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Weed suppression by soil steaming in combination with activating compounds

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Summary

The aim of this study was to determine the weed suppression potential of soil steaming plus activating compounds (KOH or CaO) to boost soil temperature. Different combinations between the compounds and rates were tested in experiments carried out in the field and in a controlled environment. Treatment effects were assessed on field weed vegetation and on seedbank and seedling emergence of three winter (*Alopecurus myosuroides*, *Matricaria chamomilla* and *Raphanus raphanistrum*) and four spring annuals (*Amaranthus retroflexus*, *Echinochloa crus-galli*, *Fallopia convolvulus* and *Setaria viridis*), were assessed on field weed vegetation. Neither maximum soil temperature (from 72 to 85°C) nor duration of high temperature in the 3 h following application consistently affected weed suppression. In the field, no significant effects on total weed density were recorded, but there were some significant effects on individual species. The weed seedbank was clearly suppressed by activated steaming: total seedling emergence was inversely related to increasing KOH rates both in the 0–10 and 10–20 cm soil layers, while for CaO the relationship was significant only in the 0–10 cm layer. Winter annuals were more sensitive to KOH than CaO and spring annuals had a more pronounced species-specific response to treatments. There was a strong negative relationship between compound rate and seedling emergence for all species. *Alopecurus myosuroides* was the most sensitive to the steam-alone treatment (77% reduction), whereas *M. chamomilla* and *E. crus-galli* were the least sensitive. Results from this study indicate that the type and rates of activating compounds for soil steaming must be adjusted to the weed community composition.

Keywords: integrated weed management, soil disinfection, methyl bromide substitutes, non-chemical weed control, preventive methods, weed seedbank.

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Introduction

Growing societal attention for environmental protection and food safety and the phasing out of methyl-bromide has stimulated research into alternative methods for soil disinfection. Solarisation is a viable alternative in Mediterranean and tropical areas (Sauerborn *et al.*, 1989; Kumar *et al.*, 1993). However, besides its limited use (just in summer months), soil solarisation subtracts vast areas from production for periods up to 3 months (Ricci *et al.*, 1999). Moreover, radiation intensity and the consequent soil temperature increase to a maximum of 55°C at 5 to 10 cm depth for 40 days (an increase of up to 11°C with respect to the non-solarised soil) (Ahmad *et al.*, 1996; Habeeburrahman & Hosmani, 1996; Arora & Yaduraju, 1998) are often insufficient to guarantee good results.

The limits of soil solarisation can be overcome by the use of hot steam, a common practice in greenhouse horticulture, but not yet adapted to large-scale field application. With soil steaming, temperatures of up to 100°C have been registered for about 10 min at 15 cm depth, after which temperature gradually decreased to 40°C (Raffaelli *et al.*, 2002).

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