Organic Matter in Horticulture – A Report from Scientific Meetings

Mario Lanthier
CropHealth Advising & Research, Kelowna, British Columbia, V1W 4A6
Email: office@crophealth.com

Scientists working in their respective disciplines will meet on a regular basis to exchange notes, report on current projects and raise questions for future research. These meetings, although technical in nature, are open for all to attend. It is a good place to catch up on the latest thinking from the people most involved on any given topic.

This presentation covers three scientific meetings attended by our company in the past two years. All events were sponsored by the International Society of Horticulture (ISHS, website www.ishs.org). By coincidence, the common thread was soils and management of organic matter. For this report, an emphasis is placed on information most useful for practical use in horticulture, especially nursery production of trees and shrubs and greenhouse production of vegetables.

2nd INTERNATIONAL SYMPOSIUM OF ORGANIC MATTER MANAGEMENT AND COMPOST USE

This event was held in October 2013 in Santiago, Chile. Attendance was 120 persons from 18 different countries, the largest contingent being from the host country. The 4-day symposium included 12 keynote presentations, 58 technical talks, 12 posters, a small trade show and a full day of visits to organic farms using compost.

Composting is the biological decomposition of organic substances under controlled conditions. The large molecules are broken down into simple molecules that can be utilized for plant growth. The finished product is a biologically stable, humus-like product that is rich in microbial flora.

How Much Compost To Use?

For short term research projects, scientists apply compost at 20 to 50 dry metric tons per hectare of soil (10 to 25 short tons per acre), incorporated 20-cm deep in the soil profile. On sites where compost is applied repeatedly over many years, application rate of 5 to 10 dry metric tons per hectare (Mg/ha) are sufficient. “Dry” refers to moisture content below 40% by volume.

If used on a volume basis, plant residue compost can be applied 2.5 to 5.0 cm-deep, equivalent to 250 to 510 cubic meters per hectare (or, a 1 to 2-inch layer is equivalent to 135 to 270 cubic yards per acre or 3 to 6 cubic yards per 1000 square feet). Lower rates (170 m^3/ha) are used where soil quality is good, and higher rates (up to 750 m^3/ha) on soils with a high content in sand or clay.

Compost made from animal manure should be applied at lower rates as soluble salts (EC) may exceed 1.25 dS/m and be injurious when placed in direct contact with plant roots.

Of note, the US Compost Council suggest aiming for 5% organic matter in the soil to derive most of the benefits (see http://compostingcouncil.org/strive-for-5/).

Quality Standards for Compost Products

A laboratory program was established in 1998 at Colorado State University to evaluate the precision in laboratory methods for testing of compost. Three times every year, participating laboratories are sent compost materials for testing. Results are compiled and accuracy determined as 95% confidence limit of the median for all lab results.

The "Compost Analysis Program" (CAP) is under the umbrella of the US Composting Council (see http://compostingcouncil.org/compost-analysis-proficiency-program/).

Results indicate the best inter-lab proficiency (measures most reliable) are:
- For inorganic methods: dry matter, total organic carbon, phosphorus, potassium and zinc;
- For biological methods: seed germination, seedling vigor, respirometry.

Results indicate the worst inter-lab proficiency (measures least reliable) are:
- For inorganic methods: EC (an excellent test but variable from lab to lab), NO_3 and NH_4;
- For biological method: pathogens (an excellent test but no standard to measure amounts).

Carbon to nitrogen ratio (C:N) is a useful measure of finished compost quality, but there is variation across laboratories, thus a result of 15 could mean anywhere from 12 to 20.

Using Soil Microbes for Decontamination of Soil with Hydrocarbons

Near the City of Mexico, a refinery complex was closed in 1988 after 70 years of operation. Pemex, the largest oil company in the country, was responsible for decontamination of petroleum residues in the soil.

One method of soil remediation was the use of *Pseudomonas putida,* a bacteria with the ability to degrade organic solvents. The bacteria produces natural surfactants which increase the solubility of the pollutants and allow their desorption from the soil. Coffee grains were used as bulking agents as this *Pseudomonas* species can live on pure caffeine and break it into inert components.

Compared to untreated soils, the use of *P. putida* removed 41% of the petroleum hydrocarbons when used alone and up to 61% when used in combination with nitrogen and phosphorus nutrients.

The 55-hectare site was opened in 2010 as the Bicentenario Park. A technical paper is found at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3833165/pdf/bjm-44-595.pdf.

Food Safety and Organic Amendments

Waste products from animals or humans may contain pathogens with a potential to cause human illness such as *E. coli* and *Salmonella*. These waste products include animal manure, biosolids, leftovers from meat and fish processing, etc.

Studies indicate high variations in the risk of infection. At one farm, some animals are more susceptible to infection and may shed more pathogens in their waste. Also, virulence varies within a pathogen population. Thus, a problem at one farm may not be a problem under similar conditions at another farm.

Methods to minimize the risks of human pathogens in organic waste:
- Strict sanitation at the farm, for example discarding animals identified with infection;
- Compost the materials with hot temperatures, then store 50 to 60 days before using;
- Test the waste products using a large sample size to find spot infection locations.

More information available at http://www.ugacfs.org/faculty/erickson.html.

