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DEVELOPMENT OF RESISTANCE IN SOUTHERN CHINCH BUGS (HEMIPTERA: LYGAEIDAE) TO THE INSECTICIDE BIFENTHRIN

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St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze lawns are used throughout the southern United States for their climatic adaptation and their ability to tolerate full sun to moderate shade. The southern chinch bug, *Blissus insularis* Barber, is the plant's most damaging pest (Crocker 1993). The adaptability of this insect is shown by developing resistance to insecticides (Reinert & Portier 1983) and overcoming host plant resistance (Busey & Center 1987; Cherry & Nagata 1997).

Insecticide resistance in southern chinch bugs (SCB) was first noted in 1953 in Miami where Wolfenbarger (1953) showed poor control with chlordane. By 1958, Kerr and Robinson (1958) documented resistance to DDT at Sarasota, Florida. The chinch bugs had become resistant to parathion at Fort Lauderdale, Florida by 1960 (Kerr 1960). Chinch bug resistance to both chlorpyrifos and diazinon was confirmed in 1977 at Pompano Beach, Florida (Reinert & Niemczyk 1982). And, in 1983, Reinert and Porter (1983) reported a 9.2 fold level of resistance to the carbamate insecticide, propoxur by SCB. Hence, by 1983, SCB had shown some resistance to chlorinated hydrocarbon, organophosphate, and carbamate insecticides.

In recent years, synthetic pyrethroid insecticides have become increasingly used for SCB control in Florida. Bifenthrin is a synthetic pyrethroid compound used as a contact and stomach poison insecticide/acaricide (Thomson 1998). Bifenthrin has been and still is being used for SCB control in Florida. During 2003, instances of difficulty in controlling SCB with bifenthrin in Florida came to our attention. The objective of our study was to determine if southern chinch bugs had become resistant to bifenthrin, and if so, note possible trends in this resistance.

Chinch bugs were collected by vacuuming in lawns of infested St. Augustinegrass. After collection, the insects were stored at 18°C in buckets with St. Augustinegrass until used for testing. The insects were collected from 16 different urban areas throughout Florida except for extreme northern Florida where fewer chinch bugs are found and control problems were not brought to our attention. Eight of the populations came from locations where there was difficulty in controlling chinch bugs with bifenthrin and resistance was suspected. In contrast, eight populations were selected randomly as encountered in other areas with there being no knowledge of the insecticidal use history of the location or current efficacy of bifenthrin against the insects.

Methods for testing closely approximated methods of Reinert and Porter (1983) used earlier in toxicological tests against SCB. In the laboratory, serial dilutions of bifenthrin were made from Talstar Flowable 7.9% AI (FMC, Philadelphia, PA). Freshly harvested St. Augustinegrass stolons (ca 10 cm long) were dipped into dilutions and allowed to air dry. Stolons were placed individually into Petri dishes (15 cm diameter) containing moist filter paper to maintain high humidity. Twenty adult SCB were placed into each Petri dish and held 24 h at 28°C and 14 D/10 L. For each test, five to seven doses with a control were tested. Robertson et al. (1984) noted that a sample size of 120 appears to be the minimum necessary for reliable estimation for LC_{50} estimation. Our sample sizes of adults tested ranged from 200 (10 doses) to 480 (24 doses) for each location to estimate LC_{50} for that location. Different numbers of adults tested per location depended on availability of adults plus variability noted in testing. Since our own objective was to estimate LC_{50} values, we selected doses expected to give 25 to 75% mortality for best LC_{50} estimation as suggested by Robertson et al. (1984). Mortality is defined as virtually no movement by an adult during a 5 minute observation period through a 5× large magnifying lens. The no movement criterion was used to avoid ambiguities of comatose, unable to stand, moribund, etc. In a separate test, >95% of adults we classified as dead after insecticide exposure did not regain movement after 24 h and the <5% showed only small twitches. Hence we believe the 24 h holding period with no movement criterion was a good measure of mortality since adults classified as dead still appeared dead 24 h later. Lethal median concentrations (LC_{50}) and slopes were calculated for each population by probit analysis on Log_{10} dose (SAS 1996).

