

5-1.4

### Interpreting results from plant growth promotion and disease suppression bioassays using compost

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Applying high rates of humified, thermophilic compost to a soil depleted in organic carbon has the potential to not only improve soil structure and fertility, but also to suppress soilborne disease. Vermicomposting also transforms manure into humified organic matter, with the compost tea (leachate) reputed to promote plant growth and to suppress root disease. In this paper, published bioassay methods were used to assess the disease-suppressing properties of cured, thermophilic cotton trash compost, and the plant growth promoting properties of tea produced from a pig manure vermicompost. The chemical properties of both composts were analysed, to provide data on other soil health parameters likely to affect the outcome of field trials.

A cotton soil infested with fusarium wilt was used to indicate the potential of the thermophilic compost to suppress root disease. Soil: compost mixtures 4:1 v/v were prepared, with recycled rubber fines added at the same volumetric ratio to the soil as the control. The available phosphorus content of each mixture was standardised by substituting in part the inorganic P fertiliser applied to each treatment with the plant-available P content of the compost. An inorganic N, K and trace element salt mix was added to each treatment. Seed of a wilt-susceptible cotton variety was sown and capillary-watered for 6 weeks. Seedling emergence counts were recorded weekly, and at the end of the trial seedlings were rated for the severity of fusarium wilt symptoms.

Tiger worms (*Eisenia foetida*) were used to compost farrowing sow pig manure in 0.1 m<sup>3</sup> compartments aerated from below. On a weekly basis, 2.3 kg of pig manure and 1 L of water was added to both the worm treatment and the no-worm control for 19 weeks. For the last two weeks, each treatment was watered but no manure was added. A 1:5 v/v vermicompost: water slurry was prepared with 3mL of filtered leachate added to petri dishes to which seeds of radish and sorghum were added. The rate of germination was assessed daily, and root length was recorded after 3 days.

Results for both bioassays were not as expected. Cotton seedling survival in the compost treatments was only marginally better than the control, with all seedlings showing disease symptoms. In the vermicompost tea, seed germination was highest in the water-only controls. Both the vermicompost and no-worm leachate reduced the root length of the seedlings, with the larger-seeded sorghum seedlings less sensitive. The common factor responsible for the unexpected results was excessive plant-available potassium. The concentration of bicarbonate-extractable K in the cotton compost was 10.9 g/kg, and in the vermicompost and no-worm control 13.0 and 12.2 g/kg respectively, orders of magnitude greater than the potassium replacement requirements of a 2 and 3 t/ha cotton and sorghum crop (40.5 and 14.4 kg/ha respectively). To realize the soil health properties associated with the humified organic carbon present in both composts, soil application rates must account for the high levels of potassium present in the products.

5-2.1

### Ten year of organic fertilizations in peach: Effect on soil fertility, nutritional status and fruit quality

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Soil organic matter has a fundamental role in sustaining long term fertility and plant productivity. The use of municipal solid waste (MSW) could be a good source of nutrient that, beside increasing the concentration of organic matter in the soil, allows recycling of urban organic wastes. The objectives of this experiment were to evaluate, the long term (10 years) effect of organic fertilization on soil fertility, tree performance and fruit quality in a commercial orchard of nectarine (*Prunus persica* var. *nectarine*, Stark RedGold grafted on GF677 peach x almond hybrid, *P. amygdalus* L.). The experiment was carried out in an experimental farm located near Ravenna, Italy (44°27' N, 12°13' E) where, since planting trees were subjected, according to a complete randomized block design to the following treatments: 1. unfertilized control, 2. mineral fertilization including P (100 kg ha<sup>-1</sup>) and K (200 kg ha<sup>-1</sup>) applied at planting and N (70 kg ha<sup>-1</sup> for the first three years and then 120-140 kg ha<sup>-1</sup>) split in two applications at 40 days after full bloom (60%) and in September (40%) and repeated yearly; 3. cow manure supplied at planting (10 t dw ha<sup>-1</sup>) and then, from the 4<sup>th</sup> year at the rate of 5 t dw ha<sup>-1</sup> per year in spring; 4. compost supplied at planting (10 t dw ha<sup>-1</sup>) and then, from the 4<sup>th</sup> year at the rate of 5 t dw ha<sup>-1</sup> per year in spring; 5. compost supplied at a rate of 5 t dw ha<sup>-1</sup> year<sup>-1</sup>, and 10 t dw ha<sup>-1</sup> year<sup>-1</sup>(6), both split as described for treatment 2. Compost, obtained from domestic organic wastes (50%) mixed with pruning material from urban ornamental trees (50%) after a 3-month stabilization, presented a N concentration between 1.9 and 2.4% (dw), while cow manure N was between 0.6 and 1.6 % (dw). Nitrate and ammonium-N concentrations, soil moisture and microbial biomass C were measured 4 times per year. Leaf and fruit mineral concentrations were evaluated in summer, the yield and fruit quality was recorded from the first bearing year (2004). In 2010, nitrate-N soil concentration was increased by the application of compost and mineral fertilizer but was always lower than 20 mg kg<sup>-1</sup>. Ammonium-N soil concentration was increased by the application of compost at the highest rate only at the beginning of the season, when soil moisture, due to heavy rains, was near field capacity (20%). Microbial C was increased by application of MSW compost, but not by cow manure. Tree yield was not affected by treatments; however fruit size was increased by mineral and high rate compost fertilizations. Chlorophyll leaf concentration, determined by SPAD, was increased by the application of compost at the highest rate and mineral fertilizer. Fruits from fertilized plots ripen later than those of control plants as indicated by precocity index and fruit acidity. These results indicate that the yearly application of compost at 10 t ha<sup>-1</sup> is a valuable alternative to mineral fertilizers in nutrition management of peach orchard in Italy.

