SOIL SOLARIZATION: A COMPONENT IN CONTROLLING ROOT ROT OF RED RASPBERRY.

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Soil solarization is a process that employs solar radiation to heat soil under a transparent plastic film to temperatures that are detrimental to soilborne pathogens. Increased soil temperatures can decrease populations of weeds and mesophylic organisms, including plant pathogenic fungi, bacteria, and nematodes. The climate in the western Oregon and Washington has proven to be suitable for soil solarization, with soil temperatures achieved comparable to those recorded in California and Florida (Pinkerton et al. 2000). In Oregon field experiments, solarization reduced population densities of *Phytophthora cinnamomi* and *Verticillium dahliae* and disease incidence in susceptible hosts (Pinkerton et al., 2000). Solarization also reduced population densities of *Phytophthora fragariae* pv. *fragariae* and several other pathogens in a strawberry planting (Pinkerton et al., 2002). Solarization more effectively controlled root rot of red raspberry, caused by *P. fragariae* pv. *rubi*, than applications of mefenoxam (Ridomil Gold) in plots with flat beds. Planting raspberries in raised beds and in soils amended with gypsum reduce the incidence of root rot of raspberry (Bristow, unpublished data). The objective of this research was to evaluate solarization, bed shape, and gypsum as components in an integrated program for managing root rot of red raspberry.

Methods. A field experiment was established in Vancouver, WA on a site naturally infested with *P. fragariae* pv. *rubi.* The area was cultivated in July 2000. Treatments were: flat beds, solarized or nonsolarized; raised beds, solarized or nonsolarized, with or without gypsum amended. Gypsum was applied at 1.36 kg per m^2 and the raised bed formed on July 24. The experimental design was split block with 4 replicates. Soil was irrigated to field capacity and allowed to drain for one day before the polyethylene film was laid. A clear 4-mil film was stretched over the solarized plots (3 m x 10 m) and secured by burying the edges. Nonsolarized plots were not covered. Soil temperatures at 10 cm and 30-cm depth were monitored continuously from July 26 through September 8. The film was removed in spring 2001. Flat bed plots were tilled in May 2001. Five Willamette and Malahat raspberry plants were planted in each plot. Weed growth in the plots was rated on 3 July 2001; 0 = no weeds, 5 = dense weed cover. Canes were cut to the ground and weighed on 24 October 2001. Healthy and wilted primocanes of both varieties were counted on 12 August 2002. Cane growth, yield, and disease data will be collected through at least 2004.

Results. Soil temperatures were 10 C higher in raised bed, solarized plots compare to nonsolarized plots (Table 1). Temperature was greater than 35 C for 226 and 8 h at 10 and 30 cm depth in raised, solarized plots.

Cane weights (grams per plant, fresh weight) at the end of the first year (Fig. 1) and cane number in August 2002 (Fig. 2) were greater in raised bed, solarized plots than in other treatments. Disease incidence, percent of canes that were wilted, was greater in the nonsolarized plots (Fig. 3). Gypsum amendments did not improve plant growth or reduce disease incidence. Solarization of flat beds was not as effective in managing root rot as in the previous experiments (Pinkerton et al., 2002).

Solarization reduced weed growth in 2001 (Table 2) and these effects still were visible in 2002 , two years after solarization.

Conclusions. Based on the results from two experiments, suppression of root rot observed in solarized soils was similar to that obtained with methyl bromide fumigation (Johnson et al., 1972), i.e. disease incidence significantly increased in the third year. Observation in the current study suggest that solarization of raised beds may extend this period. Solarization could be incorporated in current production practices. The film could be laid while forming the raised beds and burying drip irrigation tubing. Raspberry could be planted through the film early the following spring. This tactic would increase soil temperatures and promote early season root development, and would extend the period of weed control at least one season. At an estimated \$250 to \$500 ha^{-1} for the film, solarization is viable option in an integrated program for managing root rot of red raspberry.

