BioGreenhouse

Guidelines for Experimental Practice in Organic Greenhouse Horticulture

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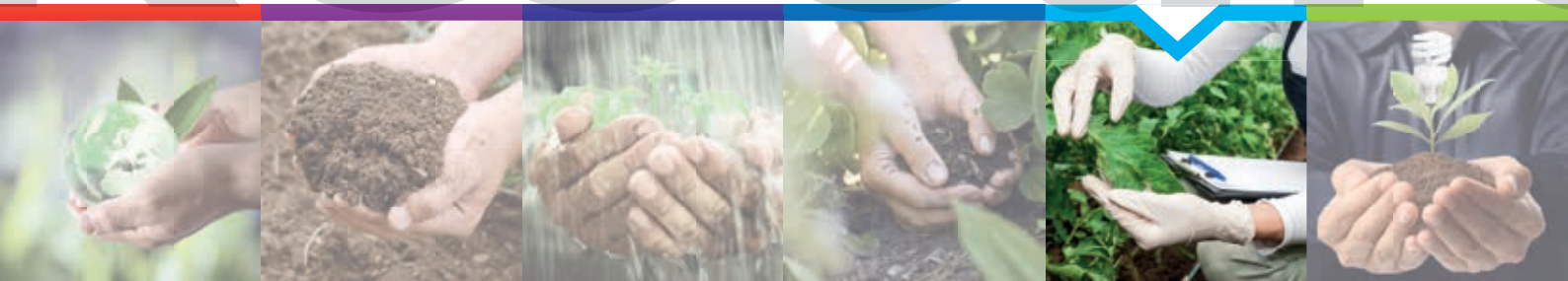

The Editorial Board *This picture was taken at the final meeting to discuss these guidelines, held in Tori, Estonia in September 2015. A commercial organic greenhouse with a tomato crop is shown in the background. Left to Right: Pedro Gomez, Stella Cubison, Wolfgang Palme, Justine Dewitte, Martin Koller, Yüksel Tüzel, Francis Rayns, Ingrid Bender and Ulrich Schmutz.*

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Pictures
All pictures are by members of the Biogreenhouse COST Action FA1105. Contributors to the pictures (in alphabetical order) are: Ingrid Bender, Stella Cubison, Justine Dewitte, Pedro Gomez, Martin Koller, Carolyn Mitchell, Jérôme Lambion, Wolfgang Palme, Virginia Pinillos, Ulrich Schmutz, Yüksel Tüzel and Anja Vieweger.

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- *Biomass quality.* Fresh weight of the sampled material is readily measured and is usually expressed as tonnes per ha although kg per square meter may be more appropriate. It is best to also use a subsample to determine the dry matter content of each crop fraction (roots, shoots, weeds etc.) by drying in an oven at 60°C until a constant weight is achieved. Chemical characterisation may be useful; this can mean analysis of major nutrients (C, N, P and K) or of the cellulose/lignin content. The C:N ratio is particularly important for predicting the mineralisation patterns of a green manure. Analysis of a large number of samples is expensive so it may be necessary, although not ideal, to pool the replicates or to use standard values from the literature in order to calculate the inputs to the soil.
- *Soil information.* Basic soil parameters (e.g. pH, available nutrients, organic matter levels etc.) should be determined at the time the experiment is set up so that the results can better be compared with those from other sites. It may be necessary to make other measurements as the green manures are growing or at the time of incorporation if soil effects are a focus of the work. Whenever soil samples are taken it is important that they are representative of each plot (adequate cores must be taken to provide a pooled sample of sufficient size for the analyses needed) and are taken with clean tools to a known depth. They must be treated appropriately before analysis (if mineral nitrogen is required they must be stored cool but not frozen although air drying is acceptable before certain determinations).
- *Environmental information.* Records of temperature, light levels etc. should be kept, together with information about watering (rainfall will probably be irrelevant but may influence the moisture levels in the subsoil beneath the greenhouse). It is also useful to record the previous cropping.

Effects after incorporation – soil

Regular soil sampling will show the pattern of release of nutrients as a result of incorporation of the green manures. This is of particular relevance in the case of nitrogen which, in its mineral forms, exists only transiently and yet is so important for crop nutrition; its availability is usually greatly affected by green manures. Quantifying soil physical and biological changes is more difficult. In situ measurements can be made of, for example, bulk density, soil hardness (using a penetrometer), water infiltration etc. In some cases diversity and abundance of various types of soil life can be assessed - this may be of particular relevance in monitoring the effects of green manures on soil borne diseases.

Effects after incorporation –crops

Performance of the following crops should be measured according to the protocols suggested in other chapters in this book. Depending on the focus of the work particular attention may be paid to various effects (e.g. competition with weeds, disease incidence, crop yield or quality). In some cases it may be desirable to continue to measure the performance of crops throughout a whole rotation.

