Soil fumigant

TECHNICAL INFORMATION

LAISOL

LAISOL®

1. *Introduction*

Reduced harvest yields caused by the "tired soil" effect, is well known by all farmers. The action of pathogen fungi, insects and nematodes, together with the accumulation of toxins produced by previous cultivation, are some of the factors that lead to the gradual reduction in yields and quality of subsequent harvests.

LAISOL is a general soil fumigant, based on **Metam sodium,** with fungicide, insecticide, nematicide and herbicide activity.

In a period of change in soil disinfection, treatment with **LAISOL** emerges as a respectful and trustworthy fumigant, without any type of ecotoxicological problems, enabling the regeneration of soil fertility and maintaining or increasing the yield and quality of harvests.

The Metam sodium of **LAISOL** is chemically strengthened by adding a series of special aids, during the manufacturing process, that provide greater stability and penetration in the soil. In this way, breakdown is slower giving a more complete treatment of all the soil, improving its fumigant action. It is also possible to apply lower dosages than other similar compounds.

2. *Action method*

2.1. *Breakdown*

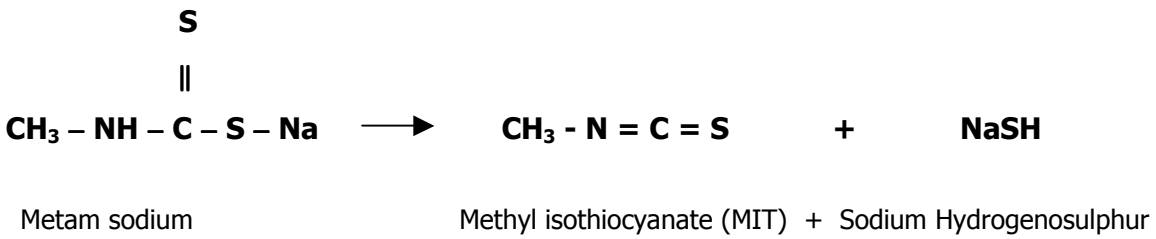
LAISOL is a synthesis organic product based on **Metam sodium** and formulated as a soluble concentrate. When diluted with water it breaks down into an active and volatile compound called **methyl isothiocyanate (MIT)** which spreads in the soil in the form of gas.

Spreading and breakdown of Metam sodium in the soil is a complex process that depends on several factors:

- pH of the soil
- Temperature
- Moisture
- Texture
- Content of organic matter
- Physical properties of the product

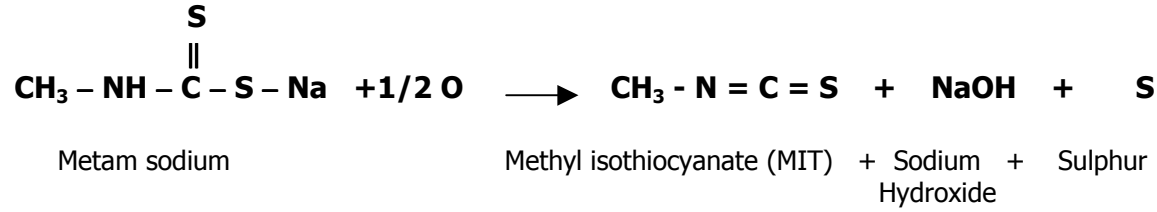
- **pH**
  The pH of the soil considerably affects the breakdown of Metam sodium. Breakdown products differ as the pH of the soil varies. In the majority of agricultural soil, in which the pH is neutral or slightly alkaline, MIT is obtained as the main product.

  In <u>neutral solutions</u>, Metam sodium breaks down into methyl isothiocynate (MIT) and Sodium Hydrogenosulphur (NaSH):



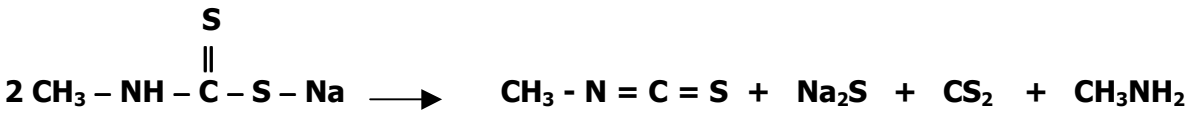
Metam sodium — Methyl isothiocyanate (MIT) + Sodium Hydrogenosulphur

  In <u>diluted alkaline solutions</u> an oxidation reaction occurs, characterised by the formation of elemental sulphur (S) and MIT:



