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Ground cover and agricultural practices manipulation in controlling tarnished plant bug population in peach orchard, Michigan 1993

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Introduction.

Catfacing, which is direct damage to peaches caused by piercing and sucking insects is a serious problem in Michigan peach orchards, resulting in from 0.2-12% damage per year. Mirid and Pentatomid bugs account for the vast majority of catfacing pests of peaches and cherries. Two of the most important mirid species present in Michigan peach and cherry orchards are *Lygus lineolaris* and *Lygus hesperus*, although *L. hesperus* is much less numerous than *L. lineolaris*.

Because of growing consumer concern for the residue from the use chemical insecticides, growers are increasingly interested in pesticide alternatives for managing orchard pests. Ground cover is particularly important in the population dynamics of many insects especially Mirids and Pentatomids because their immature stages primarily feed in ground cover. Our strategy has been to develop ground cover, including endophytic grasses, which produce insect toxic secondary plant substances which can reduce the number of nymphs and adults, resulting in less fruit damage. In addition, endophytic grasses are a particularly good competitors with broad-leaf, seed-bearing weeds like redroot pigweed and lambsquaters which are the preferred hosts for tarnished plant bugs. We also tested tillage practices as a means of reducing the tarnished plant bug population. Since the nymphs stay in ground cover and do not fly, most of them are killed during appropriately timed mowing operations. By scheduling orchard mowing based on the developmental stage of the bugs, we developed a strategy to reduce the catfacing bug population and the use of chemical insecticide simultaneously.

Materials and Methods.

The study was done on replicated 1 acre orchards located at the Southwest Michigan Research Extenuation Center, Watervliet, MI. Three treatments were used :1) conventional program, with clean-tillage ground cover practices, 2) Integrated Pest Management High input program with orchard grass as a ground cover and 3) Integrated Pest Management Low Input program with endophytic rye grass as a ground cover. Each treatment was replicated twice. The detail chemical inputs for each treatment is listed in Table 1. Note that all pesticide sprays were based on threshold in the IPM treatments. Table 2 shows the summary of the total chemicals used in all treatments.

Sampling Procedures.

Twenty five sweep net samples were taken in the ground cover both inside and outside. Sweep sampled insects were placed in plastic bags and then placed in an ice box to be transported to the laboratory (Pesticide Research Center, MSU, E. Lansing, MI) for identification and recording.

Visual observations were carried out by noting the catfacing bugs that were above the ground cover, on the peach trees or flying. The observations were done by walking along the trees throughout the orchard for six minutes. When we observed more than three adults of the tarnished plant bug, an appropriate insecticide was applied. Both sweep and visual samples were taken every other week through the whole peach growing season from May to July.

Fruit evaluation was done to observe the damage caused by the tarnished plant bugs. Twenty peaches per sampling unit, 5 sampling units from the trees in the south part of the orchard and the other 5 from the north part, were picked randomly and the number of fruit with catfacing damage were counted and recorded.

Weed evaluation was done to observe the diversity and composition of weed in each orchard. Three 1 m^2 of areas were observed in each plots in early and late peach season. The varieties of weeds present and its percentage were observed and recorded.

Data Analyses.

The data taken from sweep net sampling was analyzed by one way analysis of variance. The number of tarnished plant bug from each plot per treatment was pooled and used in the analysis of variance. The means of both treatment plots were used for pair-wise comparison of means using Duncan LSD. The data from visual observations and fruit evaluations were analyzed using the same procedures.

Results

The population of tarnished plant bugs, *Lygus lineolaris*, inside of the orchard was found to be very low in all treatments. The total number (2 replications per treatment) of tarnished plant bugs varied from 1 to 4 throughout the season. Thus, the Conventional, IPM-High and IPM-Low treatments were comparable in their management of tarnished plant bugs. There was no significant difference in the number of tarnished plant bug inside the orchard observed in all treatments ($F=1$, $P \geq 0.05$). However, the population of the catfacing bugs outside of the orchard were much higher. The total number of the bugs throughout the season outside of the Conventional, IPM-High and IPM-Low were 107, 86 and 21 respectively. However, the population outside the Conventional 2 was significantly different from the population from the Conventional 1, IPM-Low plots and IPM-High 1 ($F=2.719$, $P \leq 0.05$) but not statistically different from the population outside IPM-High 2 (See Table 3). The high number of tarnished plant bugs outside the Conventional 2 and IPM-High 1 plots was related to the alfalfa ground cover and the lack of outside developmental stage assisted mowing.

The developmental stage of the tarnished plant bug was determined every sampling period. On June 1st and July 13th the majority (>95%) of the bug population were nymphs. Therefore we timed our mowing treatment a week after the second and the fifth sampling. Since the initial tarnished plant bug population inside the plots was very low (see Table 2), there was no clear evidence that the mowing strategy contributed to the reduction of the bug population. We believe a mark-recapture experiment would help clarify this design problem.

