Compost and Compost Tea in Organic Greenhouse Horticulture Using the Soil Foodweb Approach©

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INTRODUCTION

Vzw Lochting-Dedrie is a nonprofit organization that offers employment to people who, for a wide variety of reasons, aren't able to be part of the regular work force. On average, we have about eight people working in the organic growing section lead by two instructors. The organization is supported by national and local government in the form of wage subsidies and the use of land; 30% of the income is in the form of wage subsidies but 70% has to be earned selling what is grown.

The organisation has a 1-ha greenhouse and 25 ha of outdoor land, which is used to grow leeks. The greenhouse activities are almost exclusively carried out by our own work force. Work on the fields, apart from harvest, is outsourced.

Since 2005, our aim is to base the entire fertility management on the soil foodweb approach as developed by Elaine Ingham. She is the founder and director of the Soil Foodweb Institute, Corvallis, Oregon, U.S.A.

SOIL FOODWEB APPROACH

The basic concept is that in order to grow healthy and productive crops, the complete foodweb has to present in the soil. The lowest members of the web are bacteria and fungi. The beneficial bacteria and fungi that live in the root zone use plant exudates to grow. The nutrients that these organisms "store" are released when there are appropriate numbers of higher organisms (protozoa, nematodes, and microarthropods) to start a nutrient cycle. If there are, for instance, too few protozoa this acts as a bottleneck for the nutrient cycle, and it will result in plants not growing well. A grower following foodweb principles would then try to increase the number of protozoa.

Soil Chemistry Analysis. Soil foodweb management starts with the determination of several different functional groups of organisms in the soil and their activity or diversity. An example of such analysis is shown in Table 1. In addition, a soil chemistry analysis is required to determine the total, exchangeable and soluble pool of nutrients. This type of analysis shows whether an element is really too low for good growth or whether the element is present in adequate amounts but probably doesn't become available to the crop because the organisms required to transfer it to the soluble pool are not present.

In this example, all the records apart from amoebae numbers were below that required for a healthy soil.

Compost. Good compost adds both organisms, and food for those organisms, to the soil. In order to know what contribution to the functional groups the compost presents, an analysis analogous to the soil analysis should be made. Compost also raises the level of organic matter in the soil. In Belgium, it is hard to find good compost, so growers following this approach would need to undertake their own composting.

Table 1. Soil foodweb analysis.

Dry weight of 1 g fresh material	0.81
Total nematode numbers (number/g)	3.24
Active bacterial biomass (μg·g-1)	42.6
Percent mycorrhizal colonization of root	7
Total bacterial biomass (μg·g-1)	340
Total fungal to total bacterial biomass	1.13
Active fungal biomass (μg·g-1)	27.7
Active to total fungal biomass	0.07
Total fungal biomass (μg·g-1)	386
Active to total bacterial biomass	0.13
Hyphal diameter (μm)	2.5
Active fungal to active bacterial biomass	0.65
Flagellates (numbers/g)	17148
Plant available n supply from predators (lbs/acre)	100–150
Amoebae (numbers/g)	7118
Root-feeding nematode presence	Cyst, root-knot
Ciliates (numbers/g)	72

Compost Tea. The use of compost tea is another way of adding organisms and food to the soil (or to the crop's leaves). Compost tea is made by blowing air into a mixture of a relatively small amount of compost, plus appropriate foods for the compost organisms, in a tank full of water. Compost tea can be used when it is difficult to apply compost, for example when the crop is planted or when the fields are very large so the amounts of compost become impractical to apply. The time of the brewing process depends on the type of compost brewer and the recipe for brewing. A microscope is needed to assess whether the compost tea contains organisms suitable for your needs.

Composting at Vzw Lochting-Dedrie.
We produce about 1000 m^3 of finished thermal compost per year. For our feedstock, we recycle all the organic waste products that we generate ourselves: spent aubergine, tomato, and cucumber plants, weeds, and leek leaves. Because these materials become available gradually, the initial compost piles are built in layers. The bottom layer is always a 10 cm straw layer. Then, layers of green and brown material are added over time. Brown material is either straw or wood chips. We aim for a mixture of 40% green and 60% brown material. Once the piles are large enough they are turned by machine, which is rented as necessary.

