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BIOFUMIGATION: PRACTICAL INFORMATION, ADVANTAGES AND DISADVANTAGES

This factsheet contains complementary information to the Best4Soil video on Biofumigation: Practical information, advantages and disadvantages

INTRODUCTION

Biofumigation is the use of green manures crops which release biocidal molecules into the soil after their incorporation. This best practice was developed in several countries to cope with the withdrawal of methyl bromide, a most effective but controversial chemical soil fumigant. The effect of biofumigation is partly based on the release of natural toxic substances but also on their effect as a green manure plant. The effect of green manures and cover crops are explained in two Best4Soil videos and factsheets.

The nature of the soil is also an important factor when biofumigation is used as a control method. Lighter-textured soils with low organic matter content are better suited to this approach (Kirkegaard, 2009). Isothiocyanates get fixed to organic matter (sorption) and are therefore less active against soilborne pathogens and nematodes. Therefore, the lower the organic matter content, the less sorption of the isothiocyanates occurs in a soil. Lighter soils i.e., soils with a higher part of sand, allow a better diffusion of the toxic gases in the soil.

PULVERISATION IS IMPORTANT

For *Brassicas*, the transformation of glucosinolates into toxic and volatile isothiocyanates happens during the breakdown of the plant cells. The more cells which are broken and release glucosinolates, the higher the peak of isothiocyanates will be (Morra & Kirkegaard, 2002). This is critical for the efficacy of biofumigation. Therefore, the biofumigation crop should be shredded as finely as possible before soil incorporation (fig. 1), with the best method to use are mulching devices equipped with hammers rather than blades (Matthiessen et al., 2004).

NATURAL LIMITATION OF THE BIOFUMIGATION

The amount (concentration) of isothiocyanates needed for successful control depends on the targeted soilborne pathogens, nematodes and weed seeds (Klose et al., 2008). For the more resistant microsclerotia of the soilborne pathogen *Verticillium dahliae*, *Brassica* plants will not liberate sufficient isothiocyanates for a successful control in the field (Neubauer et al., 2014).

PLANT DERIVED BIOFUMIGATION PRODUCTS

An alternative to increasing the amount of isothiocyanates in the soil is the use of defatted seedmeals from *Brassica* cultivars with high content of glucosinolates (Patalano, 2004). Such products are commercially available, and in most cases sold as organic fertilizers (fig. 2). Therefore, their efficacy is not known as such products do not undergo efficacy evaluation, as is the case when products are registered as pesticides. However, the amount of seedmeal added to the soil is limited by its nutrient content, usually nitrogen in the first instan-

Fig. 1: The finer the mulching degree of the plants, the faster and more isothiocyanates will be released.

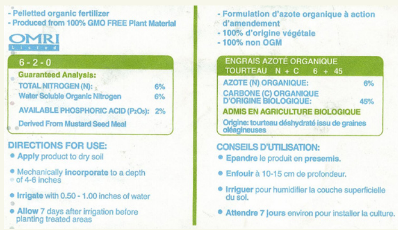

Fig. 2: Example of an organic fertilizer based on defatted mustard seedmeal.

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ce. The addition of too much seedmeal can result in an over-fertilization and potentially in the leaching of different nutrient elements (such as nitrate).

Seedmeal products are mostly applied by broadcast in form of pellets or powder (fig. 3) and incorporated into the soil before the planting of the crop. Once in contact with water in the soil, the transformation of the glucosinolates into isothiocyanates takes place. Irrigation after the incorporation of these products accelerates this transformation and also favors the diffusion and dispersal of the isothiocyanates in the soil.
Another way to apply isothiocyanates to the soil is the use of liquid *Brassica* seedmeal products (fig. 4). In this case, the seedmeal is manipulated before application. Through this manipulation, the glucosinolates are transformed into isothiocyanates and then dissolved in liquid which is applied to the soil through a drip irrigation system.

Fig. 3: Pellets of defatted mustard seedmeal before incorporation in the soil.

Fig. 4: Defatted mustard seedmeal can be applied to the soil in liquid form, even after planting the crop.

NOT ONLY BRASSICAS

The term 'biofumigation' was originally defined as the process of growing, macerating / incorporating certain Brassica or related species into the soil, leading to the release of isothiocyanates through the hydrolysis of glucosinolates contained in the plant tissues (Kirkegaard et al., 1993). But sorghum (*Sorghum bicolor*) and sorghum-sudangrass (*S. bicolor* x *S. sudanense*) cultivars with high content of dhurrin, a substance which is transformed in toxic hydrogen cyanide (also called prussic acid) are also plants that can be used for biofumigation (de Nicola et al., 2011). Both species are well adapted for growth under high temperature conditions, such as those which occur under protection in summer (fig. 5). Therefore, they are well suited to the southern regions of Europe (fig. 6). Another advantage is that they are grass species, which makes them especially suitable to be part of crop rotations in vegetable production systems.

Fig. 5: Sorghum-sudangrass 8 weeks after sowing under tunnel.

Fig. 6: Sudangrass in summer (> 35°C) in Southern Spain.

Additional information on biofumigation are published as an EIP-AGRI minipaper:

https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/9_eip_sbd_mp_biofumigation_final_0.pdf

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