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EFFECT OF INTEGRATING SOIL SOLARIZATION AND ORGANIC MULCHING ON THE SOIL SURFACE INSECT COMMUNITY

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Mulching by spreading organic matter around plants is an effective method to manage some pest insects as well as weeds (Brown & Tworkoski 2004; Johnson et al. 2004). Mulches provide shelter for predatory insects (Pullaro et al. 2006). Soil solarization, a hydrothermal method of managing nematodes, diseases, insects, and weeds, is accomplished by passive heating of moist soil covered with transparent plastic sheeting (McGovern & McSorley 1997). Because of the lethal effects from high soil temperature, solarization must be conducted before crops are planted. The objective of the present study was to evaluate the integrated effects of solarization and organic mulch on the soil surface insect community, including non-target and beneficial insects.

Field experiments were conducted in fall 2008 at the University of Florida Plant Science Research and Education Unit (lat. 29°24'N, long. 82°9'W), near Citra, FL. The soil was Arredondo sand (95% sand, 2% silt, 3% clay) with 1.5% organic matter. The field was rototilled in Jul, and beds were formed (20 cm high, 76 cm wide, with 1.8 m between bed centers). Individual plots were single beds, 9.14 m in length. Average soil moisture measured gravimetrically before bed formation was 8.7%.

Four treatments were arranged in a randomized complete block design with 5 replications. The treatments compared were: solarization (S) = plastic pre-plant, nothing post-plant; mulch (M) = mulch pre-plant, mulch post-plant; mulch + solar (MS) = plastic pre-plant, mulch post-plant; and control (C) = nothing pre-plant, mulch post-plant. For the mulch treatment, a pre-plant mulch of sunn hemp (*Crotalaria juncea* L.), 3 cm thick (8.16 kg total weight/plot), was applied over the bed surface on Aug 13. In the solarization treatment, beds were covered with Polydak® (1.3-mil-thick, UV- stabilized, transparent film, Ginegar Plastics Products, Ginegar, Israel) plastic film for 6 weeks beginning on Aug 12 as described by Gill et al. (2009). After 6 weeks, plastic was removed, and all beds were planted with 'Potomac Pink' snapdragons (*Antirrhinum majus* L.). Mulch was again applied on Oct 2, as a main mulch application, to M, C, and MS treatments. Note that is not possible to have mulch and solarization plastic present on a plot at the same time.

Soil surface insects were sampled with plastic sandwich containers (14 cm × 14 cm × 4 cm deep) used as pitfall traps as described by Borror et al. (1989). Each pitfall trap was placed in the center of the plot and buried so that the upper edge was flush with the soil surface. Traps were filled three-quarters full with tap water, and 3 to 4 drops of dish detergent (Ultra Joy®, Procter & Gamble, Cincinnati, OH) added to break surface tension, and ensure that the insects remain in the trap. Traps were set out in the morning and collected before noon the next day (recorded as the sampling date). Traps were placed in cold storage (10ºC), contents transferred and stored in 70% ethanol, and insects were identified to order and family and counted.

Data were subjected to one-way analysis of variance (ANOVA) with the Statistical Analysis System (version 9.1; SAS Institute, Cary, NC). Treatment means were separated based on the least significant difference (LSD) range test, at $P \leq 0.05$.

Preplant mulching or solarization was useful in reducing weeds in the plots. The main weeds were nutsedges (*Cyperus* spp.), grasses, Florida pusley (*Richardia scabra* L.), purslane (*Portulaca oleracea* L.), and hairy indigo (*Indigofera hirsuta* L.). The percentage of the plot surface area occupied by weeds averaged 3 to 5% in MS, ca 90% in C, 20 to 25% in S, and 35 to 40% in M plots, respectively.

On most sampling dates, Collembola populations were higher in the M treatment than in the S treatment (Table 1). Collembola are associated with decomposing organic matter (Colemen & Crossley 1996), which was provided by sunn hemp in the M treatment. Collembola were not as abundant in S plots, possibly because mulch was absent. In addition, the solarization process itself may have reduced populations that were present in soil.

