

Effect of active steam disinfection on soil microorganisms and strawberry plants health and yield.

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Abstract

Trials applying a steaming system exploiting the exothermic reaction between steam and CaO (Bioflash System™) were carried out on fields and the effect of the treatment on the soil microorganisms populations and plant pathogens and pests was assessed. The treatment generally almost completely eliminated the population of pathogenic fungi in the soil. An increase of Trichoderma sp. was registered a month after the treatment. A modification of the bacteria population was also observed, with an increase of potentially beneficial species belonging to Pseudomonads and Bacillus genera. The treatment provoked a reduction of nematodes population, and the plant parasitic species were controlled almost totally. The active steam disinfection treatment decreased the number of Verticillium dahliae propagules in the soil of strawberry nursery, which had a positive effect on reducing the severity of Verticillium wilt. The yield of marketable plants was higher than control in both years, even if not consistent.

Introduction

Soil steaming is the technique with the broadest spectrum of action among the methods of control of soil-borne pathogens that can be used in organic farming. The use of substances with exothermic reaction (active steam) that allow the reduction of energy consumption in conjunction with the development of mobile systems have been proposed to overcome several constraints of this technique. We have applied this technique to different soils and evaluated the effect on the soil microorganisms, both pathogenic and beneficial, as well as on Verticillium wilt infection of strawberry nurseries.

Material and Methods

Trials applying a steaming system exploiting the exothermic reaction between steam and CaO (Bioflash System™; Tesi *et al.*, 2007) were carried out on fields and the effect of the treatment on the soil microorganisms populations was assessed. The evaluation of the efficacy of the treatment was based on plant health, assessment of *V. dahliae* microsclerotia population density in soil, plant growth and yield of stock plants. The economic evaluation of the treatments was carried out by comparing the net marginal return (NMR) and by calculating the return on investment (ROI). The disinfection with active steam was applied in April 2011 and 2012, for a time of about 15 sec·m² to reach a soil temperature of 60-70 °C, which was maintained for about 2 hours. The control plots were not fumigated. The self-propelled tractor Eco Star SC 600 distributed CaO on the soil (400 g·m⁻²) and mixed it while injecting water steam at 90°C at a depth of 15-20 cm; the soil was then rolled and covered with VIF film. Each treatment was arranged in a block of four rows covering in total about 1000 m².

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Results and Discussion

Active steam treatment caused about a 5-fold decrease of fungi and totally eliminated harmful fungi such as *Fusarium* and *Rhizoctonia*. The size of the soil bacteria population was not changed by the active steam treatment. However, the structure of their population was modified: while the number of Pseudomonads decreased about 5-fold, the number of *Bacillus* spp., potentially beneficial species, increased by about 50 %. An increase of *Trichoderma* sp. was registered a month after the treatment. The treatment provoked a reduction of nematodes population, and the plant parasitic species (including lesion nematodes) were controlled almost totally.

In case of the strawberry nursery, the active steam disinfection decreased the number of *V. dahliae* propagules in the soil, which had a positive effect on reducing the severity of *Verticillium* wilt, but not to the same extent in the two years. Indeed, the treatment reduced the severity of wilting symptoms in the first year by about 80 %; in the second year the plants affected were less, but not statistically different from the control. We consider that the not complete consistency in controlling *Verticillium* wilt by steaming probably cannot be fully accounted to the treatment alone, but also to other environmental factors. The plants on the plot disinfected with active steam were also growing on average about 10 % more than the control. However, no influence on the production of runners and of daughter plants was observed. Nevertheless, the yield of marketable plants was higher than control in both years, even if not consistent. The overall result of the treatment can be assessed by the economical analysis: the steaming treatment resulted economically viable only in one year. However, we have not included in our economical evaluation the impact from some externalities that could be considered when assessing the new technology and change the overall economic result.

The positive changes in the soil microorganisms populations and the economical viability of this practice can make soil disinfection with active steam a feasible treatment to reduce the impact of soil-borne pathogens and pests on organic horticultural crops.

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References

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