Metam sodium — Methyl isothiocyanate (MIT) + Sodium Hydroxide + Sulphur

In <u>acid solutions</u> a non-oxidative breakdown is produced which initially produces half the MIT formed in the oxidative breakdown:



Metam sodium — Methyl isothiocyanate (MIT) + Sodium Sulphur + Carbon Sulphur + Methylamine

- **Temperature of the soil**.
  The breakdown speed of Metam sodium to MIT and the disappearance of MIT increase considerably as the temperature rise.
  The ideal temperature interval is between 10 and 25ºC <u>at a depth of 10 cm.</u>
  At higher temperatures and if the soil is too dry, vapour spreads quickly and escapes easily.
  At very low temperature, the spreading of the product is very limited and the minimum necessary concentrations cannot be achieved.

- **Moisture of the soil**.
  In dry soils, the spreading speed is so fast, particularly at surface level, that lethal dose of fumigant cannot be achieved. On the contrary, in very damp soils, the majority of pores become saturated with water and the vapour spreads unevenly with difficulty through the profile of the soil, causing deficient disinfection.
  As a general rule, the spreading speed of Metam sodium through the soil increases as the moisture of the soil decreases.
  Another factor is the breakdown of Metam sodium to MIT. Metam sodium is a stable product in concentrated alkaline solutions, but rapidly breaks down in diluted solutions. It has been observed that 2-3% dilutions of Metam sodium are stable for several days. On the contrary, solutions lower than 1% breakdown very quickly in just a few hours, and is therefore not recommended.
  The control of water during treatment and sealing is of vital importance to guarantee the effectiveness of disinfection.

- **Texture**
  In loose, sandy soil, gas is spread quicker and more effectively. On the contrary, the porous space of heavy, clay soils could be blocked, thereby preventing the product from being spread.

- **Content in organic matter**
  In soils rich in organic matter, gas is spread less favourably and the adsorption effect of active matter occurs. Dosage should be increased taking care to avoid unwanted releases later on.
  Once the waiting time is over, the aeration process must be performed and it must be checked that MIT does not exist before planting or sowing.

- **Physical properties of the product**
  At a given temperature, the ratio between the concentration of fumigant in the liquid phase (water) and gaseous phase of the soil is constant and depends on the solubility of the product in water and its vapour tension. This ratio, expressed as a concentration in water/concentration in air at 20ºC, is 19 for cis-1.3-dichloropropene (active component of DD) whereas for MIT, it is 92.
  The magnitude of this ratio determines the spreading speed of the fumigant from the liquid phase to the gaseous phase. If it is low, the product will move rapidly, and if it is high, it will move slowly. Therefore, under the same conditions, MIT spreads more slowly than cis-1,3-dichloropropene.

2.2. *Action method*

Methyl isothiocyanate (**MIT**), the main Metam sodium breakdown product, intervenes by chelation on the enzymes with metal radical and stops the absorption of oxygen in cellular respiration.

Scientists of the CSIRO Plant Industry Research Centre of Australia have recently demonstrated that some edible *cruciferae* of the *Brassica* genus such as rapeseed (*Brassica napus oleifera*) and mustard (*Brassica juncea*) act as natural fumigants, with positive effects on the yield of later cereal cultivation.

The effectiveness of these *Brassica* is because they synthesise **glucosinolates** which transform in the soil, into volatile **isothiocyanates** (ITC) with a very similar structure and action to the metabolites of the **LAISOL** breakdown**:**

PRODUCT	Composition	Metabolites
LAISOL	S ‖ R – NH – C – S - Na **Metam sodium**	R - N = C = S + NaSH **Methyl isothiocyanate (MIT)**
Brassicas	S- glucose ‖ R - N = C – O.SO_2O-X **Glucosinolates**	R - N = C = S + glucose **Isothiocyanates**

This mechanism acts as a natural "biofumigation", the result of which depends on the type of cruciferous used, the type of soil, the weather conditions, the form of breakdown of the cruciferous residues and on the type of the next cultivation (species and variety).

The metabolites of the **LAISOL** breakdown have the same structure and act in the same way as some natural products obtained from some *Brassicas* with the added advantage that it is a much more controllable process with predictable positive results.

Under the recommended conditions of use, **LAISOL** does not produce phytotoxic effects and does not completely sterilise the soil. It has been observed that it respects the antagonist fungi *Trichoderma* and therefore helps to restore the favourable microbiological balance of the soil, reinforcing the effect of the treatment.

