SETTING UP VARIETY TRIALS FOR ORGANIC AND LOW INPUT AGRICULTURE

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When setting up special variety trials for organic or low input agriculture several aspects - such as the choice of locations, design of the trials, traits to be assessed - need to be considered. Moreover, treatments and the management in certified organic fields should be in agreement with EU and national regulations on organic farming. This chapter is based on the experience of the authors with conducting organic and/or low input trials.

1. Selection of the field location

Organic fields
The main objective of organic variety testing is to provide organic farmers, traders and producers with research results obtained from trials carried out in organic fields. Ideally, trial locations should be officially certified as organic and should be managed organically for at least five years (three years conversion period + two additional years) as experience shows that the crop performance still changes in the first years after conversion.

Soil type
Soil structure and soil type should be known in order to estimate the necessary amount of fertiliser. The balance should be corrected with regard to the expected yield, the amount of precipitation (soil nitrogen leaching) and the residues of the previous crop.

Field properties
The field should be as homogeneous as possible. An appreciation of its homogeneity can be obtained by growing a monoculture in the first year and testing the different parameters (especially the yield) that will be measured later in the real trial. Awareness of field gradients will enable a more accurate placement of the trial.
The ideal field should correspond to fields used by farmers for cereal production. As cereals are grown in different environments, one should try to include the most representative farming environments in the variety testing system.

Previous crop
Previous crops in the rotation influence the nitrogen level but also the preparation of the seedbed and the disease and pest pressure on the trial (Vullioud, 2005). One should try to select a field with a pre-crop that is typical for the farming system in the region. This may be more difficult for organic trials, as in a number of countries organic farmers usually grow a large number (six or more) of different crops in a crop rotation of at least

six years. While fixing the pre-crop between locations may not be achievable, one should try to have the same pre-crop over the years at a given location
In cropping systems with spring-sown cereals, farmers sometimes grow a catch crop during the winter season. The species of the catch crop may influence the yield level and (baking) quality properties of the subsequent cereal crop (Mauscherning et al., 2006, Pedersen et al., 2006).

Distance to trial experts
The different locations of the trial system should be spread over the main growing areas of the crop. Therefore not all locations may be close to the professional who is in charge of the observations. Organic variety tests usually include a number of labour intensive observations, such as early ground cover and weed suppression. When resources are limited, it is advisable to concentrate the more labour intensive observations in trials that are as close as possible to the trial experts.

Human resources
Trials are often placed in farmers' fields. Special attention should be given to the selection of participating farmers. Their experience and motivation are fundamental for the successful outcome of the trial.

2. Field Management

Field treatment
Treatments with synthetic products are not used in organic trials, and a reduced range is applied to low input trials. Plough and mechanical interventions (tine harrow, curry comb and hoe) are the main tools to prevent weed invasion. More information on the effectiveness of harrowing is given in the chapter on weed competitiveness in this Handbook.

Organic manure
The fertilisation of organic trials needs special attention, as manure usually is not homogenous and it is difficult to spread it uniformly over the field.
In some countries, organic farmers apply an additional gift of fertilizer after tillering and at flowering stage to enhance the yield level and baking quality of wheat. Machinery may cause considerable damage in the fields, especially when liquid manure is used for this purpose. Granulated organic fertilizer (commercial name e.g. Agro Biosol, Biofert) may be applied with a drill or by hand. The most appropriate way is to fertilize each plot separately with the help of a measuring jug.

3. Trial layout and design

Variability
Random variability may be larger in organic and low input trials than in conventional trials, due to for example more heterogeneous soil conditions and the occurrence of weeds. Plot size and number of replicates may need to be increased to decrease experimental error (see Chapter Trial set up and Statistical Analysis in this Handbook).

Crop management and farm machinery
Weed management and the application of manure and other fertilizers are usually carried out with the farm machinery that is available at the location. To limit damage to the trial, plot size and trial lay-out should be adjusted to the dimensions of the farm machinery at the specific location and the direction of harrowing.

4. Choice of varieties

Choice of standards
The standard varieties should include the most used varieties in organic or low input farming. Standards should be representative for the aimed level of quality, grain yield and disease resistance. It may be useful to include special standard varieties to evaluate specific characteristics, such as weed competitiveness.

Choice of varieties
Variety testing demands a high investment. If the number of applications is too large, a pre-screening in a simplified trial can help to identify varieties that are well adapted to organic farming (e.g. high protein content, high disease resistance, good weed competitiveness and a good yield potential).

5. Seed material

5.1. Choice of seeds in organic trials

Whereas the use of organically multiplied seed is compulsory for commercial organic farms, it may not always be available, especially for varieties/lines that have not yet officially been released. Conventional seed companies tend to delay the organic multiplication of their varieties until they have been released. The EU regulation on the use of organic seeds (EC) No 1452/2003 offers the possibility of derogation for research purposes (see paragraph 7). When organic seed is available for only part of the varieties to be tested, there are two options:

- use organic seed for those varieties for which organic seed is available and conventional seed for the rest
- use conventional seed for all the varieties.

