ESTIMATED COSTS TO DISINFEST SOIL WITH STEAM

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Summary. Lack of energy efficient steam applicators and relatively inexpensive fumigants has led many to conclude that steam is not a viable alternative to methyl bromide (MB). Here we analyze the economic viability of steam application techniques available on the market place. The economics of two approaches to steam application are evaluated: 1. the Ferrari Sterliter, a commercial steam applicator from Italy, 2. a custom made steam injection auger for almond replant. Based on published results these applications can be made in flowers for less than $2500/A and in almonds for less than $400/A.

Introduction. The Ferrari Sterliter is commercially available in the USA though Oxbo Distribution, and we are testing this machine under a lease (Fig. 1). This machine injects steam into flat soil or raised beds, working automatically on tracks in greenhouses and open fields. The machine is intended for sterilizing at 10 to 20-cm depths, depending on the time of steam injection (~5 min for each 10 cm). The Sterilter steams an area of approximately 8 m by 1.5 m and can treat 0.88 to 1.6 acres per day depending on the model and depth of sterilization (Ferrari, 2009). The unit is mobile, powered by a diesel engine. Frontal plates on the machine allow it to thoroughly heat the soil, granting a homogeneous sterilization process, and preventing any wasteful leakage of steam (Ferrari, 2009). The machine has temperature sensors to constantly monitor the temperature during steam injection. Results from the Univ. of Turin indicate that the Sterilter achieved temperature quickly, in 5 to 7 minutes, and remained above 70°C for >20 min.

Fig. 1. The Ferrari Sterilter a commercial steam

Pre-plant soil fumigation has been used to prevent almond replant disease (RD), but increasing regulatory restrictions are complicating use of these treatments. With the phase out of MB in 2005, many almond growers shifted towards the use of 1,3-dichloropropene (1,3-D) for pre-plant soil fumigation. Use of 1,3-D has been effective for reducing nematode populations in course-textured soils, but it has been less effective for this in clay loam and clay soils and for controlling RD. It was determined that chloropicrin (CP) and mixtures of it with other fumigants can provide excellent control of RD. Furthermore, hand-probe and GPS-controlled-shank spot fumigation treatments with CP or CP + 1,3-D,

which focus effective fumigants on the sites where trees are to be planted and involve treating only about 10% or less of an orchard's area, were recently shown to provide adequate RD control (Browne et al., 2006; Browne 2008; Coates et al., 2008). Use of soil fumigation treatments, however, is increasingly subject to regulatory complications including, but not limited to: the phase out of MB, Telone Township Use Caps, emissions of volatile organic compounds, and the reregistration of soil fumigants. In orchards we are planning to use a tractor mounted 36-inch diameter auger to inject steam as described in Moyls and Hocking (1994). Those researchers working in apple in Canada found that 2 minutes of steam application per planting hole was sufficient steam application time to raise soil temperatures to the 70°C range.

Sterilter analysis. Ferrari manufacturer specifications indicates the machine uses 556 gals of diesel per acre (Ferrari 2009). Based on the $125,000 cash value of the machine we now lease, 100 acres per year machine operation, labor cost, machine and fuel costs, we estimate the Sterilter cost per acre at $2196 compared to $2500 plus per acre for MB (Table 1).

Steam auger analysis. Based on the published estimates of Moyls and Hocking (1994) and our experience with our 20 hp Souix steam boiler we have calculated an estimated cost per acre of $341 with 90 trees per acre (Table 1). Costs included in this estimate are machine costs of $32,291 for the steam generator plus $11,823 for a steam injection auger.

Table 1. Estimated costs per acre of steam for soil disinfestation for the Sterilter steam applicator and for the steam injection auger.

Expense	Auger injector	Ferrari Sterliter
	---------- Cost $/A ----------	
Fuel (diesel)	66	1,301
Labor	106	417
Equipment	160	453
Equipment maintenance	9	25
Total	**341**	**2,196**

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