RASPBERRY (*Rubus idaeus*) cv. 'Tulameen'
Phytophthora root rot; *Phytophthora rubi*
Crown gall; *Agrobacterium tumefaciens*
Root lesion nematode; *Pratylenchus penetrans*

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Pre-plant management alternatives to fumigation for raspberry, 2008-2009.

Soil solarization is an important component of soil borne disease management systems in many regions. Solarization and a combination of solarization plus InLine (1,3-dichloropropene: chloropicrin, 61:33, 400 L/ha) or a brassicaceous seed meal (*Sinapis alba*) were investigated as pre-plant management fumigant alternatives for raspberry production in northwestern Washington. Non-treated and linseed seed meal-amended control plots were also included. Field plots were established at the Washington State University-Northwestern Washington Research and Extension Center in Mount Vernon, WA on 15 Jul 08 and both seed meal treatments were applied. Each plot was a single raised bed (5 m x 20 cm x 94 cm). Beds were shaped and both drip tape and smooth, clear plastic mulch (Robert Marvel Plastic Mulch, Annville, PA) were applied with a Rain-Flo model 2600 bed shaper (Rain-Flo Irrigation, East Earl, PA). Plots were arranged in randomized complete blocks with five replicates. The Inline treatment was applied 23 September 08. *Phytophthora rubi* (~10^3 oospores/g produced in a vermiculite/oat seed field soil mix) and *Agrobacterium tumefaciens* (10^6 cfu/g produced in a vermiculite/field soil mix) inoculum were buried at three depths (15, 30 and 45 cm) in nylon bags (1 bag per depth) in each plot on 15 Jul 08 and retrieved in 12 Feb 09. Temperature sensors (HOBO, Onset Corp., Bourne, MA) were buried in solarization and control plots in each of two replications at the same depths. All plots were saturated (0 kPa) following inoculum placement. Inoculum viability for both pathogens was analyzed in greenhouse bioassays. For *P. rubi*, raspberry plants (cv. Tulameen) were grown in conetainers with 20 ml inoculum from the nylon bags. The conetainers were flooded for two days every two weeks. Fourteen weeks after planting, soil was washed from the roots and the roots were rated on a 0-9 scale (0=healthy, 9=severe symptoms) based upon root rot symptoms. *P. rubi* was evaluated at all depths. For *A. tumefaciens*, inoculum bags were evaluated in a similar bioassay (30 cm depth only) using raspberry cut roots (cv. Coho). A dilution plating assay was also used to quantify *A. tumefaciens* in each bag. Soil samples were collected at 15 cm depth before (1 Jun 09) and twice (15 Jan and 4 Apr 09) after treatment application for identification and quantification of the lesion nematode, *Pratylenchus penetrans*. Data were subjected to analyses of variance and means comparisons using Fisher's protected least significant difference (LSD).

For all the plant pathogens evaluated, depth of sampling in the soil was not a significant factor in the analyses of variance, so data were combined over the sampling depths for each pathogen. Soil solarization did not significantly affect the severity of disease caused by *P. rubi*, but the plots with Inline alone, solarization + InLine, solarization + *S. alba*, and solarization + linseed meal had significantly greater disease ratings than the control plots. The InLine treatment significantly increased the *P. rubi* disease rating (6.2) and the cfu/g of *A. tumefaciens* (4.3) compared to the control plots (4.9 and 2.2, respectively). The combination of solarization + *S. alba* also significantly increased the cfu/g of *A. tumefaciens* (4.9) compared to the control plots (2.2). In 2008, accumulated hours above 29°C only reached 34 hrs at a soil depth of 15 cm in the solarization plots. The lack of heat accumulation most likely explains the failure of solarization treatments to control *P. rubi* or *A. tumefaciens*. *P. penetrans* counts were generally low in this field and the observed reductions in nematode counts from Jul 08 to Jan and Apr 09 may have been a result of natural population fluxes. However, in Jan 09 the solarization plots had significantly greater nematode populations (24.4/50 g soil) compared to the control, Inline and *S. alba* plots (2.4, 0, 7.2/50 g soil, respectively) as well as the solarization + Inline (1.2/50 g soil) and solarization + *S.alba* (7.2/50 g soil) plots, but were similar to the solarization + linseed meal (14.6/50 g soil) plots. By the final sampling date, there was no significant difference in *P. penetrans* counts among treatments, although no nematodes of this species were detected in plots with either of the InLine treatments.

Treatment and rate/A	*P. rubi* root rot rating[z]	*A. tumefaciens*		# of *P. penetrans*/50 g soil		
		cfu/µg soil	galls/plant[y]	Jul 08	Jan 09	Apr 09
Control…….	4.9 c[x]	2.2 d	1.9	14.6	2.4 bc	2.4
Solarization..……..	5.3 bc	2.7 d	1.3	16.8	24.4 a	2.4
InLine™ 35…….	6.2 a	4.3 bc	0.9	9.0	0 c	0
S. alba (1% w/v) …….	4.6 c	5.7 dc	1.8	9.6	7.2 bc	2.4
Solarization + InLine… …….	6.1 a	2.6 d	1.2	12.8	1.2 c	0
Solarization + *S. alba*……..	5.7 ab	4.9 ab	2.0	7.4	7.2 bc	4.8
Solarization + linseed meal (1%w/v)	5.7 ab	5.7 a	1.2	19.4	14.6 ab	8.8
LSD ($P < 0.05$)……	*0.71*	*1.31*	NS	NS	*12.36*	NS

[z] Averaged over three bioassay plants per plot.
[y] Averaged over four bioassay plants per plot.
[x] Means followed by the same letter within a column are not significantly different as determined by Fisher's protected least significant difference. NS = not significantly different.