Economic evaluation

All trials should include some calculation of the costs and benefits of the various treatments. This is to enable any potential yield benefits to be set in a commercial context. Ideally there should be a comparison with 'standard farm practice'. Suggestions for how this can be accomplished are covered in section 3.6 of these guidelines.

Anecdotal information

This is particularly relevant for on-farm 'participatory' trials. The grower's view on the practicality of adopting a particular strategy has a value in addition to the agronomic measurements. They may be able to show that something may be very difficult or easy to adopt. They may be able to comment on something (e.g. an improvement in soil workability) that has not been quantified but is nevertheless important.

3.2.5 Fertilising experiments in growing media used for transplant production, potted herbs or ornamentals

By Martin Koller

See also section 3.2.6 and 4.5.1

The amount of nutrients and fertilisers in growing media are usually expressed in mg or g per litre of growing media (i.e. by volume rather than by weight). It is therefore crucial to use an easy and accurate laboratory method to measure bulk density. The ISHS method (Verdonck and Gabriels, 1992) or the EN 13041:2011 (CEN 2011) method are usually considered to be too time consuming. It is therefore recommended to use one of the following methods:

EN 13040:2007 (CEN 2007)	Filling a one-litre test cylinder with sample "as received", static compaction (with a plunger) and weighing the contents of the cylinder.
VDLUFA (A 13.2)	Filling a 250 ml cylinder with sample "as received" (respectively rewetted to "pot condition" - i.e. when tightly compacted in a fist it must be moist but no moisture may exude), compaction by dropping 10 times from 10 cm height and weighing of the contents of the cylinder.

Setting up experiments

Different fertilisers should be added to the growing media to supply the same amount of the element in question (in terms of mg per litre). All the other elements (especially micro-elements, which are not the subject of the experiment but may also be in the fertilisers) should be equilibrated (e.g. with appropriate additions of rock phosphate and potassium sulphate).

Changes to available nutrient levels are likely to occur during growing media storage. It is therefore recommended, as well as conducting experiments using freshly mixed growing media to store samples in closed plastic bags at least for 4 weeks and then test again with the same setup. This procedure can simulate the handling and use of most commercial growing media.

At least 4 replicates should be used. In most cases it is useful to use more than one test species to assess any possible phytotoxic effects of the fertilisers (e.g. Chinese cabbage is a plant sensitive to some phytotoxic compounds).

Evaluation of experiments

Experiments should continue at least to the normal transplanting stage of the crop. There should be assessments of:

- Fresh weight of the shoot at transplanting stage.
- Nutrients in the shoot.
- Growth after transplanting.
- Analysis of the growing media for pH, EC (salinity) and nutrients such as N_{min} at least at start and at the end of the experiment.

Determination of pH, EC and nutrients in growing media:

Either of the following methods can be recommended (Sonneveld and Voogt 2009):
1 : 1.5 volume water extract (e.g. national standard method in the Netherlands)
1 : 5 volume water extract, according to the recommendation CEN/TC 223 or VDLUFA (national standard method in Germany)

Instead of water, stronger solutions such as CAT ($CaCl_2$ + DTPA) can be used as these can give more meaningful results, especially in growing media containing compost and clay products. The presence of a chelate such as DTPA will extract higher amounts of metallic elements. Whatever method is chosen it should be clearly stated in any report of the results.

References and further information

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3.2.6 Evaluation of container growing media

By Yuksel Tüzel

Growing media are used in the production of potted herbs, ornamentals and vegetable transplants. For use in certified organic production transplants have to be organically propagated and so only substrates permitted by the regulations should be used. A successful growing medium must have good physical (porosity, water and air capacity), chemical (pH, electrical conductivity, nutrient content) and biological (organic matter, microorganisms) characteristics.

If different mixtures are to be compared the growing media should all be characterized carefully according to their water holding capacity, bulk density, pore volume and nutrient content. Mixtures should be made on a volume ratio (% v/v) rather than by weight (% w/w). However in some cases it is easier to determine the bulk density of each component beforehand and then compose the mixtures by weight. Fertilisers are also applied by a volume ratio (e.g. 300 mg N per litre substrate). Each tray (or even better each cell of the tray or each press pot) should contain the same amount of substrate. This can be checked by weighing once the bulk density has been established.

Growing media containing organic components will change significantly during storage. Therefore it is best, if resources permit this, to conduct a series experiments with growing media sored for different periods (e.g. in plastic bags) in order to evaluate organic growing media in a way that is relevant to on-farm practice.

Watering regime
Different growing media mixtures can hold different amounts of water. It is therefore crucial irrigate all treatments separately or to correct irrigation amounts individually several times. In an ideal case, all treatments will be irrigated regularly until a given water holding capacity is reached (between 50 and 80%).

Figure 3.5 *Examples of commercial growing media that may be used in trials*