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FUMIGATION OF NURSERY SOILS FOR NEMATODE ERADICATION

(This Advisory Circular supersedes Advisory Circular PM 11 Serial No. 05/09 issued in November 2009 and related previous Advisory Circulars)

1. Introduction

Parasitic nematodes, once introduced into fields, cannot be eradicated even by chemical means and hence, adopting preventive measures are of paramount importance in the integrated nematode management strategies. As such, in the integrated nematode management strategies, methods of control are largely confined to treatment of nursery soils.

2. Nematode Control in Nurseries

Nurseries are the usual focal points of spread of nematode infestation. Nematode spread through planting materials has been evident within an estate, from estate to estate, estates to small holdings and even among tea growing areas in different agro ecological regions. Resultantly, poor early establishment and growth, yield decline, and even death of mature plants can occur. This is especially so with the usage of nematode tolerant tea cultivars that may possibly carry nematodes without showing symptoms in the nursery plants. It is therefore, essential to take all precautionary measures to prevent nursery plants from being contaminated with plant parasitic nematodes as there is no curative method and the yield losses cannot be compensated by any other means. Hence, disinfection of nursery soils and the premises is compulsory in all tea growing regions. Amongst various methods, soil fumigation using chemicals is the most effective means of nematode eradication in nursery soils.

All soils and nursery premises should be mandatorily fumigated and ensuring nursery hygiene to eradicate all possible contaminations with nematode pests in view of guaranteeing nematode free planting materials.

3. Prerequisites for Fumigation

In order to assure effective soil fumigation process and avoid failures, the following prerequisites should strictly be followed with advance planning in addition to the Good Nursery Practices (GNPs) specified in Advisory Circular PN 2.

3.1 Nursery Site

- Select a little elevated location above tea fields and a demarcated area with deep drains to avoid subsequent cross contaminations through runoff water from surrounding nematode infested tea lands.
- Avoid locations with a history of nematodes as far as possible to reduce risk of possible contaminations.
- Reserve an adequate floor space in the nursery site to spread the soil volumes for fumigation purpose, preferably a disinfected area.
- Select the premises away from resident areas and heavy human and animal movements to avoid exposure to the chemicals.

3.2 Raised Beds

Always use raised beds to avoid re-contamination through water and worker movements to ensure proper hygiene. Raised beds will improve the drainage of beds as well.

3.3 Soil

- Choose the suitable soils in adequate volumes for fumigation after sieving the soils.
- Avoid selecting dry soils. Moist the soil two weeks before fumigation to activate moribund nematodes, fungi, bacteria *etc.*, and to induce germination of weed seeds, which would enhance fumigation efficiency. However, avoid wetting the soil 5 days prior to fumigation, as the soil should not be excessively wet at the time of fumigation.
- Keep the soil preferably in a shed until use, to avoid drying and / or wetting
- Turn the soil heap into a rectangular shape box with a height not exceeding 20 cm (8 inches) and any convenient width and length to accommodate the required soil volume (one cube of soil is equal to 100 cubic feet)

3.4 Irrigation

Irrigation water could contaminate the nurseries with parasitic nematode species. Therefore, please refer to Advisory Circular PM 8 for arranging irrigation water or well water system in advance to ensure pathogenic nematodes free water.

3.5 Materials

Required quantities of fumigants recommended by the TRI (Please refer Advisory Circular PU 4), undamaged transparent / translucent polythene sheets of gauge 500, mammoties or shovel and watering can.

3.6 Safety

- Select masks, gloves and boots to suit the workers
- Make the first aid kit available in the premises
- Arrange the record keeping factsheet (Table 2) and Re Entry Interval (REI) warning board

4. Soil Fumigants

Soil fumigants are substances or mixtures of substances which produce gas, vapour, fumes or smoke expected to reach and kill all forms of biological organisms.

The objective of fumigation is best achieved when nematodes are fully active and the fumigant is readily transformed into fumigating substances. Also, it is necessary that the contaminated soil is exposed with free movement of fumigating substances and the treated soil is aerated to allow untransformed fumigants to disperse after the process.

4.1 Mode of Action of Fumigation

The chemical on contact with soil moisture, is transformed into active compounds mainly methyl isothiocyanate (MITC) which are light in weight and volatile in nature. The production of MITC depends mainly on soil moisture and temperature.

