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Susceptibility of Redbanded[1] and Conchuela Stink Bugs[1] from the Texas Lower Rio Grande Valley to Organophosphate and Pyrethroid Insecticides

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ABSTRACT

We report the susceptibility of 2 stink bug species, redbanded stink bug (RBSB), *Piezodorus guildinii,* (Westwood) and conchuela stink bug, *Chlorochroa ligata,* (Say) collected in the Texas Lower Rio Grande Valley to selected pyrethroid and organophosphate technical grade insecticides. The adult glass vial test (AVT) was used and the most commonly-used insecticides on a variety of crops were evaluated. The baseline susceptibility of the conchuela stink bug as reported by LC_{50} and LC_{90} values (95 % confidence limits) shows that it is highly susceptible to the organophosphates, dicrotophos (Bidrin®), acephate (Orthene®) and the pyrethroids, deltamethrin, (Decis®) and lambda-cyhalothrin (Karate®). The RBSB has a history of being hard to kill in soybean, and the reported LC_{50} in these assays of 5.06 (3.74 - 7.26) and a LC_{90} of 26.9 (15.23 – 89.91) for acephate are higher than those reported for Louisiana, where the RBSB has a history of being difficult to control. The RBSB should continue to be monitored for insecticide resistance using the AVT especially with the organophosphate insecticides. Baseline values for susceptibility of RBSB and conchuela stinkbug to insecticides tested are important for future comparisons to monitor development of resistance.

Additional Index Words: Insecticide, susceptibility, stink bug, soybean.

The redbanded stink bug (RBSB), *Piezodorus guildinii,* (Westwood), is recognized as an economically threatening pest of soybean (G*lycine max L.)* and other legumes in South and Central America (Panizzi and Slansky, 1985, Depieri and Panizzi 2011). However within the last 15 yrs, RBSB has been expanding in distribution and increasing in density within soybean regions in Florida, Georgia, Texas and the mid-south states of Mississippi, Arkansas, Louisiana, and even more recently Missouri (Tindall & Fothergill 2011). Entomologists in the mid-south have noted that once the RBSB becomes established, it very quickly becomes the most predominant species in cultivated soybean and does not appear to be as susceptible to available insecticides when compared to other stink bug pests (Akin et al. 2011). RBSB is known to feed on other crops such as cotton (Greene, et al. 2006), wild and cultivated legumes (Panizzi and Slansky 1985) including hairy indigo, *Indigofera hirsute* L., but has established itself as a very serious threat to pod production in cultivated soybean. Armstrong, (unpublished data) collected many adult and nymphal RBSB from alfalfa, M*edicago sativa*, L., via standard sweep net in June of 2008 near Progresso, Hidalgo Co. TX and subsequently sampled RBSB from cultivated soybean consistently every year. Date of planting has been investigated as an option for managing populations of RBSB because of preference for feeding on the developing pods, which causes significant seed damage (Akin et al. 2011). Planting earlier, with earlier maturing soybean varieties has been mentioned as a management option for the mid-south region because RBSB tend to be a late season pest with a preference for developing soybean pods. A notorious pest to control with organophosphate insecticides, use of broader-spectrum insecticides has been one of the better options for control of RBSB (Baur et al. 2010).

Less information is known about the biology, host plant utilization or ecology of the conchuela stink bug, *Chlorochroa ligata* (Say). The conchuela stink bug is listed as a pest of cotton in Texas (Bomfalk et al. 2011). Hall and Teetes (1982) report the conchuela stink bug as a pest of grain sorghum in Central Texas; Traxler and Godoy-Avila (2004) report it as a significant pest of grain sorghum and of cotton near Laguna area in the state of Coahuila, Mexico. Muegge (2002) observed high, economically threatening populations of the conchuela stink bug on cotton in far West Texas. Non-crop host plants include legumes, (*Leguminosae*) with a known preference for mesquite (*Prosopis* sp.), bean pods (Muegge 2002). It is reported to feed on pistachio, *Pistachio vera* L., and pecan nuts in New Mexico (C. Sutherland, personnel comm.). Reported management strategies are non-existent with the exception that conchuela stink bug is sometimes listed under some insecticide recommendations with treatment thresholds usually listed as the same as other stinkbug pests Muegge (2002). The Lower Rio Grande Valley of South Texas is currently under boll weevil eradication. Many regions where the boll weevil has been eradicated have seen the insect species shift from lepidopteran pests to the true bug and plant bug pests in the cotton landscape. Reasons for this shift are that target specific technologies such as Bt traits that can control the larvae of the lepidopteran pests, but do not affect plant bug or stink bug species, thus the use of some broad spectrum insecticides has decreased, while leaving the stinkbug and plant bug complex to flourish.