The disinfection of soils with Metam sodium is a practice authorised by the European Directive for the Integrated Production in grapevines, published by the OILB (*Organisation International de Lutte Biologique et Intégrée contre les Animaux et les Plantes Nuisibles).*

3. *Special formula*

The Metam sodium of **LAISOL** is chemically strengthened by adding aids, with a surface active and stabilising effect, to improve its disinfection power.

The special formula of **LAISOL** gives it significant advantages over other traditional Metam sodium products:

- **STABILITY**
  The breakdown into methyl isothiocynate in the soil is delayed a few hours, and therefore reduces the loss that often occurs between incorporation and sealing.

- **PENETRATING ACTION**
  The reduction of surface tension helps penetration and spreading of the product throughout the whole volume of the soil. Effectiveness of disinfection increases considerably as the product is more evenly spread leading to uniform disinfection.

- **GREATER WETTABILITY**
  As wettability increases, **LAISOL** forms a fine film that covers all particles of the soil, thereby achieving quicker and more complete disinfection.

- **EFFECTIVENESS AT LOWER DOSAGE**
  The reduction in loss, and the higher yield of the product mean that **LAISOL** can be applied at significantly lower dosages than other Metam sodium, even increasing its effectiveness.

4. Applications

LAISOL is authorised for the disinfection of soils for seedbeds, nurseries and all types of plants (vegetables, strawberries, ornamental plants, grapes, fruit trees, etc.).

LAISOL has a wide spectrum of activity against many organisms that infect cultivation soil, such as:

ACTION	SPECTRUM OF ACTIVITY
FUNGICIDE	*Armillaria spp.* *Fusarium spp.* *Phytophthora spp.* *Plasmodiophora brassicae* *Pythium spp.* *Rizhoctonia spp.* *Verticillium spp* *Sclerotinia spp.* Others
NEMATICIDE	*Hoplolaimus spp.* *Meloidoygine spp.* *Pratylenchus spp.* *Dytylenchus spp.* *Rotylenchus spp.* Others.
INSECTICIDE	Elateridae Melolonthidae Noctuidae Terricolae larvae of other insects
HERBICIDE	Annual herbaceae species Some perennials (*Oxalis, Convolvulus, Chenopodium, Malva, portulaca, etc.)*

5. *Application method*

5.1. *Application conditions*

LAISOL can be applied during any season of the year, before planting or sowing, bearing in mind the following conditions to stimulate the action of the product:

- **Preparation of the ground**
  Remove completely all remains of previous plants. Do not bury them unless they are finely crushed to avoid possible sources of reinfection. Work the soil to a depth of 25-30 cm., leaving the earth lose and without clods nor surface crusts. It is then recommended to level the earth.
  LAISOL should never be applied to established plants and a minimum safety distance of 1 metre should be left between the area to be disinfected and any plants to be protected.

- **Moisture of the soil**
  At the time of application, the soil should be fairly moist, with the same moisture considered optimum for sowing or planting (soil in season or ready for sowing).
  Depending on the characteristics of the soil, the time or year and application method, it may be advisable to slightly water (10 to 12 l/m^2) before treatment.

- **Temperature of the soil**
  The ideal temperature of the soil for disinfection, is between 10 and 25ºC at a depth of 10 cm. At lower temperatures, the breakdown of Metam sodium is too slow, and on the other hand, if the temperature is over 25ºC, the product becomes volatile and is easily lost. In this case, sealing is recommended using a plastic cover.

5.2. *Application dosage*

The application dosage of **LAISOL** can vary between 400 and 900 l/ha.
To determine a more exact dosage, the following factors should be considered:

- **Type of action**
  As a fungicide, nematicide and insecticide, a medium to low dosage can be applied for weak blights and safety disinfection. In cases of strong blights, a medium to high dosage should be used.
  To achieve a good herbicide effect, a higher dosage is required.

- **Type of soil**
  In light or sandy soils, dosage should medium to low. However, in heavier or clay soils, dosage should be medium to high.
  In soils rich in organic matter, a higher dosage should be applied, owing to high retention and the difficulty in spreading the product. However, it is not recommended to excessively increase the dosage, as the risk of phytotoxicity would increase owing to the possible release of fumigant remains adsorbed by the organic matter.

- **Depth of disinfecting**
  If cases of replantations of trees or woody plants, the dosage should be increased to ensure that the product reaches an optimum depth (0.6 to 1 m). In this case, injection is the most suitable application method.

