N O T E

Nontarget Effects of Two Pest Management Programs on Biodiversity in Miniature Landscapes[1]

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Seventy-six percent of Georgia homeowners maintain their own landscape and turf and 62.0 percent of these use insecticides. Fifty, 49.0, and 56.0 percent of Georgia homeowners who apply insecticides treat their lawns, trees/shrubs, and/or flowers, respectively (Varlamoff et al. 2000, Pollution Prevention Review, In press). Insecticide applications have been implicated in the decline of non-target arthropods in alfalfa (Radcliffe et al., 1976, Environ. Entomol., 1195-1207), apple orchards (Pekár, 1999, Agriculture, Ecosystems, and Environment, 155-166), turf (Cockfield and Potter, 1985, Can. Ent., 423-429; Arnold and Potter, 1987, Environ. Entomol., 100-105), winter wheat (Matcham and Hawkes, 1985, Pestic. Sci., 317-320), and other crops (Inglesfield, 1985, Pestic. Sci., 211; Wiktelius et al., 1999, Agriculture, Ecosystems, and Environment, 121-131). The objective of this study was to determine the impact of two landscape pest management methods, frequent, calendar-based cover sprays and scouting-based integrated pest management, on target pests and non-target arthropods on diverse, identical, miniature landscapes.

A randomized complete block design was used with 12, 12.2-m diam miniature landscapes arranged in four blocks of three plots spaced 12.2 m apart. Each landscape included centipedegrass (*Eremochloa ophuiroides* Munro. Hack.) and ornamental plants commonly used on residential properties (Table 1). Applications of glyphosate (2.84 kg active ingredient/ha) (Monsanto Co., St. Louis, MO) were made to mulched areas of all plots on the same dates for weed control. One plot per block received frequent, calendar-based cover sprays using pesticides with active ingredients available to homeowners, timed to coincide with key pest activity (Table 2). Bonide Mite and Insect Spray With Kelthane® (Bonide Products, Inc., Yorkville, NY) and Orthene 75SP® (Valent USA Corporation, Walnut Creek, CA) applications were made biweekly 31 May to 24 August, and Sevin SL® (Lesco, Inc., Rocky River, OH) was applied weekly to birch and crape myrtle 7 June through 27 July. All of the above applications were made using a backpack sprayer (SOLO™ Kleinmotoren GmbH,

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Table 1. Plant material and scouting regime in twelve miniature landscapes May 11-August 31, 1999 in Griffin, GA

Plant	Number/plot	Scouting method
birch, *Betula nigra* L.	1	5, 30.5 cm branch terminals, accompanying foliage
boxwood, *Buxus microphylla* Sieb. & Zucc. kor. 'Wintergreen'	4	1 beat sample/plant*
cotoneaster, *Cotoneaster dammeri* Schneid. 'Coral Beauty'	1	1 beat sample/plant
euonymus, *Euonymus japonicus* Thunberg. 'Aureo-marginata'	3	3, 15.24 cm. branch terminals, accompanying foliage
gardenia, *Gardenia jasminoides* Ellis 'August Beauty'	2	5, 30.5 cm branch terminals, accompanying foliage
juniper, *Juniperus horizontalis* Moench. 'Plumosa Compacta'	3	3 beat samples/plant
Burford holly, *Ilex cornuta* Poiret cv. canariensis	1	3, 30.5 cm branch terminals, accompanying foliage; 3 beat samples/plant
crape myrtle, *Lagerstroemia indica* L. wildflowers	1	5, 30.5 cm branch terminals, accompanying foliage 2, 30 second scans

* all beat samples performed over a 40 × 20 cm white enamel pan.