During the 2011 production season we observed high densities of the RBSB in soybean test plots at the USDA-ARS research farm, Weslaco, TX followed by high populations of adult and nymphal conchuela stink bugs on canola, *Brassica napas* L., plots at the same farm. The current study was undertaken to determine the susceptibility status (LC_{50} and LC_{90} values) of the RBSB, an established threat to soybean production in the Rio Grande Valley of Texas, and for the conchuela stink bug, an occasional pest of many crops for which there is no known history of insecticide exposure data. Establishing the baseline susceptibility and providing toxicological data for organophosphate and pyrethroid insecticides is a proactive approach in establishing integrated systems management for either of these pests.

MATERIALS AND METHODS

Insect Collection. Adults and nymphs of RBSB were collected from the USDA ARS research farm, Weslaco TX to use in these assays. The RBSB were collected from soybean using a pneumatic KISS (keep it simple sampler, Beerwinkle et al. 1997) where air is blown across the foliage and the insects are captured in a net. The adults were used in the assays when captured, while nymphs were maintained on green bean, *Phaseolus vulgaris* L., pods and corn, *Zea mays* L. in ventilated tupperware containers until they molted to adults. Nymphs were then tested in subsequent assays identical to the RBSB captured as adults. Conchuela stinkbugs were collected from a canola (*Brassica sp*) variety trial located directly across the road from the soybean trial. There were literally hundreds of adults available for testing.

Adult-vial Test. The adult vial test (AVT), originally developed by Plapp et al. (1990) for determining the susceptibility of tobacco budworm, *Heliothis virescens* (F.), to pyrethroids, and later adapted by Snodgrass (1996) for determining the susceptibility of tarnished plant bug, *Lygus lineolaris* (Palisot de Beavois), to insecticides was used for determining mortality at 48 h. Technical-grade insecticides (>96% AI) were purchased from Chem Service, (West Chester, PA), and diluted in acetone (99.9% HPLC grade, Sigma Aldrich, St Louis, MO). Dilutions (0.5-ml) were pipetted into 20-ml glass scintillation vials and rolled for 10 minutes on a hot dog roller (Star Manufacturing, St Louis, MO) until only the dried insecticide residue remained on the interior surface of the glass vial. The insecticides tested were the organophosphates, dicrotophos (Bidrin®) and acephate (Orthene®), and the pyrethroids, deltamethrin, (Decis®) and cyhalothrin (Karate®). There were 10 replications (vials) of six to nine concentration ranges, including untreated checks, and each vial had three adults of undetermined sex aspirated into them. A 1.5-cm cross-section of green bean was placed as a food source in each vial. The top of each vial was plugged with a cotton ball. The insects were maintained with artificial light at 72 ± 4ºF on a bench in the laboratory where mortality was assessed at 48 hrs.

Data Analysis. Mortality data were analyzed by probit analysis (Finney 1971) at the 48-hour time interval for the pyrethroid, and organophosphate classes of insecticides for estimating and comparing the 95% confidence intervals for LC_{50} and LC_{90} values (Robertson and Preisler 1992) using Polo-Plus (LeOra ® software 2003). Mortality of the controls never exceeded 1.5%, therefore no adjustment for the correction of mortality in the controls was needed.

RESULTS

Adult-vial Test. The probit models were a good estimate of the relationship between dose of insecticide and mortality as indicated by the χ^2 valued for these assays (Table 1). Lethal dose values [LC_{50}(95% Confidence Limits)] for the RBSB ranged from 5.06 (3.74 - 7.26) for acephate, to 1.62 (1.28 - 2.04) µg/vial for dicrotophos which are significantly different when

Table 1. Probit statistics and lethal concentration (95% Confidence Limits) (LC_{50} & LC_{90}, µg/vial) data for red-banded stink bug, *Piezodorus guildinii,* and the conchuela stink bug, *Chlorochroa ligata*, exposed to technical grade organophosphate and pyrethroid insecticides using the adult vial bioassay.

