalities and garden centres. Peat moss is not recommended by some experts as its production may destroy wet lands essential for the environment, besides it is acidic and low in plant nutrients. When in need mushroom compost is a tempting alternative but most mushroom farms use pesticides which are not allowed by organic standards. Some mushrooms are grown organically.

If space allows, plant a green manure crop on one part of the garden one year and on another part of the garden the following year. Low-growing white clover is the best garden legume; it has an extensive root system and fixes atmospheric N in its roots. Sow as early in the spring as possible and add bone meal or rock phosphate and wood ashes, as clovers need calcium as well as P and K. For large areas red or sweet clover are better as they have more green mass. Seed can be inoculated with bacteria to improve nitrogen fixation.

Chemical Fertilizers

In dealing with soils low in nutrients, we must consider what the difference is between organic and synthetic chemical fertilizers. The latter are used to feed the plant directly; therefore the ingredients have to become available rapidly, which means that a spring application has to produce a satisfactory crop during that growing season. Except for phosphorous, any left-over nutrients will mostly have leached out by the following spring and in doing so may pollute the groundwater. Although certain bacteria are needed for the breakdown of some chemical fertilizers, the balanced activity of soil organisms in releasing nutrients from natural sources (as discussed earlier) is not needed in the chemical program. It has been reported that chemical fertilizers actually suppress microbial life in the soil.

Organic Fertilizers

Organic fertilizers, on the other hand, have low solubility; to release their nutrients and for further decomposition they depend on micro-organisms and weak acids from organic matter. They activate microbial life instead of suppressing it. Nutrients become available when needed and there is little or no leaching. This means that most organic fertilizers work more slowly, except blood meal and, to some extent bone meal. It is a matter of long-term fertility rather than creating instant fertility. This explains why it is good practice to mix these slow acting fertilizers in the compost pile to start bacteria working on them.

The bio-dynamic method stresses the importance of a natural balance of soil life; if disturbed by chemicals, other undesirable organisms may increase and fill the gap. It is claimed that this not only pertains to bacteria but also to other important soil organisms like fungi, nematodes, beetles, springtails and larvae.

Organic matter, although so important in the life of the soil, is not usually very rich in nutrients by itself unless organic fertilizers have been added, and beginners in particular may need these to

bring their soil to full fertility, which can then be maintained by compost and such organic amendments as are necessary.

Descriptions and Uses of Available Organic Fertilizers

Note: *Certified organic growers should check their certifying body guidelines before using organic fertilizers.*

- **Blood Meal** - works rather quickly and is an excellent source of nitrogen for the garden;
- **Bone Meal** - releases its phosphorous faster than rock phosphate. It is relatively expensive and more suited for garden use than for farm use;
- **Wood Ashes** - hardwood preferably for most soils. Can not be purchased. Keep dry before application to stop potash from leaching out;
- **Kelp** - is derived from seaweed and, in addition to being rich in potash, has several other beneficial properties. It promotes the release of locked-up minerals and it contains hormones which enhance growth and have been reported to increase resistance to insects, diseases and light frost. It also contains trace elements;
- **Liquid Fish Fertilizers** - are good for side dressing during the summer if plant growth is not satisfactory and for container-grown plants. Dilute according to the directions. They contain trace elements and work fairly fast;
- **Hard and Soft Rock Phosphates** - do not move or dissolve in the soil, hence they have to be worked in. The phosphorous becomes available after it has been acted upon by micro-organisms; therefore, combine it with compost, manure or green manure, especially clovers. Do not apply lime at the same time. If the soil is acid, soft rock phosphate is preferred. Excess phosphate does not harm the plants or leach out. It is stored in the soil until needed by plants in later years. Wear a dust mask or respirator for handling rock phosphate;
- **Granite Dust** and **Greensand** - are an excellent source of potash which becomes available slowly. **Greensand marl** has a high moisture-holding capacity and is rich in trace elements due to its origin in the sea. It is difficult to find a source of supply. Feed stores, garden centres, nurseries or even hardware stores may be able to get it for you;
- **Worm Castings** - boost the activity of soil life and improve structure;
- **Manure** - from livestock and poultry varies widely in N, P and K content depending on the kind of animal and its feed; also on the storage method, period of aging, moisture content and the amount of incorporated bedding (straw, etc.). If improperly handled, most of the ingredients may be lost by leaching and volatilization. Manure contains high amounts of bacteria and organic matter and activates soil life. Dried poultry and livestock manure (ideally from organic farms) is sold in bags with a guaranteed analysis of N, P and K and is much easier to handle than raw manure;
- **Compost** -made correctly by aerobic methods with good organic residues in sufficient quantity, with the right carbon/nitrogen (C/N) proportions is valuable. (See COG Reference Series #4/91 - Composting for Gardeners.) It will break down to an ideal C/N ratio with a high concentration of minerals. The effect of compost is cumulative and too much should not be expected from it at once;
- Various **commercial granular organic fertilizer** mixtures suitable for general use are on the market. They can be applied with applicator equipment, such as lawn spreaders.