Table 2. Pesticide use in twelve identical miniature landscapes in Griffin, GA in 1999

Plot	Formulation	Active ingredient	# treatments	Rate: kg AI/ha	Plant/area treated
All	RoundUp Ultra	glyphosate	7	2.84	mulched areas
IPM	Vantage	sethoxydim	1	0.20	turf
IPM	Mach 2	halofenozide	1	1.68	turf
Cover spray	Vantage	sethoxydim	1	0.20	turf
Cover spray	Orthene 75SP	acephate	7	0.50	shrubs, turf, wildflowers
Cover spray	Sevin SL	carbaryl	8	0.60	birch, crape myrtle
Cover spray	Sevin SL	carbaryl	1	7.89	turf
Cover spray	Bonide	2.5% carbaryl	7	0.03	shrubs
		1% dicofol	7	0.01	shrubs, wildflowers
		5% lindane	7	0.07	shrubs, wildflowers
		12% malathion	7	0.16	shrubs, wildflowers

Sindelfingen, Germany). The second plot per block received pesticide applications based on site monitoring, and the third was an untreated control plot. Plots were scouted biweekly 24 h after insecticide/acaricide applications by performing beat samples and stem/foliar examinations; wildflowers were scouted by recording the taxa observed in two, 30-s visual observations per plot (Table 1). Birch and crape myrtle also were scouted weekly 7 June through 27 July. Ten vacuum subsamples per plot were taken weekly in turf and wildflowers by placing the sampler (11-cm diam sampling aperture, Burkhard Manufacturing Co., Ltd., Rickmansworth, England) on the ground for 1.0 s. Subsamples were pooled. Data were analyzed as seasonal means by treatment using an analysis of variance and Fisher's least significant difference (SAS Institute, 1995, SAS/STAT user's guide, Cary, NC). Taxa with significant differences ($P < 0.05$) were analyzed by sampling date. Orthogonal contrasts were used to compare cover sprayed plots to the untreated IPM plots and controls.

Key pests were not present in appreciable numbers, and no insecticides or acaricides were applied to trees, shrubs, and wildflowers in the IPM plots (Table 2). Eight, 12, 21, and 28 arthropod taxa were observed one or more times during branch and foliar examinations of Burford holly, euonymus, birch, and crape myrtle, respectively, but quantities of each were insufficient for analysis, as were the results of the wildflower scans (Table 1). Five of the 41 arthropod taxa observed in beat samples on juniper showed significant treatment differences, as did 4 of the 29 arthropod taxa observed in boxwood beat samples (Table 3). Significant treatment differences were observed in beat samples in 2 of the 29 arthropod taxa from cotoneaster and in 1 of the 24 arthropod taxa from Burford holly (Table 3). Less mobile miscellaneous hemipteran nymphs (predominately mirids) on juniper were adversely affected but adult populations were statistically similar.

Significantly greater flea beetle (Coleoptera: Alticinae) populations were present

Table 3. Seasonal means of nontarget arthropods per beat sample indentical miniature landscapes in Griffin, GA in 1999

Plant	Spiders	Ants	Parisitic hymenoptera	Hemiptera nymphs	Cicadellidae total
Juniper-41	Control 0.44a	Control 0.12a	IPM 0.24a	IPM 0.19a	Control 0.18a
taxa observed,	IPM 0.44a	IPM 0.03b	Control 0.12ab	Control 0.13ab	IPM 0.16a
5 significant	Cover 0.16b	Cover 0.03b	Cover 0.05b	Cover 0.01b	Cover 0.04b
Plant	**Spiders**		**Alticinae**	***Bryobia praetiosa***	**Misc. Coleoptera**
Boxwood-29	Control 0.51a		IPM 0.20a	IPM 0.06a	IPM 0.15a
taxa observed,	IPM 0.32a		Control 0.03b	Cover 0.03ab	Control 0.13ab
5 significant	Cover 0.18b		Cover 0.00b	Control 0.01b	Cover 0.03b
Plant	**Spiders**		**Membracidae**	**Plant**	**Spiders**
Contoneaster-29	Control 0.40a		IPM 0.04a	Burford holly-24	IPM 0.78a
taxa observed,	IPM 0.33a		Control 0.01a	taxa observed	Control 0.28ab
4 significant	Cover 0.15b		Cover 0.00b	1 significant	Cover 0.14b

* Means followed by the same letter are not significantly different at $p = 0.05$ level.