2nd INTERNATIONAL SYMPOSIUM ON ORGANIC GREENHOUSE HORTICULTURE

The event was held in October 2013 in Avignon, France. About 120 persons attended, including 6 from Canada.

Soil management is important in organic production. Soiless media, the standard growing medium in conventional greenhouses, is not accepted by many organic certifying agencies. Organic greenhouse production has to be “in natural soil”.

Soil Fertility Management in Organic Greenhouse Crops

Organic farming is about “Feeding the soil not the plant”. The goal is to reach equilibrium between the soil capacity and other production factors. Thus, the goal is not to maximize the yields, but higher yields are necessary to recoup the financial investment.

Organic growers need to improve plant fertilization. Incorporation of excess compost at planting is inappropriate as it may result in high salts (EC) near plant roots. Top dressing after planting is effective if the material is mineralizing rapidly, but may lead to leaching of nutrients in the soil profile.

The answer may be to fine tune the nutrient supply-and-demand via irrigation scheduling. The grower can use liquid fertilization (compost applied as a liquid after planting) or fertigation (application of fertilizers via the irrigation system).

Composts to Improve Soil Fertility and Plant Health

Soil steaming is a fumigation method used in organic production to clean the soil of pathogens. Steaming creates a void in soil biology that may lead to a rapid recolonization by plant pathogens. The problem can be prevented by using compost immediately after steaming, which will recolonize the soil with the beneficial microbes found in the compost.

However, not all composts are created equal. Some composts immobilize nitrogen while others release nitrogen. Composts can also differ in their salt content and some have high pH, leading to iron deficiency in the plant tissue.

Managing Root-knot Nematodes in Organic Greenhouses

In Southern France, 40% of farms are damaged by root-knot nematodes (*Meloidogyne* spp). Plants most affected are salad winter crops, cucurbits and spring solonaceous crops. Usual methods to decrease nematode numbers include soil sterilization or steaming, green manure, selection of resistant cultivars or use of non-host crops.

In controlled trials, solarization + green manure (sorghum-Sudangrass) lowered the number of root-knot nematodes, but the soil was recolonized by nematodes surviving in deeper soil depths, or in untreated borders, or multiplying after sowing a sensitive crop.

Influences of Vermicompost as Growth Medium for Seedlings

Vermicompost is a by-product of specialized worms digesting plant and food residue. It can be used as an alternative growing media in seedling production as it increases water-holding and is rich in NPK compared to peat or field soil.

Trials done in Turkey in organic greenhouse cucumber production found the highest yields and longest plant lengths in growing media made of 40% vermicompost + 60% peat moss, with second best in a mixture 20% + 80%, compared to the control of 100% peat moss.

1st WORLD CONGRESS ON THE USE OF BIOSTIMULANTS IN AGRICULTURE

The event was held in November 2012 in Strasbourg, France. It was attended by 705 persons from 50 countries, a large audience that reflects the growing importance of this topic for academics, growers, manufacturers and fund investors (looking for upstart companies).

The word "biostimulant" is relatively new. It is meant as a classification for products that regulate and enhance plant physiological processes.

- Biostimulants are not fertilizers but they improve plant nutrition.
- They are not pesticides but they protect from disease infection.
- They are not growth regulators but they stimulate plant growth.

Research on biostimulants is fairly new and the science is not fully developed. Under controlled conditions, the impact is most obvious when the plant is under stress, but it is unclear the products are useful under optimized growing conditions.

What Are Biostimulants?

The products are usually derived from natural sources such as seaweed extracts, humic acid, amino acids, plant extracts, soil microorganisms, silicates, trace elements or manure fermentation. They are complex molecules that may contain plant hormones, leading to multiple and synergestic effects. They are applied in small quantities to influence plant respiration, photosynthesis, nucleic acid synthesis and nutrient ion uptake.

A report was prepared in 2012 looking at 250 publications in peer-reviewed scientific journals. The author concluded: "Biostimulants are defined more by what they do than by what they are, since the category includes a diversity of substances. They stimulate growth, but they do much more. Stress tolerance is perhaps the most important benefit". See http://ec.europa.eu/enterprise/sectors/chemicals/files/fertilizers/final_report_bio_2012_en.pdf

The Science of Biostimulants

Generally, plants recognize a pathogen attack with a genetic response that leads to production of proteins to increase cell wall thickness, act as antibiotics or physically isolate the pathogen. Commercial products of biostimulants try to mimic one of these pathways.

The effects from biostimulants may not be seen until 4 to 6 weeks after application. There is a drawback: if the plant defense system is activated in absence of stress, too much resources may go to production of defence proteins at the expense of food production.

Biostimulants can be effective in the lab but not in the field. This is because of genetic variability in the host plant, the pathogen adapting rapidly to a modified host, or different environmental conditions. For a grower to adopt a commercial product, it is important the supporting research be based on field experiments.

Seaweed Extracts As Biostimulants

Dr. B. Prithiviraj is based at Dalhousie University in Nova Scotia. He is recognized as "the most reputable researcher on the topic" in the world. His work was done with the brown seaweed *Ascophyllum nodosum*. Results published in scientific journals indicate that:

- Seaweed improved growth and vigour of barley seedlings;
- Seaweed induced tolerance to frost stress and salinity stress in the plant Arabidopsis;
- Seaweed protected against oxidative and thermal stress in spinach.