Italian ryegrass is a good crop with which to biologically disinfect the soil.

Cutting and ploughing in the grass.

Biological soil disinfection

Biological disinfection is based on the principle of applying organic matter to the soil and, under wet anaerobic circumstances, allowing it to ferment. The gases produced then kill microorganisms in the soil.

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Many vegetable farms specialise in a limited number of crops, making crop rotation impossible. These mono cultures are very vulnerable to soil borne pests and diseases like nematodes, fungi and insects which can reduce the yield of a crop considerably. There are a number of solutions to the problem like treatment with chemicals, steam sterilisation and growing on a hydroponic system. Biological soil disinfestation is a method, that might be useful to vegetable farms providing it occurs when the soil is warm enough.

A high soil temperature is essential so this method of disinfection has to be carried out in the summer in temperate climates. To disinfect the soil biologically grow 40 tons/ha of fresh produce such as Italian ryegrass, or apply fresh produce which has been grown elsewhere. An alternative to Italian ryegrass is *Tagetes*, which is also used as a bio control against *Pratylenchus penetrans*.

Cut the crop and dig it into the soil to a depth of 30-40 cm. Use more produce, when digging deeper. Apply water (40 mm) and compress the soil. Cover it with air-tight foil to create an anaerobic environment. Allow six weeks for the fermentation process to complete.

This process will kill many fungi and diseases present in the soil although its usefulness will depend on the diseases that are present in the soil. Excellent results have been obtained in the control of nematodes and especially fungal diseases like *Verticilium*. The effect on insects and weeds is not very clear yet. It is not clear how many insects it will kill but probably those which find it difficult to crawl away. Nevertheless, biological disinfection appears to cause less disruption to the ground life than steaming which will kill virtually everything in the soil.

Bio fumigation

Bio fumigation follows the same process, but uses crops like cabbage, broccoli, mustard or *Rhaphanus sativus*. These crops release a chemical called "isothiocyanate" when they decompose. This chemical is related to Metham Sodium and kills a number of soil borne pathogens. Another crop suitable for biofumigation is Sorghum. This crop releases cyanides during decomposition, which kill nematodes and probably fungi like *Verticilium*.

Research has shown that this method of disinfection will prevent contamination of a number of nematodes. Also, fungi are well controlled: Verticillum is killed to around 90% compared with using a chemical treatment;

Covering the soil with airtight film after watering and compressing the soil.

Mechanically applying the film.

Fusarium shows mixed results and Rizoctonia is completely controlled whereas Pythium appears not to be controlled at all. Control of weeds is less clear, certainly there seems to be little control of root weeds.
The biggest risk is that, due to circumstances such as low temperature or perforated plastic, which might occur if is damaged by birds or wild animals, the effect of biological disinfection will be reduced.
Although this method appears reasonably effective it is not very cheap. Firstly growing a crop on the area to be disinfected and then ploughing it in and leaving it for six months means that the ground is out of commercial use for a large part of the season. Additionally, there is the cost of the film and its application. ■

BACTERIA REBALANCE AFTER FUMIGATION

Fumigating may temporarily leave the soil barren, but there is evidence that helpful soil dwellers (beneficial bacteria, fungi and terrestrial species) can quickly return – typically in greater numbers than before – while the unwanted organisms stay away.
Beneficial soil organisms play a central role in producing quality fruit producing soils through the maintenance of the nutrient cycle and provision of organic matter. The impact of sterilising on beneficial soil flora and fauna has been studied by Etienne Van Wambeke, Certis Europe's soil fumigant technical manager and previously a researcher on the subject at the KULeuven University in Belgium. He explains that a depleted soil profile will naturally recolonise quickly. "Fumigating creates the space for organisms to populate the area. The target crop pests and diseases have been controlled, so the normal natural balance and the resulting environmental benefits are restored in favour of the crop," he says.

Different sterilants

Commenting on the effects of different sterilants Mr Van Wambeke explains that there is very little published data specifically relating to sterilants and how populations of soil organisms are influenced. From the studies that have been conducted he points to US research comparing the impact of methyl bromide and alternative sterilants on microbial communities. "Methyl bromide is a harsh treatment and produces a more pronounced impact on the beneficial soil populations," he says.
Methyl bromide along with high concentrations of chloropicrin and 1,3 dichloropropene (Telone) applied to land with no history of fumigant treatments resulted in major beneficial bacterial populations declining to below any level of detection after the first week. It took 12 weeks for there to be a significant recovery of major species.
Treatment with Basamid (containing dazomet which releases the sterilising gas MITC) and lower concentrations of 1,3-dichloropropene and chloropicrin showed no such decline. The soil populations of beneficials remained comparable to the control soils after eight weeks. High population diversity was also maintained for these treatments but not for methyl bromide.
MITC is a high concentration of a naturally occurring gas, produced when growing some mustard types," says Peter Shakespeare of Certis in the UK. MITC gas has no ozone depleting potential and breaks down into harmless by-products. He adds that the granular formulation allows growers to apply Basamid easily and accurately.

Terrestrial organisms

In other studies the use of this treatment has resulted in an initial decline of beneficial microorganisms that has quickly recovered with no long-term detrimental impacts. While there was an immediate drop in the number of individual organisms spiders, beetles, springtails and earthworms were found in abundance in treated plots after two to three months having quickly moved in from uncultivated bordering areas of the field. Earthworms were shown to survive the treatment in cocoons or in deep soil layers. The study concluded that Basamid has no lasting effects and the treated areas were favourable habitats for beneficial soil organisms.

Reliable control

Whilst the long-term impact on beneficial soil organisms appears minimal, Mr Van Wambeke notes that Basamid remains a reliable means of controlling soil pathogens. "There are also indirect benefits such as improved crop plant vigour and a greater degree of disease resistance," he says.
To obtain the best results it is important that conditions before, during and after application are favourable. Hydration of target organisms so that they are 'active', sufficient soil temperature, correct depth of incorporation, optimum soil moisture levels, soil tilth, and effective sealing following application are all critical factors.