N, P and K Values of Available Organic Fertilizers

Approximate Percentages

Name	N	P	K	Remarks
Blood meal	12-14	1.5	1	Works rather fast
Bone meal	1-2	21-30	0.2	High in calcium
Kelp	2	0.5	2-6	
Feather meal	12-15	-	-	
Fish plus bone meal	5-6	6-11	1	Some also contain kelp
Fish liquid fertilizer	5	1	1	Some also contain kelp
Hard rock phosphate	-	30	-	
Soft rock phosphate	-	20	-	Contains 25% calcium
Wood ashes (broadleaf)	-	1.5	10	High in calcium
Wood ashes (conifers)	-	-	2	High in calcium
Granite dust	-	-	3-6	
Greensand marl	-	1.5	5-7	
Basalt rock dust	-	-	2	
Worm castings	0.7	0.3	0.1	

How Much to Use?
It is impossible to give a direct answer to this question. Every soil is different and all species of plants are different in their requirements. There are, however, some guidelines. Each province has laboratories for carrying out soil tests and there are private agencies as well. Check with your provincial department of agriculture. Test results show the available NPK levels, the pH readings and sometimes organic matter content. The report recommends the amounts of chemical fertilizers to be applied depending of the crops to be grown. These recommendations are based on desired plant growth and disregard the organic concept of natural fertility becoming available. For poor and neglected soils, follow the indicated soil test rates in organic fertilizer equivalencies, from the above table. For healthy, living soils, the nutrient levels, whether low, medium or high, are only a guide.

Be careful not to give too much nitrogen as this may cause excessive leaf growth with poor fruit and root formation of such plants as carrots and tomatoes. Phosphorous can be given in reasonable amounts; any excess does no harm and is carried over for use in the following years. In contrast, surplus potash may leach out. Sowing cover crops, such as rye, in August will prevent this to some extent.

The pH should be above 6.5, if it is lower apply wood ashes. If the pH is above 7.2 the soil is alkaline. Gypsum or sulfur can be used with caution to lower the pH. Consult your department of agriculture for more information. If the pH is too high or too low, the desirable organisms become inactive and nutrients become less available. Soil test kits are available but are not very accurate. When starting on an unknown soil, a proper soil analysis should be carried out. In following years, this information and your own observation and experience should suffice.

Another guideline is the type of vegetable or other crops to be grown. Leafy vegetables such as lettuce, brassicas or cole crops need much N. The foliage is pale green when nitrogen is deficient. For seed, flowers and root growth, adequate phosphorous is required. Root crops such as potatoes and carrots like to have plenty of potash. Brassicas, corn, potatoes and leeks are heavy feeders; give them a side dressing of diluted fish fertilizer or a home-made "tea" made of compost or manure (steep for 8-10 days in plenty of water). Stinging nettles (N) or comfrey (K) are excellent for this purpose.