Johnson, F., Crandall, P. C. and Fisher, J. R. 1972. Soil fumigation and its effect on raspberry root rot. Plant Dis. Reptr. 656:467-470.

Pinkerton, J. N K. L. Ivors, K. L., Reeser, P. W., Bristow, P. R., and Windon, G. E. 2002. The use of soil solarization for the management of soilborne plant pathogens in raspberry and strawberry production. Plant Disease 86:645-651.

Pinkerton, J. N., Ivors, K. L., Miller, M. L., and Moore, L. W. 2000. Effect of soil solarization and cover crops on populations of selected soilborne plant pathogens in western Oregon. Plant Disease 84:952-960.

Table 1. Soil temperature from 27 July to 8 September 2000.

				Cumulative hr.	
Treatment		Depth (cm)	Max temp.	>35	>40
Flat bed	Nonsolar	10	32.3	0	0
		30	28.0	0	0
Flat bed	Solar	10	41.6	151	0
		30	32.1	0	0
Raised bed	Nonsolar	10	32.6	0	0
		30	26.1	0	0
Raised bed	Solar	10	44.0	226	0
		30	35.3	8	0

Table 2. Weed rating recorded 3 July 2001.

Treatment			Weed rating[z]
Flat bed	Nonsolar	No gypsum	3.3 a
Flat bed	Solar	No gypsum	2.1 a
Raised bed	Nonsolar	No gypsum	3.1 a
Raised bed	Solar	No gypsum	1.5 b
Raised bed	Nonsolar	Gypsum	3.4 a
Raised bed	Solar	Gypsum	1.9 b

[z]Rating: 0 = no weeds, 5 = dense weeds. Means followed by a different letter are significantly different based Duncan's Multiple Range Test.

Figure 1

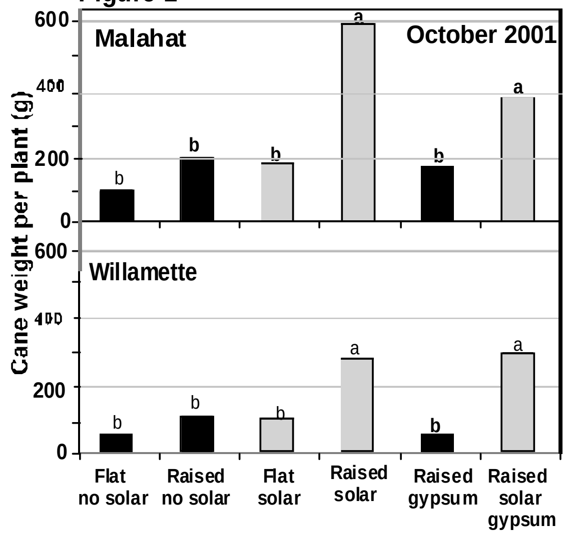

Figure 2

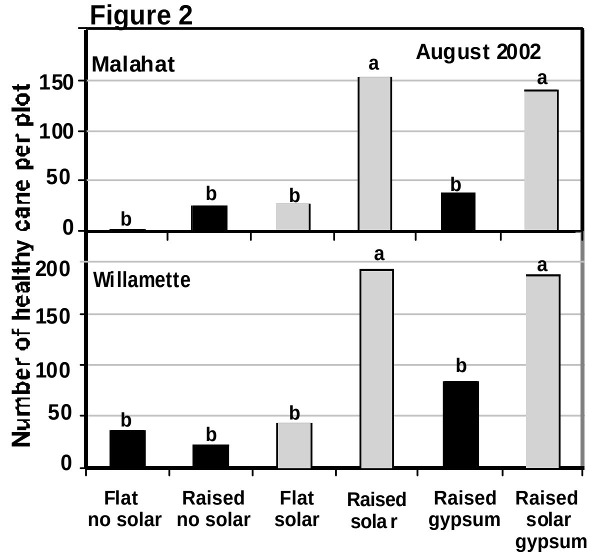

Figure 3