The number of tarnished plant bugs observed visually is reported in Table 2. There was no statistical different between treatments. The tarnished plant bugs were only observed in plot 2 of the Conventional treatment. No tarnished plant bugs were observed in IPM-High and IPM-Low plots, therefore no chemical insecticide was applied in either treatments. This strategy reduced the number and active ingredient of chemical insecticides applied in IPM plots (see Table 2)

Fruit evaluations were done on August 13, 1993. No statistical difference between treatment was observed ($F=1$, $P \geq 0.05$). Tarnished plant bug damage or catfacing, was observed only in the Conventional plot (3 out of 400 peaches, see Table 3).

The weed diversity and composition observed is reported in Table 4. There were 13 different weeds were observed during the study. The average percentage of clean (in Conventional plots), fescue grass (IPM-High plots) and endophytic rye grass (in IPM plots) was 93.3, 82.45 and 46.65 at early season, and 90.7, 89.6, and 89.15 at late season respectively.

Conclusion

1. The tarnished plant bug population in Conventional, IPM High Input (IPMH) and IPM Low Input (IPML) plots were statistically not different, indicating that each of the management strategies resulted in excellent tarnished plant bug control.
2. Application of pesticides based on a calendar system or monitoring system was equally effective in reducing the number of tarnished plant bugs.
3. The catfacing damage on peaches from Conventional, IPM-High and IPM-Low plots was not significantly different, again indicating that either IPM strategy was equivalent to the Conventional practice.

Publication Plans

1. Environmental Entomology or Crop Protection Journals; Title: Management of Leafhopper Vectors and Tarnished plant bug with Ground Cover Manipulation in Orchards.

Table 1. Pest and pathogen controls, fertilization, irrigation and cultural program at the peach orchard sites in Southwest Michigan Research Extension Center, Watervliet, MI 1993.

PRACTICES	CONVENTIONAL		IPM High Input (IPM-High)		IPM Low Input (IPM-Low)	
Ground Cover	Clean Tillage		Orchard grass		Endophytic rye grass	
Insecticide application	Calendar system		Monitoring system		Monitoring system	
Insecticides, fungicides, fertilizers & herbicides used (per acre) Timing		Date		Date		Date
Dormant	Ferbam 76W, 4.5lbs Simizin, 2lb a.i Paraquat, 0.5lb a.i Fertilizer Calcium citrate 0.3oz/tree actual N within herbicide strip	5/12 5/12 5/12 5/6	Ferbam 76W, 1.5lbs/100gal Simizin, 2lb a.i Paraquat, 0.5lb a.i Fertilizer Calcium citrate 0.5oz/tree actual N, 4 times 2 weeks interval	5/12 5/12 5/12 5/13		
Bloom	Bravo 720, 4 pts	5/5	Sulfur 95W, 15 lbs	5/5		
Petal Fall	Guthion 35W,3lbs Bravo 720, 4 pts Fertilizer Calcium nitrate: 0.5oz/tree actual N drip system	5/14 5/14 5/26	Sulfur 95W,15 lbs	5/14	Horse manure 90 lbs/tree	5/26
Shuck-split	Asana XL, 8oz Bravo 720, 4pts	5/24 5/24	Guthion 35W,3lbs Sulfur 95W, 15lbs	5/24 5/24	Guthion 35W, 3lbs	5/24
1st Cover	Lorsban 50W, 3lbs Captan 50W, 6lbs Fertilizer Calcium nitrate: 1.5oz/tree actual N within herbicide strip	6/10 6/10 6/7	Lorsban 50W, 3lbs Sulfur 95W, 15lbs Fertilizer Calcium nitrate 0.5oz/tree actual N drip system	6/10 6/10 6/9	Asana XL, 8oz	6/10

Table 1. (Cont.)

PRACTICES	CONVENTIONAL		IPM High Input (IPM-High)		IPM Low Input (IPM-Low)	
2nd Cover	Lorsban 50W, 3lbs	6/21	Fertilizer Calcium nitrate: 0.5oz/tree actual N drip system	6/23		
	Captan 50W, 6lbs	6/21	Sulfur 95W, 15lbs	6/21		
3rd Cover	Lorsban 50W, 3lbs	7/2	Lorsban 4E, 3qt/100gal-runk spray	7/8	Lorsban 4E, 3qt/100gal-trunk spray	7/8
	Lorsban 4E, 3qt/100gal-trunk spray	7/8	Sulfur 95W, 15lbs	7/2		
	Captan 50W, 6lbs	7/2	Hi-Dep 2,4-D, 4oz	7/5	Hi-Dep 2,4-D, 4oz	7/5
4th Cover	Guthion 35W,3lbs	7/22	Benlate 50W,1lbs	7/23	Sulfur 95W,15lbs	7/23
	Captan 50W, 6lbs	7/22	Captan 50W, 1lbs	7/23		
Pre Harvest	Asana XL, 8oz	7/30	Asana XL, 8oz	7/30	Asana XL, 8oz	7/30
	Rovral 50W, 2lbs	7/30	Benlate 50W,1lbs	7/30	Sulfur 95W,15lbs	7/30
	Rovral 50W, 2lbs	8/9	Benlate 50W,1lbs	8/9	Sulfur 95W,15lbs	8/9