The MITC fumes penetrate spaces between soil particles destroying the active soil organisms and germinated seeds. As the effectiveness of fumigation process depends on concentration of the active compounds transformed and the length of exposure to target organisms, the texture and moisture of soil, physiological state of the organisms and degree of covering treated soil are the determining factors. Nematodes in root fragments, nematodes in resting or dormant stages, dormant seeds are unlikely to be destroyed while, all the free living and motile nematodes and germinating seeds are affected. Chemical transformation in soils occurs within 1 - 5 hours depending on the type of soil used. Odour of hydrogen sulfide and the strong eye-irritating properties of MITC can be experienced soon after application of fumigant. Immediate and complete covering would therefore be critical and helpful to avoid rapid loss due to volatilization and to enhance the performance of fumigation process. Exposure of soil for one week completely eradicates the nematodes. Thereafter, the cover should be removed to escape residual MITC fumes which would otherwise cause phytotoxic effects on cuttings. Mixing and turning the treated soils several times at regular intervals would help to enhance this process.

5. Soil Fumigation Process

5.1 Method of Soil Fumigation

The soils prepared for fumigation should be treated according to the schedule given in Table 1 in order to ensure effective fumigation process.

Table 1. Schedule of nursery fumigation

Step	Operation	Time
1	Prepare soil heap and keep soil moisten	At least 2 weeks before soil fumigation
2	Nursery bed sterilization: Fumigation / polythene layer	At least 2 weeks before soil fumigation
3	Pierce 1-3 holes in the metal lid of the Metham sodium bottle and the spread / sprinkle the required amount of fumigant evenly.	
4	Mix the chemical immediately into soil by turning the soil uniformly using a mamoty	
5	Level and turn the treated soil in to a rectangular shape box to a height not exceeding 20 cm (8 inches)	
6	Moisten soil lightly by a watering can	
7	Cover the soil immediately with a 500 gauge transparent polythene sheet and seal completely	
8	Remove the polythene cover	8 th day after treatment
9	First mixing / turning of the soil	9 th day after treatment
10	Second mixing / turning of the soil	12 th day after treatment
11	Third mixing / turning of the soil	15 th day after treatment
12	Bagging soil	22 nd day after treatment
13	Planting cuttings	29 th day after treatment

5.2 Record Keeping

All the steps followed as per the time schedule including the names of person/s fumigating individual soil heap/s should be recorded for reference by managers, inspectors and / or extension personnel. Sample of a record keeping factsheet is shown in Table 2. It is also advisable to maintain such records on display boards along with individually treated soil heaps.

Table 2. Record keeping factsheet

Details	Soil heap No.				
	1	2	3	4	5
Volume of soil prepared					
Amount of fumigant used					
Treatment done					
Restricted Entry Interval (REI) (8 th day after treatment)					
Removal of polythene cover (8 th day after treatment)					
First mixing (9 th day after treatment)					
Second mixing (12 th day after treatment)					
Third mixing (15 th day after treatment)					
Bagging soil (22 nd day after treatment)					
Planting cuttings (29 th day after treatment)					

6. Nursery Bed sterilization

Previous nursery beds could possibly contain nematode infested soil as well as tea root fragments with residual nematode populations which could bring infestation to the new plants. Hence, it is essential to treat the nursery beds prior to stacking nursery bags in order to avoid possible contamination with treated soil.

The following should be carried out at least two weeks prior to stacking of the nursery bags filled with fumigated soil.

- 1) Bed fumigation using bleaching powder at the rate of 10 g per square meter basis. It is important to remove all roots from the bed by forking.
- 2) Lay a thick gauge porous polythene over the bed.

Never use un-fumigated soils such as soils from drains and beds for stacking and restacking purposes, and for other general nursery operations. Therefore, always maintain a reserve of fumigated soil for such purposes.

In case there is a history of nematodes in the nursery and/ or surrounding area, please obtain additional advice on precautions and treatments from Nematologist, TRI.

7. Safety

7.1 Occupational and Residential Exposure

For personal safety, Personal Protective Equipment (PPE) and protective clothing should strictly be used by the workers during treatment.

Following treatment, human and animal entry should be prevented by imposing Restricted Entry Interval (REI) of 8 days. A display board should be visibly posted at the fumigated site.

7.2 Environmental Safety

Adequate measures should be taken to dispose used bags, containers and bottles of the fumigants to avoid dissipating chemical residues to air and water bodies.

Fumigants should always be stored under cool and humid conditions and away from direct sun light and heat. Plan to use the whole bottle of Metham for appropriate volume of soil; once opened, do not leave any balance in the bottle for reuse.

Note: As soil fumigation is mandatory for all the tea growing regions, nursery soils need not be tested for nematodes.

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