Toxicological data for the 16 chinch bug populations are shown in Table 1. Lowery and Smirle (2003) note that non-overlapping 95% confidence intervals show that LC_{50} values are significantly different ($P < 0.05$). A wide range of LC_{50} values were observed in the 16 populations with many of the LC_{50} values being significantly different. These data clearly show that SCB has now developed resistance to bifenthrin in some locations. Resistant populations were observed inland (Clermont) and on both the east coast (i.e., Daytona Beach) and west coast (i.e., Sarasota) of Florida. The resistant populations extended from as far south as Key Largo (25°15' latitude) to as far

TABLE 1. RESPONSES OF FLORIDA POPULATIONS OF SOUTHERN CHINCH BUGS TO BIFENTHRIN.[a]

Location	Adults tested	Slope ± SE[b]	LC_{50}[c]	CI[d] Lower	CI[d] Upper	Resistance ratio[e]
Control problem						
Clermont	200	1.5 ± 0.4	78.7	41.1	426.8	34.2
Daytona Beach	220	0.9 ± 0.2	243.3	56.2	813.9	105.8
Key Largo	480	1.2 ± 0.2	148.2	105.1	240.1	64.4
Ormond Beach	220	0.7 ± 0.2	698.8	230.4	2,767.6	303.8
Palm Coast	240	0.5 ± 0.1	1,693.4	796.1	3,998.9	736.3
Palmetto	320	0.8 ± 0.2	493.6	159.3	3,088.7	214.6
Sarasota	220	1.3 ± 0.3	89.2	45.6	192.7	38.8
Spring Hill	240	0.7 ± 0.2	159.3	47.5	30,238.3	69.3
Random						
Belle Glade	300	1.3 ± 0.2	2.6	1.7	4.2	1.1
Gainesville	200	1.8 ± 0.2	10.6	7.3	14.2	4.6
Fort Pierce	240	1.3 ± 0.3	2.8	1.4	6.7	1.2
Kendall Lakes	240	1.0 ± 0.2	9.3	3.1	22.0	4.0
Lithia	240	1.6 ± 0.2	5.4	4.1	7.0	2.3
Orlando	220	1.3 ± 0.3	2.3	0.5	4.6	1.0
Royal Palm Beach	200	1.2 ± 0.2	7.3	4.4	10.7	3.2
Tamarac	220	0.8 ± 0.2	9.7	4.3	16.4	4.2

[a]24 h exposure at 28°C by the method of Reinert and Portier (1983).
[b]Probit analysis with Log_{10} (dose).
[c]LC_{50} = AI = ppm..
[d]CI = 95% confidence interval
[e]Resistance ratio = LC_{50} of population/lowest LC_{50} of any population.

north as Palm Coast (29°35' latitude). These data show that SCB populations resistant to bifenthrin already range throughout much of Florida.

The LC_{50} data clearly fell into two distinct groups. Locations where control problems were encountered consistently had high LC_{50} values. These data suggest the control problems at these locations were at least partly caused by resistance and not faulty application procedures, etc. In contrast, locations which were randomly selected consistently had low LC_{50} values. It should be noted that LC_{50} values of all random populations were significantly lower than LC_{50} values of all control problem populations clearly showing a sharp delineation between the two groups. These latter data show most SCB populations in Florida are more susceptible to bifenthrin than the resistant populations encountered in control problem locations. The high variability in insecticide resistance we observed between populations of SCB within Florida is consistent with earlier reports (see Reinert (1982) for review; and Reinert and Portier (1983) for best example).

In summary, our study is the first to report on southern chinch bug resistance to a synthetic pyrethroid, bifenthrin. As noted earlier, various synthetic pyrethroids are commonly used for chinch bug control in Florida turf. Hence, the potential problem exists of increasing insecticide resistance in southern chinch bugs to other synthetic pyrethroids.

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SUMMARY

Synthetic pyrethroids are currently widely used for southern chinch bug control in Florida turf. Southern chinch bugs were tested from 16 locations in Florida to determine possible resistance to the synthetic pyrethroid, bifenthrin. This study is the first to show southern chinch bug resistance to a synthetic pyrethroid, bifenthrin.

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