- **Type of sealing**
  Sealing using a plastic sheet, practically prevents losses through direct gasification, and is much more effective than sealing by water sheet. This means that the application dosage can be reduced.

5.3. Application methods

The application method of **LAISOL** is fundamental to achieve a high level of disinfection.

In optimum application conditions (preparation of the ground, temperature and moisture), the product should be localised at a depth of between 20 and 25 cm. This is achieved by watering or by means of a mechanical injection system.

It is very important to bear in mind that in very diluted solutions, **LAISOL** breaks down quickly, and therefore concentrations in water under 2.3% are not advisable. This means that in watering applications, the volume of water used should be carefully controlled.

- **DRIP WATERING**
  The application of **LAISOL** by drip watering is a very practical and simple application method. This system enables the concentration or dilution of **LAISOL** to be precisely controlled, which is essential to the effectiveness of the treatment.
  By knowing the features of the watering system (litres/time/drip, number of drips/surface and the real coverage surface) the time needed to incorporate the dose of **LAISOL** to the required concentration (not less than 2-3%) can be easily calculated.
  The soil should then be slightly watered to wash the system and seal the soil.

- **INJECTION**
  This consists of the mechanical introduction of **LAISOL** in the soil at a depth of 20-25 cm. using an injector plough.
  LAISOL can be applied neat or diluted. In both cases, the output of the product should be calculated depending on the speed of the tractor, and then adjusted to the surface to be disinfected.
  The soil should be worked in depth and with an optimum moisture to assist in spreading and breaking down **LAISOL**. If the soil is too dry, it should later be watered.
  Normally, this type of plough has a roller that flattens the soil to be sealed.

5.4. Sealing

The fumigant action of **LAISOL** is based on keeping a minimum concentration of MIT in the soil for a certain period of time. There are three different ways of avoiding loss of gas:

- **SEALING WITH WATER**
  Immediately after treatment, lightly water the soil to seal it and to prevent gas from being released to the atmosphere. This consists of saturating the most superficial layer of the soil and forming a thin crust. In any event, excessive watering which could wash away the product and/or lead to the breakdown being too quick will be avoided.

- **SEALING WITH PLASTIC SHEET**
  Covering the treated surface with a plastic sheet is the most effective way of stopping losses and improving disinfection. It is recommended to seal with plastic before 15 minutes after the application.

- **FLATTENING OF THE SOIL**
  Slightly compacting or flattening the soil by passing a roller or board over the surface, can be sufficient to avoid loss of gas. This system is usually used in applications using an injector plough, which have a device to slightly compact the soil.

5.5. Waiting time

The normal waiting time for **LAISOL** to start disinfecting is between 15 and 21 days.
In the conditions indicated below, special precautions should be taken in case gas residues are still found in the soil:
- Very compact soil and with a high organic matter content.
- Temperatures below 16ºC during the disinfection period.
- Excessive moisture in the soil.

5.6. Aeration

After the waiting period, the ground should be worked to assist the remaining gases to escape. Take care not to dig more than a depth of 20 cm, to avoid disinfected soil mixing with lower layers that could quickly cause reinfection.

The new plant can be planted after 5 or 6 days of aeration.

In order to be absolutely certain that there are no phytotoxic residues in the soil, a few lettuces can be planted, which are very sensitive to MIT residue.

TECHNICAL SPECIFICATIONS

LAISOL

PRODUCT	Special soil fumigant
ACTIVE INGREDIENT	a) **Metam sodium: 40% w/v (400 g/l)** b) **Stabiliser: 11% w/v (110 g/l)**
FORMULATION	Soluble liquid (SL)
CHEMICAL NAME	a) Sodium methyl dithiocarbamate
CHEMICAL FORMULA	a) $C_2 H_4 N S_2 Na$
ASPECT	Orange liquid
pH (1%)	10.0 – 11.0
DENSITY	1.17 – 1.19 g/ml
SOLUBILITY	Water soluble (722 g/l a 20ºC).
COMPATIBILITY	Don't mix with other products
ESTABILITY	Stable in concentrate water solution but unstable when diluted and in acid solutions
ACUTE TOXICITY	LD_{50} (oral rats): 2.418 mg/kg LD_{50} (dermal rabbits): 2.359 mg/kg
TOXICOLOGICAL CLASSIFICATION	Corrosive (C) Dangerous for the environment (N)
ENVIRONMENTAL TOXICITY	Mammalians: B. Moderate dangerous Birds: B. Moderate dangerous Fish: B. Moderate dangerous
PACKING	25 litres and 210 litres

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