Optimization of growing media for organic greenhouse production

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Background

In greenhouse vegetable production large amounts of nutrients are needed. It can be difficult to control the fertilisation, such that excess of nutrients are avoided, and in conventional as well as organic productions this can lead to nutrient losses due to leaching or gaseous emissions. To improve organic greenhouse production it is important to optimize the nutrient supply. As nutrients for organic plant production can be limited it is the aim to compose compost based on readily available plant residues, which can be used as growing medium as well as fertilizer. This compost must supply the plants with a sufficient and balanced nutritional input without loosing large amounts of nutrients under or after the composting period. As the compost is mixed in the soil or used alone as a growing media the structure and stability are also important. Especially when using compost in closed containers as in potted plant production the structure is important as the plants are growing in a limited volume. The availability of water, air and nutrients are therefore determined by this growing medium.
A suitable growing medium for organic production could be produced by composting readily available plant residues focusing both on nutritional quality and physical structure.

Objective

The objectives are:

1) To examine the nitrogen transformation – mineralisation, immobilisation and losses in different types of compost.
2) To extend the knowledge of changes in plant material structure during composting.
3) To produce stable compost which in combination with amendments of plant residues can be a suitable growing media and fertilizer for organic greenhouse production.

Progress - 2003

Focus has primarily been on how to control the quality of a compost by choice and combination of materials to be composted, and by management of the composting process. In order to obtain a compost which can supply the plants with the nutrients they need, an important part of the focus has been on how compost quality is affected by the timing of addition of the different materials. By postponing the addition of most of the nutrient rich material, it is the hypothesis that composting can take place with less decomposition of the structural material (straw) and less immobilisation of the nutrients from the nutrient rich material (clover grass hay) than if all the structural and nutrient rich materials are mixed together from the beginning.

In the fall 2001 a large scale composting experiment was set up to investigate this hypothesis. In contrast to an initial small-scale experiment, no significant effect was found on the CO2 release from the different treatments determined as weight loss. On the other hand, the postponing affected the availability of mineralised N after composting significantly. After 7½ weeks of composting twice as much nitrate was available in the treatment where addition of 75% of the clover grass was postponed until later during the composting process.

Finding that postponing addition of nutrient rich material has such an extended effect on mineralisation has brought interesting new insight on influencing compost processes. Instead of just changing the composition of plant material we have found another simple way to affect the compost processes using the same amount and type of material.

The compost was tested as a growing media in a small-scale growth experiment using lettuce (Lollo bionda) as test plant. The compost was suitable as a growing media, but the level of mineralised nitrogen was too high initially in the treatments with postponed N addition, which led to delayed root growth.

Due to these results a new composting experiment was set up, still following the same hypothesis, but with a higher initial C/N ratio. The results from this experiment showed that this time the initial nitrogen level was too low, thus no net mineralisation was observed. With low levels of nitrogen and additionally high amounts of chloride the plants grew poorly in a growth experiment with potted cucumber.

Samples of compost was also placed in leaching tubes, where the release of nutrients and the weight loss was followed during half a year after the end of the composting process, to enlighten whether the different treatments of the compost affects not only its quality at the end of the composting, but also its nutrient release and stability during the subsequent period where it will be used as a growing medium for plants. Results showed that postponing the addition of some of the nutrient rich material did not significantly affect the compost stability. Nutrient release results are still lacking.

Experience from the growth experiments with lettuce and cucumber showed that compost based solely on wheat straw and clover grass hay had some structural problems. Water retention capacity and stability of the medium was not satisfactory. This could also be a problem if the crops were grown in limited systems.

In 2003 focus have also been on the structural aspects of decomposition of plant materials. Wheat straw has been used in the experiments up till now, as the high-C and structural component of the composts, as it is a cheap and very easily available material. However, I also work in more detail with the structural aspects of other plant materials. Samples of hemp and *Miscanthus* straw and different qualities of wheat straw was placed in litterbags in the larger compost containers, and the actual decomposition of cellulose and lignin was examined by the use of light and scanning electron microscopy (SEM). This might give insight in which types of material are best suited as structural elements in compost. Results from the SEM analyses showed how hemp and *Mischanthus* straw as expected are much more stabile than wheat straw. Additionally I believe, that the high fibre content of hemp will enhance the structure and water retention capacity of the compost.

Plans - 2004

Due to the results obtained through the composting experiments it is possible to make compost based on plant residues, which contains sufficient nutrients to function as a growing media. It is important to have the right nutrient input but assuming that nutrients are sufficient management of the composting process can partly control the release of nutrients.

Future work will focus more on the structure and water retention capabilities. This can be influenced by the degree of cutting the material, or it can be influenced by the use of other plant materials. New experiments are starting within a few weeks testing the effect of adding hemp or mischanthus straw to the compost, and how these materials may stabilise the compost and enhance the water retention capacity due to the low degradability and special fibre quality of especially hemp.
Besides that a major part of the remaining time will be used presenting results in papers and writing the Ph.D. dissertation.