Table 2. Total agricultural chemical inputs into each of the treatments (per acre)

TREATMENT	Chemicals	Application Frequency	Total Active Ingredients	Total Saved in IPM Application	Total Saved in IPM Active Ingredients
CONVENTIONAL	Insecticides	7	5.1032 lbs and 0.484 gal		
	Herbicides	2	2.5 lbs		
	Fungicides	9	17.42 lbs and 0.54 gal		
	Fertilizers	3	2.3 oz		
IPM-High Input	Insecticides	4	2.5516 lbs and 0.484 gal	3	2.5516 lbs
	Herbicides	3	2.625 lbs	6	14.78 lbs and 0.54 gal
	Fungicides	4	2.64 lbs	5	2.64 lbs
	Fertilizers	3	1.5 oz	0	0.8 oz
IPM-Low Input	Insecticides	4	1.0532 lbs	3	4.05 lbs
	Herbicides	1	0.125 lbs	1	2.375 lbs
	Fungicides	0	0	9	17.42 lbs and 0.54 gal
	Fertilizers	0	0	3	2.3 oz

Table 3. Number of tarnished plant bugs swept in Conventional, IPM-High and IPM-Low plots at Southwest Michigan Research Extenuation Center 1993.

Sampling date	Conventional			IPM-High			IPM-Low		
	IN	OUT	Vis*	IN	OUT	Vis	IN	OUT	Vis
May 12	0	4	0	1	6	0	1	8	0
May 19	0	10	0	0	3	0	0	0	0
June 1**	0	8	0	1	41	0	0	11	0
June 15	2	16	1	0	19	0	0	1	0
June 30	0	8	0	0	0	0	0	0	0
July 13**	1	56	1	2	14	0	1	1	0
July 31	0	10	0	0	0	0	0	0	0

* IN: inside the plot, OUT: outside the plot, Vis: visual observation

** The plots were mowed within a week after sampling

Table 4. Fruit damage caused by tarnished plant bugs

Treatment	Fruit Evaluation			# of tarnished plant bug per 25 sweeps/week	
	Sampling Units (20 peaches/unit)	Mean Number Fruit damaged* C	D	Inside	Outside
Conventional 1	10	20	0	0 a	0.74 a
Conventional 2	10	19.7	0.3	0.43 a	15.28 b
Mean	20	19.85 a	0.15 a		
IPM-High Input1	10	20	0	0.29 a	3.86 a
IPM-High Input2	10	20	0	0.29 a	8.43 ab
Mean	20	20 a	0 a		
IPM-Low Input 1	10	20	0	0 a	1.86 a
IPM-Low Input 2	10	20	0	0 a	1.14 a
Mean	20	20 a	0 a		
LSD (0.05)		0.24	0.24	0.57	9.85
SD		0.09	0.09	0.27	3.45
CV		1.94	774.60	245.95	174.99

* Mean number of fruit damage caused by tarnished plant bugs. C: mean clean fruit, D: mean tarnished plant bug damage/20 fruit. Means followed by same letter do not significantly differ (Duncan, P=0.05)

Table 5. Weed diversity and composition at early and late season at Southwest Michigan Extenuation Research Center, Watervliet, MI 1993*.

WEED	CONVENTIONAL				IPM-HIGH				IPM-LOW			
	PLOT 1		PLOT 2		PLOT 1		PLOT 2		PLOT 1		PLOT 2	
	E	L	E	L	E	L	E	L	E	L	E	L
Clean	**93.3**	**91.6**	**93.3**	**88.3**	0	0	0	0	0	0	0	0
Clover	0	0	0	0	0	0.7	1.7	3.3	61.7	10.0	0	5.0
Dandelion	0	0	0	5	0	1.7	1.7	1.7	0	0	21.7	1.7
Endophytic rye	0	0	0	0	0	0	0	0	**36.7**	**85.0**	**56.6**	**93.3**
Horsenetle	0	1.7	0	0	15.0	1.7	1.7	0	0	3.3	0	0
Lambsquaters	3.3	0	0	0	0	0	0	0	0	0	0	0
Milk weed	0	0	0	0	5.0	1.7	0	0	1.6	0	0	0
Orchard grass	0	0	0	0	**70.0**	**89.2**	**94.9**	**90.0**	0	0	0	0
Plantain	0	0	0	0	0	0	01.7	1.6	0	0	0	0
Quack grass	0	6.7	0	6.7	0	0	5.0	0	0	0	0	0
Ragweed	0	0	6.7	0	0	0	0	1.7	0	1.7	0	0
Vetch	0	0	0	0	0	0	0	0	0	0	5.0	0
White champion	1.7	0	0	0	10.0	0	0	0	0	0	16.7	0
Wild carrot	1.7	0	0	0	0	0	0	0	0	0	0	0

* Mean percentage of weed composition. E: early season (June 30, 1993), L: late season (July 31,1993).

Figure 2. Nitrate concentration in suction tubes 6 feet below the soil surface in the Conventional, Moderate input and Low input peach plots at SWMREC, 1991-92.