Piles are turned based on temperature, CO_2, and moisture measurements. Turning is needed when temperatures get too high (65 °C or more), when oxygen is too low (4% or less), and when the material gets too dry (less than 50% moisture). The number of times the pile has to be turned depends largely on the initial composition of the pile. Too much green material generates a lot of heat, so turning may be needed more than once per day. For a well-designed pile, turning once per day in the first week is usually enough. After that, a few turns may still be needed, some with the addition of water.

The cost for making compost, including the purchase of some raw materials, time spent measuring and turning the pile, and rent of the equipment, is about €25 per m^3 finished product. This cost is often prohibitive for farmers. The volume reduction in composting for a well-designed pile is in the best case 66%. The more green material added, the more the volume decreases in the process. Too much green material also reduces nutrient availability for the compost microorganisms.

RESULTS FROM USING COMPOST ON CROPS IN 2006

Aubergine (*Solanum melongena*). The crop was planted 5 May at a density of 1.1 plants m^{-2}. Most were planted in holes filled with compost. The holes were about 20 cm in each dimension. Some plants were planted in plain soil. No obvious differences were seen in plant growth between the two methods.

Plants were grafted on resistant rootstocks as a protection against root disease and nematodes. Aphids were controlled by natural introductions of ladybirds, and predators and parasites against other insect pests were purchased. There were almost no white flies. Spider mites grew fast after mid-August. Thrips were controlled by predator mites, although as we came to the end of the season, we saw more fruits with thrips damage.

About 5% of the plants were killed by wilt, which is common for aubergine whether conventionally or organically grown. In part of the greenhouse, there was stunted growth caused by cyst and root-knot nematodes.

Figure 1 shows the direct cost distribution for the 2006 aubergine crop. The plants and planting costs account for more than half the total costs. The plants are expensive at €2.2 each because they are grafted.

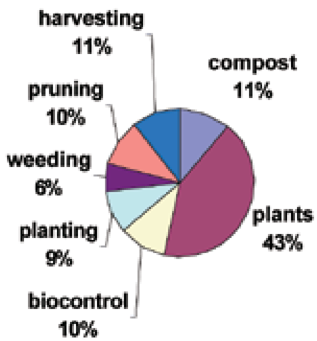

Figure 1. Cost distribution for aubergine.

We started harvesting 5 weeks after planting and by the end of August had achieved 4.5 kg per plant, which is considered excellent by normal commercial standards in Belgium. The progress of the harvest is shown in Figure 2. Gross profit is €11.5 m^{-2} over a period of 5 months.

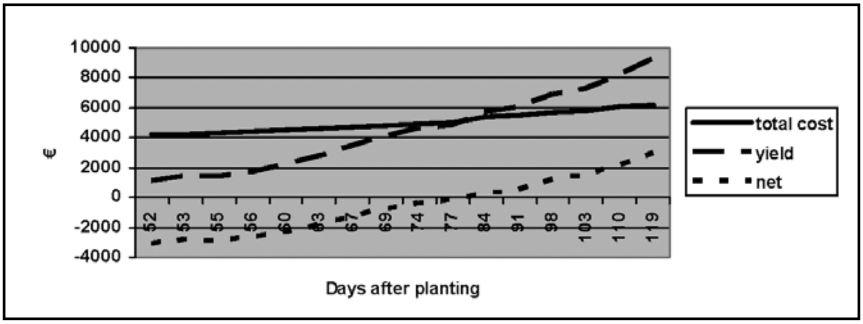

Figure 2. Progress of harvest for aubergine.

Tomato (*Lycopersicon esculentum*). The crop was planted at the same time and density as the aubergines. Compost was applied at 100 m^3 per ha into the holes. Some plants were planted without compost but again no noticeable difference was seen in plant growth.

Plants were grafted as a protection against root disease and nematodes. Leaf miner was present but was controlled by introduced parasites. Powdery mildew was controlled using sulphur pots.

Figure 3 shows the direct cost distribution for the 2006 tomato crop. We expect to harvest the last tomatoes by mid-September [i.e., 2 weeks after this presentation, ed.]. As with the aubergines, half of the direct costs are related to planting. Again, the plants are expensive (€2.2 per plant) because they are grafted.