Hard rock phosphate can be applied at the rate of 4.5 kg (10 lbs) per 10 sq. m. (100 sq. ft.). Soft rock phosphate can be used at 7 kg (15 lbs) on the same area. One application at these rates will be sufficient phosphorous for up to 5 years. Wood ashes are used at 2 to 4.5 kg per 10 sq. m. (5 to 10 lbs per 100 sq ft). If freshly applied on the soil surface, keep them 2 - 4 cm (1-2 inches) away from germinating seeds and young transplants.

So far this paper has mainly been about soil conditions and improvements in the garden. The principles are, of course, the same for organic farms. However, the choice of fertilizers and methods is somewhat different. Rock phosphates are more practical than bone meal for phosphorous; bloodmeal is not economical. Good crop rotations (alfalfa, red and sweet clover) and animal manure supply nitrogen and organic matter. Crop rotation is an important aspect of both organic farming and gardening. Different plants make different demands on plant food ingredients, so it makes no sense to keep on depleting one nutrient more than others year after year. Also deep rooting plants take up nutrients from lower subsoil levels and bring them to the upper layer by growth and decay which benefits shallow-rooting plants in the next rotation.

Lawns

The usual recommendations call for heavy applications of nitrogen and regular watering. By reducing both, the grasses are encouraged to root much deeper in search of food and moisture; hence such a lawn is less susceptible to drought. Also the natural nitrogen supply by micro-organisms can function. For easier maintenance, consider seeding a mixture of grasses and white clover which requires no nitrogen application and less watering. Seeding clover in an existing lawn may be difficult as germination is often unsatisfactory. It can be tried after raking out the thatch and spreading a thin layer of compost or topsoil

Conclusion

Soil fertility is influenced by so many factors that it is impossible to give simple rules for its improvement. Be prepared to do some experimenting, make observations and keep records.

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Additional Sources of Information:

Bio-Dynamic Gardening. *John Soper*. Revised and enlarged by Barbara Saunders-Davies. U.K. 1996. 210 pp.
Explains the principles and use of special preparations that enhance soil fertility, cosmic influences, companion planting, green manuring and composting.

Building Soils for Better Crops. *Fred Magdoff and Harold van Es.* Sustainable Agriculture Network, Burlington, VT. 2000. 240 pp.
Directed at farmers, gardeners, students and agriculture professionals. This book presents soil concepts in an easy-to-read manner and discusses topics such as soil tilth, nutrient management, using animal manures, making and using compost and cover crops.

Fertile Soil. A Grower's Guide to Organic and Inorganic Fertilizers. *Robet Parnes*. Fertile Ground Books, Davis, CA. 1990. 240 pp.
Discusses the basics of soil fertility, how to determine nutrient requirements, compost and organic fertilizer sources and has a radical emphasis on carbon.

The Soul of the Soil. A soil-building guide for master gardeners and farmers. *Joe Smillie and Grace Gershuny*. Revised 4th edition. Chelsea Green Publishing, White River Junction, VT. 1999. 173 pp.
A easy-to-read handbook on the creation and care of soil, including information on composting, organic matter management, nutrient balances, soil testing and weed control.

Sustainable Soil Management. *Preston Sullivan*. Available from Appropriate Technology Transfer for Rural Areas (ATTRA). Fayetteville, AR. http://www.attra.org/
Covers the components of the living soil, soil organisms, organic matter, fertilizers and soil quality along with ways to asses soil health and build soil.

The Sustainable Vegetable Garden. A backyard guide to healthy soils and higher yields. *Jon Jeavons and Carol Cox*. Tenspeed Press. 1999. 118 pp.
Written for gardeners trying bio intensive gardening for the first time with a focus on soil and ensuring sustainable soil fertility.

Tips for Buying Garden Compost. *Bob Richards and David Jennings*. In Cognition Fall, 1996. pp. 7-8. Information to help gardeners shop for top quality commercial compost.

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