2-1.2

### Compost application to replace Sphagnum peat and to suppress *Pythium* root rot in turf

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The natural soils of the coastal plains in the southern Arabian region are dominated by saline sands. The organic carbon content of these alkaline sands is 0.54%, equivalent to an organic matter content of 0.9%. The recommended organic matter content for turf and ornamental plant establishment in sand is 8.0%. In the Municipality of Doha in Qatar, the application of sphagnum peat and animal manure or plant-based compost at rates of 200 m<sup>3</sup>/ha/yr and 150 t/ha/yr are specified for turf production. Application of the selective fungicide Ridomil is also specified to control *Pythium* root rot. In this trial, a cured, agronomically defined compost was applied as the sole soil conditioner, at a rate calculated to replace all fertilizer phosphorus required during the establishment period for growing Bermuda grass. The rate of application of fertilizer potassium and nitrogen was also adjusted.

The compost was produced from sugar milling byproducts in Queensland (Qld), Australia. The soil conditioning properties of the compost include a water-holding capacity of 72%, a nutrient-holding capacity of 53 mEq/100g (cation exchange capacity), and an organic carbon content of 137 g/L. As a cured compost, the loss on ignition is low (24%), indicating that this compost should have a half-life of years in the soil under Middle Eastern climatic conditions. The trial consisted of the standard Doha Municipal specification, the partial replacement of peat with the Qld compost, the total replacement of peat with one annual application of Qld compost, and the total replacement of peat with one split application of compost to be repeated twice over the establishment period. The turf was irrigated daily and grown for 9 weeks prior to the first cut. The clippings were collected and weighed, the area of yellowed, disease patches in each quadrant was estimated, and the water infiltration rate was recorded as an index of rooting intensity.

The results indicate that the Qld compost successfully replaced the combination of peat and the local compost as an organic soil conditioner for the establishment of turf. At half the volume, the water and nutrient-holding properties conferred to the soil by the Qld compost were equivalent to the full 200 m<sup>3</sup>/ha application of light peat. In combination with the adjusted fertilizer regime, the application of the Qld compost also reduced the severity of *Pythium* root rot by 50%.

Many other field trials have been conducted applying compost with the goal of suppressing root disease. However, results are often inconsistent, and at worst, disease severity is increased. The results of this trial prove that the soil conditioning properties of a cured compost can be objectively quantified, enabling the calculation of application rates to replace the use of peat and inorganic soil conditioners. However, if the fertilizer contribution of the compost is not accounted for in the fertiliser management schedule, the desired outcome of reducing disease severity may not be realised.

2-1.3

### Designer compost: Facts or fantasy? A case study on compost rich in lignin and low in phosphorus

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Soils in Northern Belgium under agricultural use are low in organic carbon. Application of compost as a source of stabilized organic matter is one strategy for increasing the organic carbon content. Compost for this purpose can be prepared at the farm level, giving the farmer the opportunity to recycle organic wastes. To meet environmental standards on nutrient leaching, especially the total P content of the composts limits the application rate. A functional compost with high lignin content and low P concentration would be a valuable tool for maintaining soil fertility.

We aimed to determine the effect of feedstock composition on P and lignin content in compost when small-scale on-farm composting was applied. The research is based on three compost experiments with 3 treatments each. Besides general characteristics, lignin and ergosterol content and total and plant-available P and N concentrations were measured in the composts during the process. A 12 week incubation experiment was set up to measure N mineralization and P release by each of the composts when mixed to the soil.

In general, compost characteristics varied due to differences in feedstock and composting process characteristics. The leachable P fraction strongly decreased during composting. Although different crop residues were tested as feedstock, total P content in the composts only varied by a factor 3. Ash content of the compost, an indicator of soil particle load, had a strong effect on P availability and lignin content. However, the lignin content for the organic part of the compost was relatively constant for different compost types. The incubation experiments indicated different effects of the compost type on N and P release when applied to the soil. The effect on P availability in soil was strongly related to changes in soil pH after compost addition. High ergosterol contents, indicating high fungal biomass, were measured in composts with slowly decaying organic matter.

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