EFFECT OF SOLARIZATION AND COVER CROPPING ON PESTS, BENEFICIALS AND PEPPER YIELD

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Management practices that maintain soil health are becoming increasingly popular, and non-chemical alternatives to methyl bromide are gradually being pursued. Objectives of this research were to examine effects of non-chemical pest management strategies on several key soil-borne pests and beneficial soil organisms, and to compare these treatments with methyl bromide fumigation. A field experiment was conducted in 2003 and 2004. Soil treatments carried out in summer months included methyl bromide (MB) fumigation, solarization on raised bed (SB) and flat bed (SF) for 6 weeks, cowpea (*Vigna unguiculata*) cover cropping for 3 months (CP), combination of raised bed solarization and cowpea cover cropping (SCP), and a weed fallow throughout the summer as a control (C). At termination of summer treatment, all treated plots were planted to pepper (*Capsicum annuum*) under metalized mulch with drip irrigation.

In both years, cowpea or solarization treatments alone were not as effective as methyl bromide for root-knot nematode suppression at the end of the pepper crop. However, the combination of solarization and cowpea cover crop matched the root-knot nematode suppression performance of methyl bromide fumigation, and suppressed the population densities of root-knot nematodes compared to the control (Table 1).

All solarization treatments were effective in suppressing weeds compared to the weed fallow control (Table 2). In fact, solarization outperformed methyl bromide ($P \leq 0.05$) for weed suppression in 2003 when weeds were not managed during the summer prior to the methyl bromide treatment. In 2004, when weeds in MB and C were managed by glyphosate and tillage in the summer, there were no differences among treatments in weed densities before and after a fall crop of pepper. Among the solarization treatments, SF did not suppress total weeds as effectively as SCP in 2003. This is mainly because SF was installed manually and was not sealed as tightly as SB and SCP, which were installed mechanically. Thus, heat was not trapped as efficiently in the SF treatment.

Pepper yield was higher in two of the solarization treatments (SB and SCP) as compared to MB and C in 2003 (Table 3). However, there were no differences among SF, CP, C and MB (Table 3). Poor yield in MB in 2003 was most likely due to the poor management of weeds, and resulted in cutworm damage on pepper seedlings early in the season (Saha et al., unpublished). Thick weed residues in MB in 2003 likely interfered with the efficacy of MB. Although, weeds were managed properly during the summer in 2004, severe hurricane events after pepper transplanting resulted in a *Pythium* epidemic. Consequently, crop yields were not different regardless of the summer treatments (Table 3), despite differences in root-knot nematode numbers.

Initially, mortality of pepper seedlings after the first hurricane was greatest ($P < 0.05$) in both of the cowpea cover crop treatments. However, after the second hurricane, plants in the methyl bromide treatment had twice the mortality as those in the flat solarization treatment (Table 4). The extra organic matter in the CP treatment probably favored the development of *Pythium*, and MB fumigation had created a biological vacuum for the invading pathogens (Saha et al., 2006).

Another objective was to evaluate the impact of these treatments on beneficial organisms, using nematode communities as bioindicators. The nematode community was analyzed using structure index (SI), a weighted system for nematode functional guilds in relation to structure of the food web (Ferris *et al*., 2001). A higher SI indicates a food web that is less disturbed. In general, levels of impact from soil treatment followed a pattern of MB > SB > SCP > CP > C (Wang et al., 2006). While disturbance from MB on the nematode communities persisted until the end of the pepper crop, that from the solarization often diminished or disappeared by the end of the experiment (Table 5). SI in treatments that contained cowpea was never lower than C, indicating cowpea can minimize soil disturbance. For example, SI in SB at pepper harvest was not different from MB in both years, but SI in SCP was consistently less than MB at termination of the pepper crop (Table 5).

