5. Why does the organic sector not want ‘PPF hybrid varieties’?

No inbred plants wanted in hybrid seed

Section 3 explains that the advantage of hybrid varieties is their uniformity. However, before plants of a hybrid variety are actually 100% uniform, there is another problem to be tackled. The mother line should not be allowed to self-pollinate, as otherwise the seed lot will contain deviating inbred plants. There are various ways of preventing this, depending on the crop.

Manual emasculation and manual pollination

Manual removal of stamens (‘emasculation’) and pollination is relatively expensive. In the case of crops such as tomatoes, peppers, cucumbers, courgettes and pumpkins this is worth it and is carried out (see Figures 1 and 2). Often the stamens are first of all removed from the mother line to ensure that self-pollination cannot take place.

Figure 1. Manual removal of stamens from a tomato flower (Photo: J. Myers, OSU)

Figure 2. Manual pollination of tomato flowers (Photo: F. Meijer-Dekens, WUR)

Using natural male sterility

In the case of most field crops manual pollination is not economically feasible. It makes the seed too expensive. The only alternative is to look for genetic mechanisms as a result of which the mother line does not self-pollinate. In the case of crops such as carrots, onions and leeks male sterility (MS) sometimes occurs naturally. These male-sterile plants can be recognised by the fact that their flowers do not have stamens. These plants can be used in breeding as the mother line in order to avoid the mother line being able to self-pollinate. This male sterility occurs naturally in the nucleus of some types of crops but not in all crops. In the case of some crops (sunflowers and radishes) male sterility is to be found not in the nucleus but naturally in the cytoplasma of the cell; in this case it is called cytoplasmic male sterility, abbreviated to CMS.

Table 1. Overview of several crops with and without natural male sterility in the nucleus (MS) and cytoplasmic male sterility (CMS) and possible alternatives.

Crops	Natural MS	Natural CMS	Alternatives
Cucumber	No	No	Cucumbers produce separate female and male flowers on the plant. There are F1 hybrids on the market that produce only female flowers. To be able to obtain pollen for seed cultivation the father line does have to produce male flowers (using plant hormones).
Cabbage	No	No	'Self-incompatibility', i.e. the plant does not accept its own pollen but prefers that of another plant. This characteristic is often not 100% effective and sometimes under certain conditions produces up to around 10% inbred plants. However, this does in practice work fairly well.
Carrots	Yes	No	Not necessary.
Radishes	Unknown	Yes	Not necessary.
Tomatoes and peppers	Not necessary	No	Manual emasculation can be done well (i.e. removing the stamens with tweezers).
Onions	Yes	No	Not necessary.
Chicory	No	No	Chicory also has a form of 'self-incompatibility'. In the 'normal' hybrid process in the case of chicory a limited number of generations are inbred and several inbred plants will always be produced.
Sunflowers	Probably not	Yes	Not necessary.

Natural self-incompatibility

In the case of several crops (cabbage and chicory) male sterility does not occur at all. In the case of these crops there is another mechanism available: so-called self-incompatibility. This mechanism ensures that a plant (in most cases) does not accept its own pollen. It is a complex characteristic and not all breeding companies have a good set of genes that ensure self-incompatibility.

Artificial CMS in cabbage and chicory via protoplast fusion: PPF hybrids

Breeders want complete male sterility and try to introduce this characteristic from another (non-crossable but to some extent related) type of plant artificially. CMS was introduced to cabbage from radishes via protoplast fusion (i.e. unnaturally); in the case of chicory this was done using sunflowers. In the case of both these crops complete sterility is achieved only using forced protoplast fusion, see Figure 6. To this end first of all the cell wall is dissolved using an enzyme treatment, so that the protoplasts (the cells without a cell wall) can be fused using electrical stimuli and the organelles and the mitochondria are combined, as a result of which CMS is transferred to the other desired species.

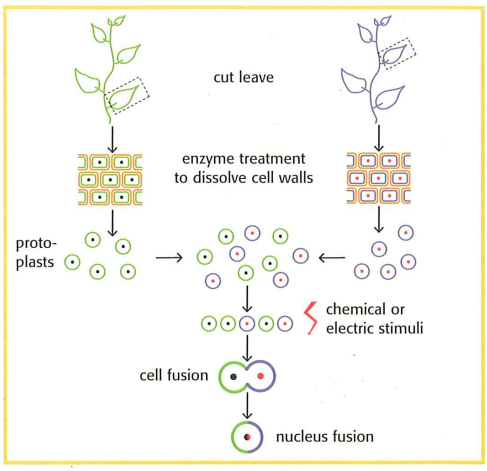

Figure 6. Process of protoplast fusion between two different plants. Source: FiBl dossier 2001

Protoplast fusion (PPF) is not a desirable technique for the organic sector

The reason that PPF techniques are formally permitted within organic farming is complicated. It is to do with international definitions, legislation and references. For several countries this acceptance is a reason to draw up additional 'private' rules for the use of 'PPF hybrid' varieties that were obtained using these techniques. Several market players, such as Demeter, Bioland and Naturland, have forbidden the use in Germany of varieties produced using protoplast fusion.

In 2013 there was an uproar in the German media about 'genetically modified organic chicory'. This was about organic chicory that had been cultivated using seed from a so-called PPF variety (conventionally produced seed).

How can growers know that they are not getting a PPF hybrid of cabbage and chicory?

Not every seed company indicates which hybrid varieties were developed on the basis of protoplast fusion. Seed companies in the organic sector consciously take into account the objections to protoplast fusion and put only organic seed of F1 hybrid varieties on the market developed on the basis of self-incompatibility (so-called SI varieties). This does not alter the fact that there are only a few suitable SI chicory varieties on the market and there are no seed companies that invest in the development of new SI chicory varieties. In the case of cabbage there are SI varieties being maintained, in particular by Bejo, Enza/Vitalis and Rijk Zwaan. But it is clear that there needs to be investment in the breeding of new organic varieties.