Stink bug species	Insecticide[a]	n	Slope ± SE	LC_{50} [cd] (95% CL) ug/vial	LC_{90} [cd] (95% CL) ug/vial	χ^2 (df)	$P>\chi^2$
RBSB[a]	Acephate	160	1.76 ± 0.35	5.06 (3.74 - 7.26)aA	26.9 (15.23 – 89. 91)aA	2.42 (5)	0.48
RBSB	Dicrotophos	140	2.91 ± 0.44	1.62 (1.28 - 2.04)bA	4.46 (3.31– 7.21)bA	1.39 (4)	0.34
RBSB	Deltamethrin	160	1.67 ± 0 .33	3.66 (2.56 - 6.16)aA	21.4 (10.72 – 93.35)aA	0.60 (4)	0.15
RBSB	L-Cyhalothrin	140	1.69 ± 0 .31	1.84 (0.99 - 4.03)aA	10.5 (5.27 – 54.41)aA	5.46 (4)	0.67
Conchuela[b]	Acephate	77	1.75 ± 0.39	2.32 (1.44 - 4.04)aA	12.5 (6.33 – 59.34)aA	1.68 (4)	0.17
Conchuela	Dicrotophos	183	2.1 ± 0 .32	3.02 (2.40 - 3.85)aB	12.3 (8.20– 24.75)aB	2.75 (4)	0.40
Conchuela	Deltamethrin	140	1.87 ± 0.35	3.66 (2.64 - 5.77)aA	17.7 (9.70 – 60.93)aA	0.93 (4)	0.42
Conchuela	L-Cyhalothrin	140	1.38 ± 0 .27	0.26 (0.17 – 0.68)bB	0.86 (0.48 - 1.30)bB	6.01 (4)	0.20

a Redbanded stink bugs collected from soybeans, USDA ARS research farm, Weslaco, TX August 2010.
b Conchuela stink bugs collected from canola, USDA ARS research farm, Weslaco, TX September 2010.
c LC_{50} and LC_{90} values within each column for the same species and for the same insecticide class followed by different small letters are significantly different based on the lack of overlap in the 95% confidence limits.
d LC_{50} and LC_{90} values within each column for different species and the same insecticide followed by different capital letters are significantly different based on the lack of overlap in 95% confidence limits.

tested using the adult vial assay. Acephate resulted in a significantly higher LC_{50}, requiring higher doses of AI compared to dicrotophos but this might be expected as has been observed for other stinkbug species (Lopez, et al. 2012). RBSB collected locally from Weslaco, TX were also susceptible to the pyrethroids deltamethrin (LC_{50} = 3.66, 2.65 – 6.16) and lambda cyhalothrin (LC_{50} = 1.69, 0.99 – 4.03), although the LC_{50} was approximately 2x higher for lambda cyhalothrin, but the difference was not statistically significant.

The conchuela stinkbug was most susceptible to lambda cyhalothrin resulting in an LC_{50} of 0.86 (0.48 - 1.30), with the lowest slope for all insecticides tested, and this was 4x times more toxic than the other pyrethroid deltamethrin that resulted in an LC_{50} of 3.66 (2.64 - 5.77), (Table 1). The conchuela stink bug was also highly susceptible to acephate with a LC_{50} = 2.32 (1.44 - 4.04) more so than the 3.02 (2.40 – 3.85) for dicrotophos which is unusual for bug species tested with the AVT.

DISCUSSION

These lethal concentration values from assays of 2 different stink bug species indicate that at least local populations from Weslaco, TX are susceptible to the organophosphate and pyrethroid insecticides. There does not exist any data on the susceptibility of the conchuela stink bug to insecticides using the AVT method, although it has been reported as a pest of cotton in the United States (Mugee 2002) and Mexico (Traxler and Godoy-Avila 2004), and a pest of grain sorghum in the United States (Hall and Teetes 1982). The data reported here should provide baseline data for future resistance monitoring.

The RBSB has more documented history of being a difficult pest to control, especially as a pest of soybean from the states of Parana and Sao Paulo where organophosphate insecticides (methanmidophos, acephate, chlorpyriphos, and monocroptophos) and the cyclodiene (endosulfan) have been used for controlling RBSB for more than 30 years (Gazzoi and Olivera

1979, Oliveira et al. 1988, Sosa-Gomez et al. 2001). More recent AVT assays establishing susceptibility of RBSB from Louisiana suggests that the LC_{50} value for acephate was 3.8-fold (Baur et al. 2010), lower than ours reported here for Weslaco of 5.06 µg/vial. Although no lambda-cyhalothrin, or dicrotophos were used in Louisiana bioassays for comparison with Weslaco,TX data, the LC_{50} values are low and do not indicate any form of either tolerance or resistance. Considering the importance of the RBSB as a pest of soybean, monitoring for resistance and establishing baseline susceptibilities to older classes of insecticides used in the past, and for those that are newer and in development should be a priority.

