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FACT SHEET | JUNE 2024

Biofumigation

Benefits

Adding biofumigants to a vegetable crop rotation can improve overall soil health and reduce input costs. The benefits of biofumigant crops, observed by vegetable growers, include improvements in soil structure and a reduction in fertiliser, water, and chemical inputs. Success will depend on the type of biofumigant crop used, its suitability to the crop rotation, local climate and soil conditions, its management and its termination and incorporation method.

Soil biology

Biofumigant crops act as break crops, disrupting the life cycle of pests and diseases. Suppression may result from direct biocidal activity as well as indirectly through changes in the soil fauna and microbial community. Biofumigant crops need careful planning though, as the chemical compounds released can have a detrimental effect on beneficial microbes such as Trichoderma and mycorrhizal fungi.

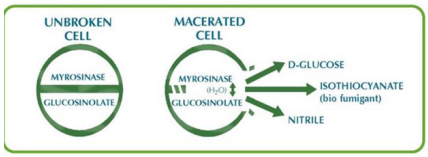

Diagram of isothiocyanates release from the reaction of glucosinolates and the enzyme myrosinase after cell maceration

KEY MESSAGES

- Biofumigation is the process of using specialised cover crops to suppress soil-borne pests, diseases, and weeds
- Once terminated and macerated, the cover crop must be immediately incorporated into the soil
- The cover crop residue will release the fumigating chemical compounds

The first passage of the tractor is to mulch the biofumigant crop, while the second one is to incorporate the residues and seal the soil surface.

Hort Innovation

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Weed suppression

Early vigorous growth of the biofumigant crop and subsequent improved plant vigour of the cash crop contribute to outcompeting weeds. When incorporated correctly, the isothiocyanates (ITCs) derived from the glucosinolates (GSLs) stored in the Brassicaceae biofumigant crop tissues have strong biocidal activity, burning weed seedlings in their early life stages. Sorghum species produce another biofumigant compound called cyanogenic glucoside, which has comparable effects.

Soil organic matter

Organic matter in the soil is replenished after the biofumigant is incorporated. As microorganisms break down organic matter, they produce sticky substances that bind soil particles together into stable aggregates. These binding agents can improve:

- Porosity, aeration, water infiltration and drainage
- Structural stability, reducing the risk of compaction
- Soil friability, making the soil easier to work
- Resilience to wind and water erosion
- Nutrient and water holding capacity
- Overall biological activity
- Root penetration and density

Organic matter also acts as a buffer against changes in soil pH, salinity and sodicity, and it can inactivate or filter toxic elements.

Common biofumigant crops

Common name	Scientific name
Black mustard	*Brassica nigra*
White mustard	*Sinapis alba*
Indian mustard	*Brassica juncea*
Fodder mustard	*Brassica napus*
Oil radish	*Raphanus sativus*
Rocket	*Eruca sativa*
Sorghum	*Sorghum bicolor*
Sudan grass	*Sorghum sudanense*
Sorghum x sudangrass hybrid	*S. bicolor x sudanense (Sorghum x drummondii)*

Nutrient cycling

Deep-rooted break crops can access nutrients stored deep in the soil profile. These nutrients are translocated to the upper layers of the soil, making them more accessible to the shallow-rooted vegetable crops that follow. Improved biological activity due to more available soil organic matter can also lead to improved nutrient cycling and crop nutrient uptake. Increased rates of nitrogen mineralisation have been recorded following brassica type and other break crops.

Details of sclerotia of *Agroathelia rolfsii* (syn. *Sclerotium rolfsii*) and *Sclerotinia sclerotiorum*, two soil-borne diseases that biofumigant crops can help manage.

QUICK FACTS

- Glucosinolates (GSLs) are chemical compounds commonly found in the Brassicaceae family.
- Around 140 different GSLs have been identified, produced in different proportions by various species and varieties. Each combination can have a different impact on specific elements of the soil biology, making the choice of the right biofumigant crop all the more important.
- When brassica biofumigant crops are macerated, GSLs react with the enzyme myrosinase, also contained in the plant but separated from GSLs, and degrade into isothiocyanates (ITCs), highly toxic chemical compounds.
- Dhurrin is the cyanogenic glucoside contained in sorghum, and in lower concentrations in Sudan grass. It releases hydrogen cyanide (prussic acid) after enzymatic degradation.
- Young sorghum plants can cause cyanide poisoning in livestock if grazed too early (plants smaller than 50 cm).
- ITCs and hydrogen cyanide are volatile; therefore, the macerated residues need to be incorporated as soon as possible and the soil needs to be sealed by rolling or irrigation to avoid their loss into the atmosphere.

Managing a biofumigant crop

Growing a biofumigant crop requires good management and attention to detail, similar to a vegetable crop. Unlike many of the low-input, low-management green manure crops, biofumigation crops may need some fertiliser and irrigation to develop properly and obtain the desired effect.

How to obtain a successful biofumigant crop:

- Select species and varieties suitable to the crop rotation and local growing conditions. There are many available, each with specific requirements and benefits.
- Select species and varieties suitable for the rotation to avoid carryover of pests and diseases. Brassica biofumigants should not be used before or after a brassica cash crop, and sorghums should not be used in rotation with sweet corn.
- Use the necessary equipment to manage the crop correctly, from planting to maceration and incorporation.
- Carry out soil analyses to ensure appropriate nutrient management for the biofumigant crop and the subsequent cash crops. Sulphur levels need to be adequate, as sulphur is fundamental to produce GSLs. Sufficient boron is important for brassicas.
- Time planting and termination to maximise biomass ITC production. In brassicas GSL levels are highest at 25% flowering. Brassica biomass production at termination is higher in cooler months, with soil temperatures above 12°C improving ITC formation.

- Incorporate sorghum 4-6 weeks after planting, when its biofumigant compound is at its highest level.
- Seed at the recommended rate to maximise biomass.
- Macerate and incorporate correctly and in the right conditions (e.g. incorporation might damage soil structure if soil moisture is too high).
- Seal the soil surface straight after incorporation to avoid loss of volatile biofumigant compounds into the atmosphere. Rain, irrigation or rolling can be used. Sufficient soil moisture is also needed for the chemical reaction that produces ITCs.

Benefits of biofumigants may not always be evident immediately after the first crop.

N.B. Biofumigants should not be grazed; sorghum and Sudan grass can be lethal to animals.

If a biofumigant crop has to be terminated early, you will still get benefits compared to bare soil!

All agronomy management practices should be discussed with your production advisor.

Further reading

- Guide to Brassica Biofumigant cover crops
- Webinar: Biofumigation Cover Crops PART 1: What variety and when?
- Webinar: Biofumigation Cover Crops PART 2 Pest & diseases & impact on soil-borne diseases
- Soil Wealth Webinar: Biofumigation cover crops in vegetable production with Julie Finnigan
- Controlling soilborne diseases and pest with biofumigants

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MORE INFORMATION

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