Many groups of arthropods, including spiders, ants, grasshoppers, crickets, elaterids, and staphylinids were unaffected by the treatments (data not shown), but interesting trends were observed in some others. Cicadellids were more abundant ($P \leq 0.10$) in C plots (12.0 ± 2.59/ trap) than in MS plots (5.8 ± 2.42/trap) on Nov 9. On Oct 28, highest numbers ($P \leq 0.10$) of carabids (0.8 ± 0.37/ trap) and flea beetles (0.4 ± 0.24/trap) were observed in S plots. Highest numbers ($P \leq 0.10$) of dolichopodids (8.0 ± 2.43/trap) were observed in S plots on Dec 8. Solarized plots were free of mulch and had relatively low weed levels, both of which might influence insect movement. Environmental heterogeneity is known to interfere with movement and host finding of flea beetles and other insects (Root 1973; Smith & McSorley 2000).

TABLE 1. EFFECT OF TREATMENTS ON INSECT TAXA (NUMBERS/PITFALL TRAP) ON SELECTED SAMPLING DATES—2008.

Treatment[1]	Collembola	Other plant feeders[2]
	Oct 13	
MS	10.2 b ± 3.34	1.6 a ± 0.51
C	21.8 ab ± 5.46	4.4 a ± 1.54
S	14.6 b ± 5.33	3.8 a ± 0.97
M	32.2 a ± 6.63	6.8 a ± 3.34
ANOVA[3]		
F value	3.26	1.24
P value	0.0492	0.3268
	Oct 28	
MS	13.8 b ± 4.93	1.0 b ± 0.45
C	15.0 b ± 1.76	7.6 a ± 2.87
S	12.0 b ± 1.52	2.4 b ± 1.03
M	32.8 a ± 3.51	0.6 b ± 0.40
ANOVA		
F value	8.9	4.3
P value	0.0011	0.0209
	Nov 9	
MS	46.6 a ± 8.25	0.8 b ± 0.37
C	34.4 b ± 6.45	6.4 a ± 2.38
S	14.0 b ± 3.73	1.6 b ± 0.81
M	32.6 a ± 5.35	1.6 b ± 0.51
ANOVA		
F value	4.76	3.9
P value	0.0148	0.0287
	Dec 8	
MS	21.8 ab[4] ± 3.80	3.0 a ± 0.71
C	34.4 a ± 7.56	1.6 a ± 0.93
S	16.0 b ± 2.61	2.6 a ± 0.75
M	24.2 ab ± 2.24	2.0 a ± 0.84
ANOVA		
F value	2.83	0.59
P value	0.0717	0.6302

[1]Solarization (S) = plastic pre-plant, nothing post- plant; mulch (M) = mulch pre-plant, mulch post-plant; mulch + solar (MS) = plastic pre-plant, mulch post-plant; and control (C) = nothing pre-plant, mulch post-plant.

[2]Other plant feeders include whiteflies, aphids, and thrips.

[3]Statistics from analysis of variance (ANOVA).

Data are means ± standard error of 5 replications. Means followed by the same letters do not differ significantly based on LSD test ($P \le 0.05$)

[4]Mean separation at $P \le 0.10$

On Oct 28 and Nov 9, other plant feeders (whiteflies, thrips, and aphids) were significantly higher ($P \le 0.05$) in the C treatment compared with the other 3 treatments (Table 1). It is possible that whiteflies, thrips, aphids, and maybe leafhoppers were present and fed on the abundant weeds in the control treatment. Treatments that limit weeds may be helpful in limiting these plant-feeding insects as well. Integrating solarization and mulching did not have much overall impact on the insect community, compared to solarization alone, but it did lead to recovery of Collembola populations later in the season to similar levels found in mulched plots.

SUMMARY

Integration of solarization and organic mulch did not affect the insect community as much as solarization alone. Solarization and mulching influenced Collembola population levels and occasionally affected other insect groups, depending on their behavior. Plots without solarization or mulching developed heavy weed levels and increased levels of plant-feeding insects.

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