Table 4. Seasonal means of nontarget arthropods per vacuum sample in identical miniature landscapes in Griffin, GA in 1999

Plant	Parasitic hymenoptera	Sminthuridae	Cicadellid adult	Cicadellid nymphs	Ants
Wildflowers	IPM 31.2a	IPM 13.8a	Control 4.5a	IPM 2.0a	Control 5.3a
	Control 28.1ab	Control 13.8a	IPM 4.5a	Control 1.8a	IPM 4.9ab
	Cover 19.6b	Cover 3.5b	Cover 2.4b	Cover 0.4b	Spray 2.4b
Plant	**Parasitic hymenoptera**	**Sminthuridae**	**Cicadellid nymphs**		
Turf	IPM 14.6a	IPM 144.4a	IPM 22.1a		
	Control 11.2ab	Control 118.1ab	Control 17.4a		
	Cover 7.1b	Cover 43.3b	Cover 3.1b		

on boxwood in IPM plots than in controls on three early season dates. The subfamily was observed feeding on weeds in and around the plots. While seasonal means of membracids and clover mite (*Bryobia praetiosa* Koch) showed significant treatment differences, the extremely low numbers recorded cause us to question their biological significance.

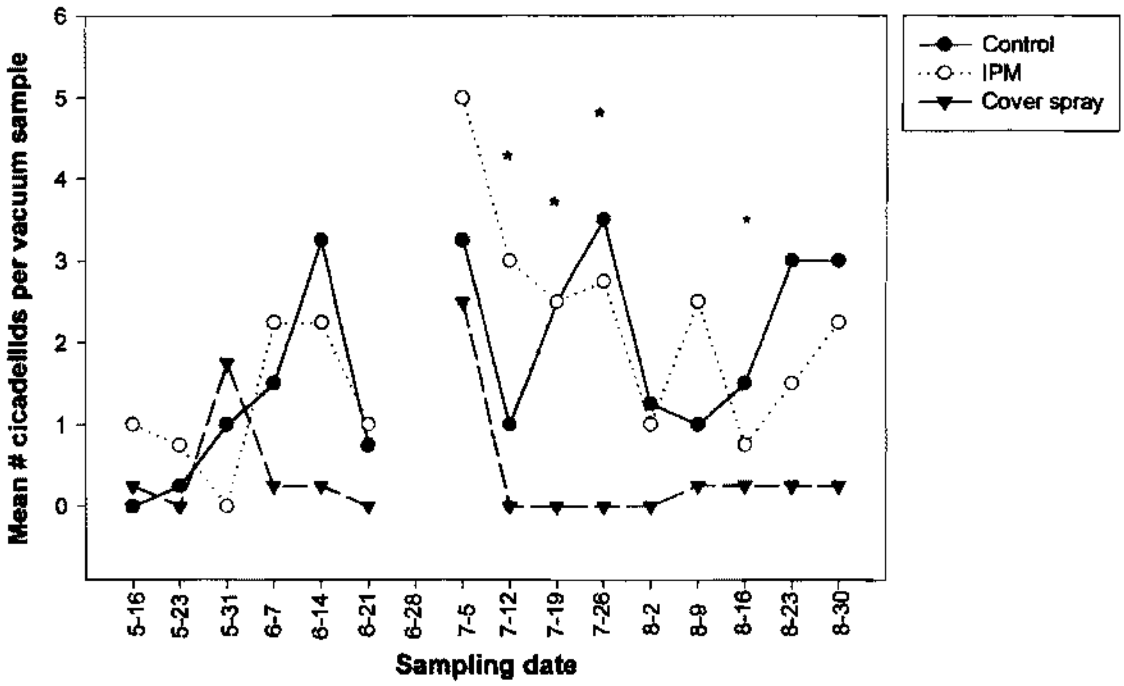

Fig. 1. Abundance of cicadellid nymphs in wildflowers in identical miniature landscapes in Griffin, GA in 1999. *Control, IPM plots significantly different from cover sprayed plots.