In conclusion, growing a cover crop of CP reduced the disturbance on nematode communities that contained beneficial nematodes involved in nutrient cycling but failed to reduce the population densities of root-knot nematodes at pepper harvest. However, combining CP and SB reduced the impact from SB alone on nematode communities, achieved a suppression of root-knot nematodes equivalent to MB at crop harvest in both years, suppressed weed population densities in both years, and out perform MB in pepper yield in one year. Further research is needed to improve the SCP treatment for managing post-plant soil pathogens.

References:

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Table 1. Effects of summer soil treatments on root-knot nematode population densities at pepper harvest in 2003 and 2004 (data from Saha et al., unpublished).

Treatment	2003	2004
	-----------------Nematodes per 100 cm^3 soil----------------	
Bedded Solarization	55.50 a[Z]	31.67 ab[Z]
Solarization + cowpea	13.17 b	7.08 dc
Flat solarization	169.67 a	16.25 bc
Cowpea	75.67 a	18.92 bc
Methyl bromide	0.83 b	0.42 d
Control	180.50 a	122.30 a

[Z] Values are means of 6 replications. Means in a column followed by the same letter do not differ according to Waller-Duncan k-ratio ($P \leq 0.05$) t-test based on log (x+1) transformation.

Table 2. Effects of summer soil treatments on weed population densities at the end of summer in 2003 and 2004 (data from Saha et al., unpublished).

Treatment	2003	2004
	------------------Horsfall-Barrett Rating[y] -------------------	
Bedded Solarization	1.50 dc[z]	7.25 a
Solarization + cowpea	1.17 d	4.08 a
Flat solarization	1.83 c	5.92 a
Cowpea	6.00 b	5.08 a
Methyl bromide	8.33 a	5.33 a
Control	8.33 a	7.50 a

[y]Rating on a scale from 1 (0% of area covered by weeds) to 12 (100% of area covered by weeds). [Z] Values are means of 6 replications. Means in a column followed by the same letter do not differ according to Waller-Duncan k-ratio ($P \leq 0.05$) t-test.

Table 3. Effects of summer soil treatments on pepper yields in 2003 and 2004 (data from Saha et al., unpublished).

Treatment	2003	2004
	Fruit weights (g) / 60 plants	
Bedded Solarization	20.28 a [Z]	8.330 a
Solarization + cowpea	19.53 ab	7.778 a
Flat solarization	17.84 bc	9.988 a
Cowpea	18.19 bc	7.976 a
Methyl bromide	17.28 c	7.363 a
Control	17.42 c	7.699 a

[Z] Values are means of 6 replications. Means in a column followed by the same letter do not differ according to Waller-Duncan k-ratio ($P \leq 0.05$) t-test.

Table 4. Area under the disease progress curve (AUDPC) of the incidence of *Pythium* wilt on pepper in fall after two hurricanes in 2004 (data from Saha et al., 2005).

Treatment	AUDPC[z]
Bedded Solarization	15.59 ab
Solarization + cowpea	20.60 ab
Flat solarization	13.27 b
Cowpea	23.42 a
Methyl bromide	22.62 ab
Control	17.03 ab

[Z] Number of dead plants / 60 plants over a 10-week period. Values are means of 6 replications. Means in a column followed by the same letter do not differ according to Waller-Duncan k-ratio ($P \leq 0.05$) *t*-test.

Table 5. Effects of summer soil treatments on nematode community structure index in 2003 and 2004 (data cited from Wang et al., 2005).

Treatment	2003		2004	
	Pi[y]	Pf[y]	Pi	Pf
Bedded Solarization	6.13 c [Z]	15.19 ab	13.01ab	9.36 ab
Solarization + cowpea	20.50 b	21.83 a	15.87 a	27.7 a
Cowpea	44.38 a	20.86 a	14.3 ab	12.8 ab
Methyl bromide	18.80 b	0.54 b	0.0 b	1.97 b
Control	9.88 bc	15.66 ab	19.18 a	12.28 ab

[y] Pi = structure index measured right before pepper planting, Pf = structure index at pepper harvest.
[Z] Values are means of 4 replications. Means in a column followed by the same letter do not differ according to Waller-Duncan k-ratio ($P \leq 0.05$) *t*-test.