For variety testing it is important that seed quality is as similar as possible for the different varieties. As the seed quality may differ according to the provenance, the second option is preferable.

5.2 Seed health

Seed quality and health can influence the trial results and it has to be analysed more precisely than in conventional testing. The germination capacity of winter cereals should be analyzed at 10 °C instead of at 20 °C (which is commonly used).
As chemical treatment of seed is not possible in organic trials, it is likely that the trial results will be influenced by the presence of seed borne diseases. In this way varieties can be selected that produce healthy seeds, which is an interesting aspect for organic farmers. Wheat seeds should be treated if there are more than 5-10 spores of *Tilletia caries* on a kernel.
If one chooses to evaluate a set of varieties without the constraint of seed borne diseases, the following non-chemical methods, among others, may be used for this purpose:

Warm and hot water treatment
This old technique can be used for a range of diseases in several crops. Seeds are submerged in water of a fixed temperature for a fixed time, depending on crop and disease. In wheat it has been reported to be effective against root rot (*Microdochium nivale, Fusarium* spp.) and glume blotch (*Septoria nodorum, Stagnospora nodorum*) (Winter et al., 1998; Schachermayr, et al., 2000; Osman et al., 2004).
In barley it can be used against leaf stripe (*Pyrenophora graminea*) and loose smut (*Ustilago nuda*) (Nielsen et al., 2000).

Hot humid air
Seeds are exposed to steam of a fixed temperature for a short period. Temperature and application period should be established for each separate seed batch, because the effectiveness of the treatment is influenced by the physiological condition of the seeds. The method has been commercially developed by the Swedish company Acanova. It has been reported to be effective against a wide range of diseases (Forsberg, 2005; www.acanova.se).

Electron treatment
This method is based on treating seeds with low-energy electrons. It is commercially applied in Germany (www.e-ventus.de). Whether this methodology is suitable for organic agriculture is a topic of debate within the organic sector. It shows effects against Common bunt (*Tilletia caries*) and to a lesser degree against Glume blotch (*Septoria nodorum*) in wheat (Tigges et al., 2002; Vogt-Kaute & Tilcher, 2004)

Mustard flour
Mustard flour (commercial name e.g. Tillecur) is mainly used against common bunt (*Tilletia caries*) in wheat (Borgen and Kristensen, 2000; Schachermayer, et al.; 2000; Vogt-Kaute & Tilcher, 2004).

Bacterial treatment
In Austria and other countries a bacterial treatment (commercial name e.g. Cerall, Cedomon) based on the soil bacterium *Pseudomonas chlororaphis* is applied. Cerall is used in common wheat, durum wheat, rye and triticale and effective against seed-borne *Tilletia sp., Fusarium sp., Microdochium nivale* and *Septoria nodorum*. Cedomon is suitable for barley and oats. (Widén & Annas, 2004).

5.3 Seed density

The same seed density should be used for all varieties. It is calculated on the basis of the thousand kernel weight and the germination rate of the grains. In organic trials, seed loss is usually higher than in conventional trials, due to the use of non-treated seeds, intensive harrowing and to a slower development, caused by lower nitrogen availability. Seed density in organic trials should be 15-30 % higher than in conventional trials to compensate for these losses.

6. Additional traits to be observed

Some additional traits may be evaluated in organic variety trials, which are not commonly observed in conventional trials. An overview of extra traits that are proposed for wheat and barley in a selection of countries is given below:

TRAIT	Austria	France	Germany	Nether-lands	Switzerland
Tolerance to seed borne diseases	X	X	X		X
Early vigour	X	X	X	X	X
Weed suppression	X	X	X	X	X
Nutrient use efficiency	X				
Yield Stability	X				X
Product Quality					X
Bread quality under organic or low N input conditions	X	X	X	X	X
Baking test without additives			X	X	X
Wet gluten content			X		X
Stability of quality	X				X

Source: Oberforster (2004); Goyer et al (2005), Schnock (2003); Osman & Lammerts van Bueren (2003)

7. EU regulation on organic production and the implications for variety trials

When fields are organically certified this means that all practices have to comply with EU and national legislation on organic farming.

Field management.
The management aspects (e.g. use of inputs) of organic fields and products are dealt with in EU Council Regulation (EEC) No 2092/91. Annex 1 contains the principles of crop production, while Annex 2 lists the allowed crop protection products and fertilizers.

Seeds
A special regulation on the use of organic seeds came into force in 2004: Regulation (EC) No 1452/2003. According to this regulation organically multiplied seeds should be used. In certain cases derogations for the use of conventional, not chemically treated seeds, can be requested from the national certifying authorities. Article 5.1(d) specifically mentions that certifying bodies may grant authorization for the use of non-organic seeds in the case of research. More information on the procedure for requesting this derogation should be obtained from the national certifying body.

Full texts of both EU regulations can be downloaded from: http://eur-lex.europa.eu/

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