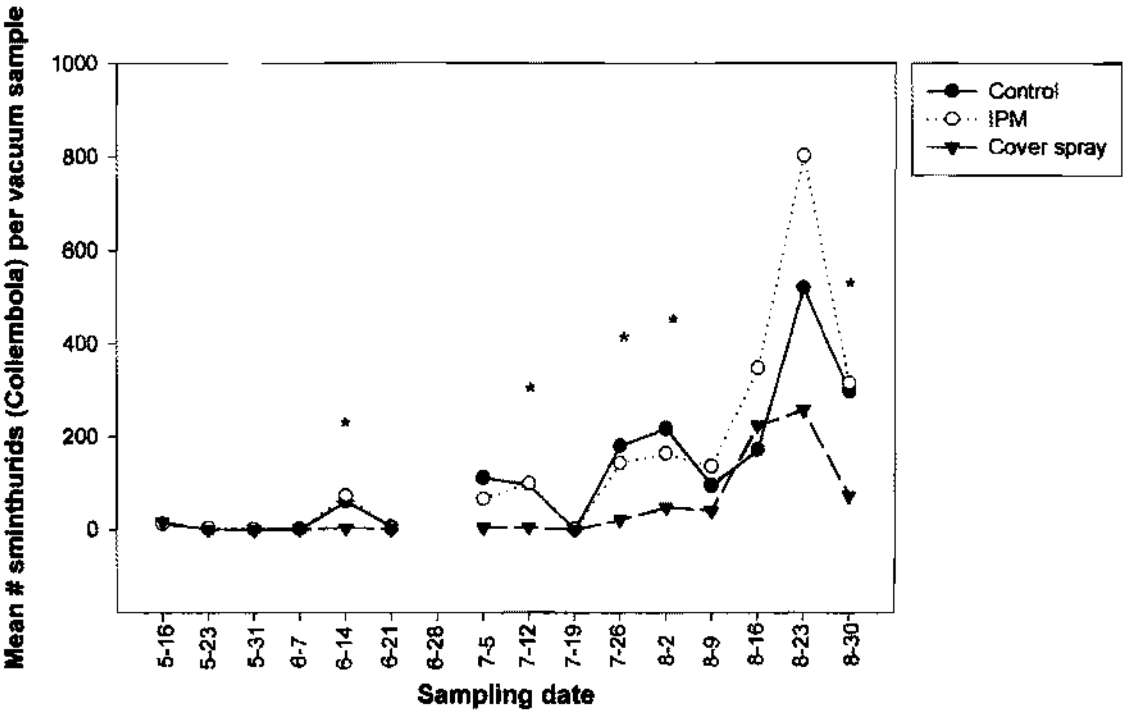

Fig. 2. Sminthurid (Collembola) abundance in turf in identical miniature landscapes in Griffin, GA in 1999. *Control, IPM plots significantly different from cover sprayed plots.