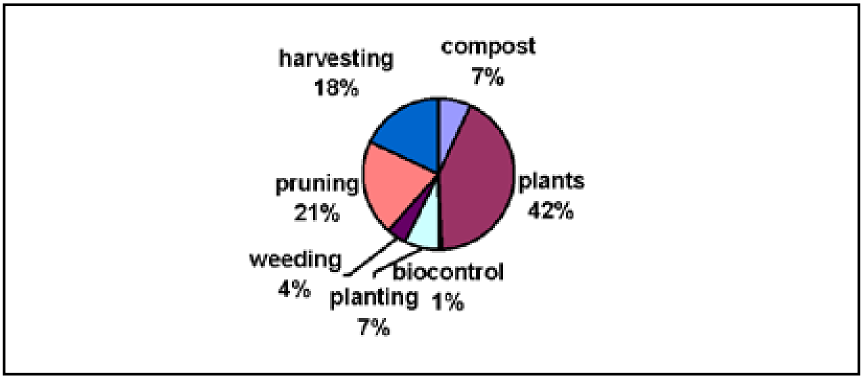

Figure 3. Cost distribution for tomato.

We started harvesting 9 weeks after planting and by the end of August had achieved 7.8 kg per plant. We do not expect to reach 10 kg per plant, which is what can be reasonably expected commercially. According to our tomato consultant this is probably due to a slight lack of nitrogen in the early stages of the crop. The progress of the harvest is shown in Figure 4. Gross profit is €9.4 m^{-2} for a period of 5 months.

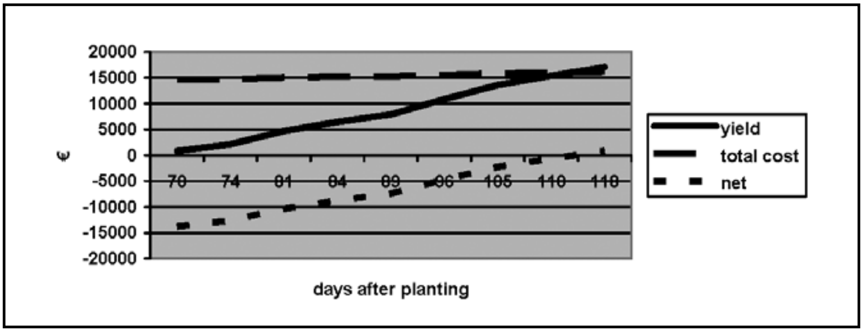

Figure 4. Evolution of harvest for tomato.

Bell Pepper (*Capsicum annuum*). The crop was planted on 27 April at 6.4 stems m^{-2} in the same size planting holes as the aubergines. Most plants were planted in holes filled with compost, the remainder in plain soil. Again no noticeable difference was seen in plant growth.

The plants are not grafted. There were no insect pests or disease problems recorded up to the end of August. The direct cost distribution is shown in Figure 5 to the end of August, when the season still has 2 months to go.

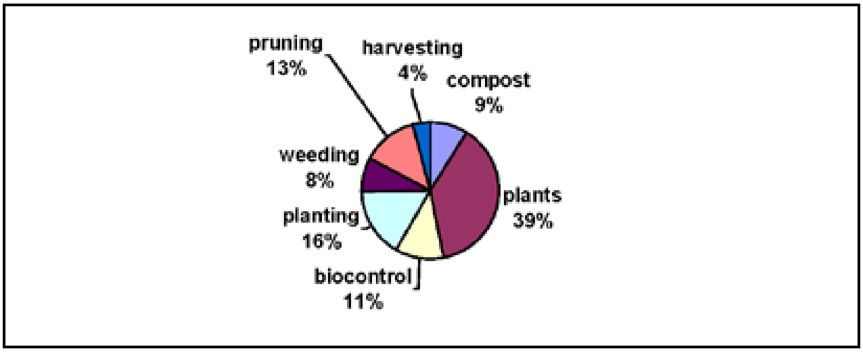

Figure 5. Cost distribution for bell pepper.

This crop did not grow well. The planting soil was too cold for this type of plant, so growth was slow and the leaves and stems pale. Later in the season, two heat waves caused greenhouse temperatures to reach 40°C in the afternoon, too high for bell pepper. As a consequence we have only harvested 1.3 kg m^{-2}. We hope we can add 1 kg in the last 2 months but at least 3.5 kg m^{-2} should be obtained for the crop to be profitable.

Acknowledgements. City of Roeselare for their support of vzw Lochting-Dedrie. Soil Foodweb Institute, www.soilfoodweb.com, for supporting us through a 2-year consulting program.