Technology in Soil Sterilization©

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INTRODUCTION

Soil pasteurisation/sterilization with steam is a common practice in Europe and parts of the United States of America, where boilers have in any case been available for heating. For the past 8 years Agrelek has done a lot of research and development with low-pressure steam boilers. This electrode steam generator has been successfully introduced into the nursery industry.

METHODS

Chemical fumigation of soil is widely practised in South Africa. A range of chemicals are available, each with its own characteristics. Most chemicals designed for fungus and bacterial control act by interrupting the normal life processes within plants and animal cells without disrupting their chemical and physical characteristics, as heat treatment does.

The earliest method of soil sterilisation required dry heating of soil. It was achieved simply by making a fire above or below it. This method can burn the soil and has several other negative side effects but, where no other method is available, its advantages usually outweigh the disadvantages. Dry heat primarily kills by an oxidation process.

Soil solarisation is a means of controlling root-infecting organisms through hydrothermal heating of soil, accomplished by covering loose moist soil with transparent polyethylene sheeting during the summer months. The effectivity of solarisation is largely dependent on weather conditions. Generally up to 6 weeks of summer sunshine may be required to effect disease control, but soil type, moisture content, density, and type of infestation will determine overall effectivity.

Moist heat or steam kills by a coagulation of the organism's proteins when the latent heat in this steam is released and come into contact with a body cooler than itself. Steam, if properly applied, is much less dangerous to use to both plants and operator, than fumigants. It leaves no harmful residue, but consequently requires a higher degree of post-treatment sanitation.

APPLICATION OF STEAM TREATMENTS

Various methods have been devised to apply heat treatment to soil over recent years. Most of these methods are custom-designed to treat a specific volume of media in a specific time with a specific amount of energy.

Various systems have been developed over the years. Here follows a short description of some of them:

- Drum: an insulated 210-litre drum and lid can be mounted between two posts. Steam can be introduced into a sieved plenum at the bottom of the drum. Such a system, using multiple containers, could be very efficient, producing, after an initial start-up period, 200 litres of medium every 15 min, using a 40-kw steam generator.

- Rubber dustbins: municipal dustbins without the plenum chamber are used successfully on most media. A 60-kw steam generator will take 3 to 5 minutes to sterilise the media, depending on the media type and moisture content.
- Cube box: this method makes use of a 1 m^3 box with a lid. Low-pressure steam is introduced into a sieved planum chamber at the bottom of the box. This process can take from 20 to 60 minutes, depending on the media and the size of the boiler.
- Vacuum steaming: this method is ideal for steaming very wet media and/or media that has organic fibres that become soft and collapse with heat treatment, causing back pressure, which affect pasteurising temperatures. Steam is introduced from the top of the box and moisture draining from the box creates a partial vacuum in the media, which assists steam percolation through the media.
- Bin steaming: this implies media volumes of more than 1 m^3. This process can take several hours, depending on medium, volume, type, steam volume, and insulation quality. This steam is again introduced via a sieved plenum or pipe manifold under the media. Batches of up to 15 m^3 have been successfully pasteurised in 10 to 12 h using a 60-kw steam generator.
- Hoddeson pipe system: this is an in situ greenhouse batch sterilization process that uses a network of 40-mm diameter pipes, buried 400 mm below the soil to be steamed. The volume of steam required is determined by the size of the bed. The pipes are recovered from the soil after the period of cooling.
- Sheet steaming: this involves simply laying a sheet of suitable material over the soil bed in situ and supplying steam to the underside of the sheet so that it penetrates downwards into the soil. This may require 10 to 30 kg of steam $h^{-1} \cdot m^{-2}$. It can take several hours to bring the soil to the required temperature.

EQUIPMENT

Agrelek has developed a low-pressure steam generator that can generate steam of up to 120 $kg \cdot h^{-1}$. The boiler is mobile and could be used via the connection of a welding plug onto a trailing cable and a standard hosepipe connection. The boiler can be wheeled to its points of use, connected to its power and water supply, and provide instantaneous steam for batches of media of up to 15 m^3.

The sterilised media would be available for planting within 1 h after reducing the temperature, while the boiler would be ready immediately for use on a new batch. A one-person operation could do 8 m^3 per day in batches of 1 m^3 using a 40 kilowatt mobile electrode boiler. Larger installations could be scaled up for larger quantities of media and could be automated to operate at night, using cheaper off-peak electricity.