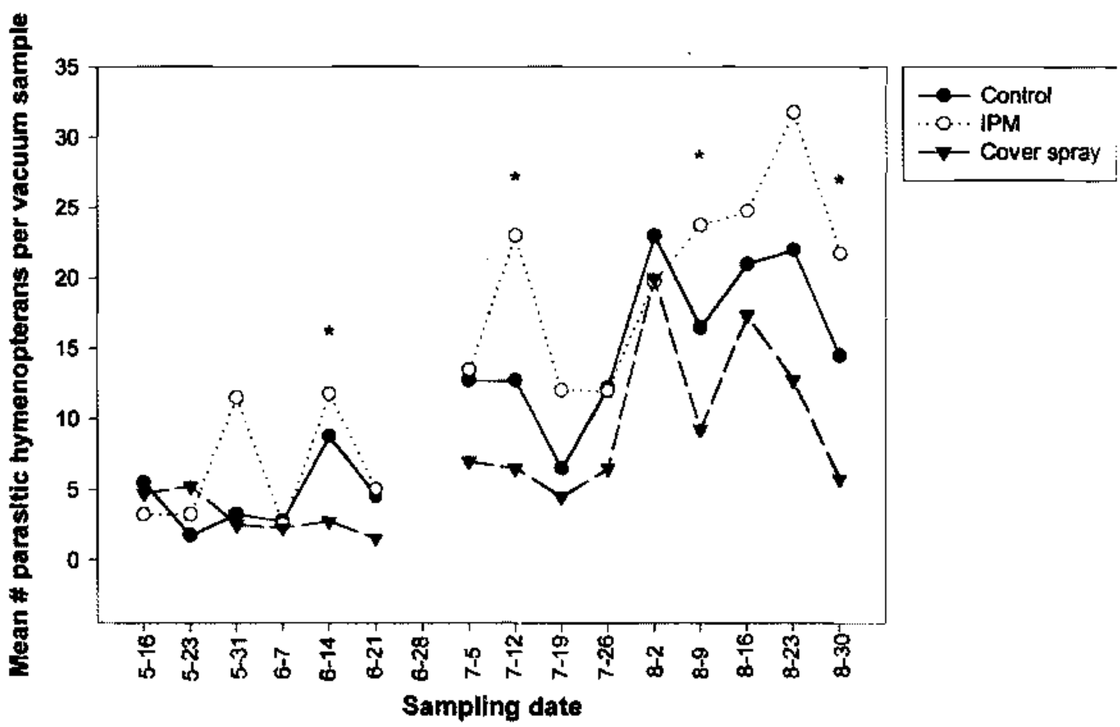

Fig. 3. Parasitic hymenopteran abundance in turf in identical miniature landscapes in Griffin, GA in 1999. *Control, IPM plots significantly different from cover sprayed plots.

Over 40 arthropod taxa were collected from wildflowers and turf. Significant treatment differences were observed in five taxa (parasitic Hymenoptera, Collembola: Sminthuridae, cicadellid adults, cicadellid nymphs, and ants) on wildflowers and three taxa (parasitic Hymenoptera, Collembola: Sminthuridae, cicadellid nymphs) on turf (Table 4). Rain prevented vacuum sampling during the week of 21 June. Seasonal means of leafhopper (Cicadellidae) adults and nymphs were significantly greater in wildflowers in the control and IPM plots than in cover sprayed plots, as were the means at four individual sampling dates (Fig. 1). Cicadellid nymph levels were significantly lower in cover sprayed turf suggesting that either the more mobile adult is more capable of recolonizing treated areas or may be less susceptible to the insecticide treatments.

Overall, no clear trends regarding insecticide treatment effects on ant levels emerged. Ants were significantly more abundant in juniper in control plots than in cover sprayed and the untreated IPM plots (Table 3). However, in wildflowers there were significantly more ants in controls then in cover sprayed plots. Seasonal means for ants in all other plant material were statistically similar.

Sminthurid (Collembola) populations were adversely affected by cover sprays in turf and wildflowers. We suspect this was largely due to acephate which was applied to both areas. Significantly greater sminthurid populations in controls and IPM plots were observed on five dates in turf and one date in wildflowers (Fig. 2). Populations of Entomobryidae, the other collembolan family collected, were statistically similar in turf and wildflowers. Chlorpyrifos has been implicated in short-term decline of spiders, non-sminthurid collembolans, ants, and parasitic hymenopterans in centipedegrass (Braman and Pendley, 1993, J. Econ. Entomol. 86: 494-504), and with entomobryid,

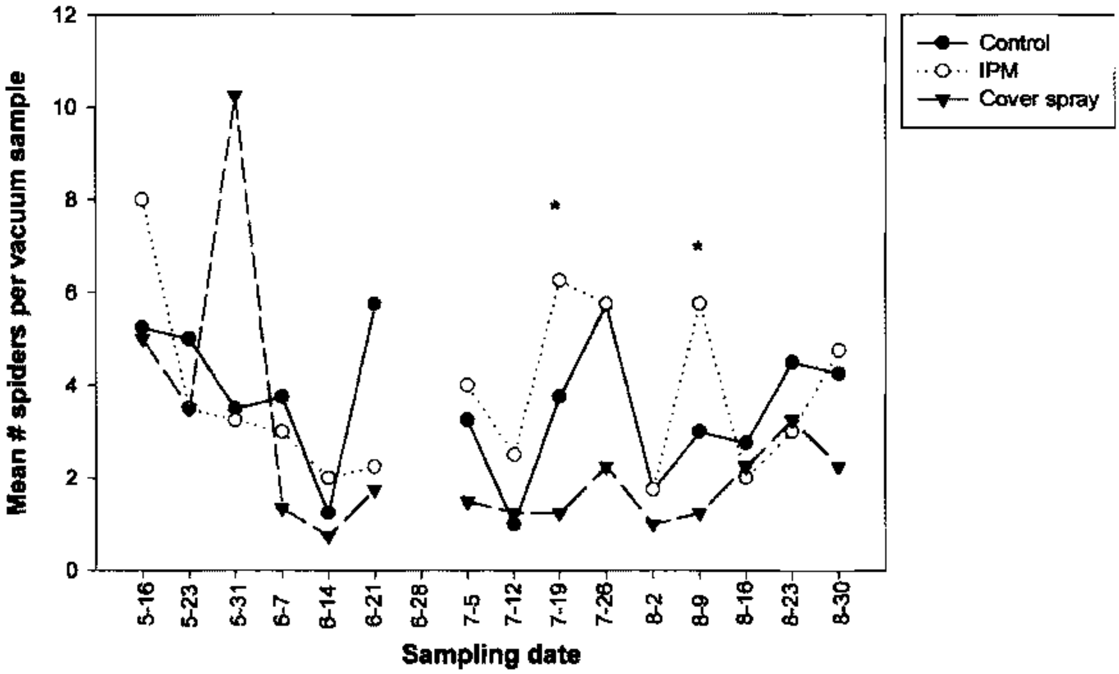

Fig. 4. Spider abundance in wildflowers in identical miniature landscapes in Griffin, GA in 1999. *Control, IPM plots significantly different from cover sprayed plots.

isotomid, and sminthurid collembolan decline on winter wheat (Frampton, 1999, Pestic. Sci., 875-886).

Parasitic hymenopterans were significantly less abundant in cover sprayed plots than in IPM plots on boxwood, wildflowers (Table 3), and turf (Table 4). Significant reductions in the number of parasitic hymenopterans in turf were observed on four dates (Fig. 3) and in wildflowers on three dates. We suspect this is due to acephate application.

Spider populations were significantly greater in control and IPM plots than in treated plots on all beat-sampled plant taxa. Seasonal means of spiders in wildflowers were not statistically different, possibly due to large numbers collected in one cover sprayed plot on 31 May. Spider numbers were significantly greater in IPM and control plots on two dates (Fig. 4). In turf, seasonal means were not statistically different. Spider numbers were significantly greater in IPM and control plots only on 30 August. Spiders were the most abundant natural enemy encountered on azalea, boxwood, and juniper at the majority of landscape sites surveyed in an IPM pilot program (Stewart, 2000, Ph.D. Diss., Univ. Georgia, Athens). The impact of the loss of these important landscape predators needs to be assessed.

Our data indicate that frequent insecticide and acaricide applications may be less disruptive than expected. We suspect that the small, diverse plots, similar to residential landscapes, were rapidly recolonized from adjacent fields (Braman and Pendley, 1993, J. Econ. Entomol. 86: 494-504).

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