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REFERENCES CITED

Akin, S,. J. Phillips, and D. T. Johnson. 2011. Biology, identification and management of the redbanded stink bug. Univerisity of Arkansas Agricultural and Natural Resources, circular FSA7078, www.uaex.edu.

Baur, M. E., D. R. Sosa-Gomez, J. Ottea, B. R. Leonard, I. C. Corso, J. J. Da Silva, J. Temple, and D. J. Boethel. 2010. Susceptibility to Insecticides Used for Control of *Piezodorus guildinii* (Heteroptera: Pentatomidae) in the United States and Brazil. J. Econ. Entomol. 103:869-876.

Beerwinkle, K. R., J. R. Coppedge, and T. M. O'Neil. 1997. "KISS" - A new portable pneumatic "keep it simple sampler" for row crop insects. Proceedings, Beltwide Cotton Conf. 1997. 1330-1333. National Cotton Council, Memphis, TN.

Bohmfalk, G. T., R.E. Frisbie, W.L. Sterling, R.B. Metzer and A.E. Knutson. 2011. Identification, biology and sampling of cotton insects. Texas A&M Extension circular B-933. http://www.soilcropandmore.info/crops/CottonInformation/insect/B-933/b-933.htm#top.

Depieri, R. A., and A. R. Panizzi. 2011. Duration on feeding and on superficial and in-depth damage to soybean seed by selected species of stink bugs (Heteroptera: Pentatomidae). Neotrop. Entomol. 40:197-203.

Finney, D. J. 1971. Probit Analysis. 3rd ed. Cambridge University Press, Cambridge, England.

Gazzoni, D. L., and E. B. Oliveira. 1979. Recomendacoes de inseticidas para utilizacao no programa de manejo de pragas da soja safra 1979/1980. Embrapa Centro Nacional de Pesquisa de Soja. Comunicado Tecnico 2. 1 - 13.

Greene, J. K., C. S. Bundy, P. M. Roberts, and B. R. Leonard. 2006. Identification and management of boll feeding bugs in cotton. Clemson University Agriculture and Natural Resources circular EB 158.

Hall, D. G., and G. L. Teetes. 1982. Damage to grain sorghum by southern green stink bug, conchuela stink bug, and leaffooted bug. J. Econ. Entomol. 75:620-625.

LeOra Software. 2003. PoloPlus, v1.0, LeOra Software, Petaluma, CA.

Lopez, J. D., M. A. Latheef and B. Ree. Toxicity by glass vial bioassay of selected pyrethroid and organophosphate insecticides to adult brown stink bugs (Heteroptera: Pentatomidae) from Central Texas. S.W. Entomol. (In Press).

Muegge, M. Far West Texas Cotton Insect Update. 2002. Texas AgriLife newsletter. Vol. 1:1, lubbock.tamu.edu/cottondvd/content/cottondvd/Insects/Conchuela

Oliveira, E. B., D. L. Gazzoni, I. C. Corso, G. L. Villas Boas, and C. B. Hoffman-Campo. 1988. Pesquisa com inseticidas em soja: sumario dos resultados alcancados entre 1975 e 1987. Embrapa-CNPSo Documentos, 30.

Panizzi AR, and F. Slansky Jr. 1985. New host plant records for the stink bug, *Piezodorus guildinii,* in Florida (Hemiptera: Pentatomidae). *Fla. Entomol*. 68:215–16

Plapp, F. W. Jr., J. A. Jackman, C. Campanhola, R. E. Frisbie, J. Graves, R. Luttrell, W. F. Kitten, and M. Walls. 1990. Monitoring and management of pyrethroid resistance in the tobacco budworm (Lepidoptera: Noctuidae) in Texas, Mississippi, Louisiana, Arkansas, and Oklahoma. *J.* Econ. Entomol *83*: 335-341.

Robertson, J. L., and H. K. Preisler. 1992. Pesticide Bioassays with Arthropods. CRC Press. Boca Raton, FL.

Snodgrass, G. L. 1996. Glass-vial bioassay to estimate insecticide resistance in adult tarnished plant bugs (Heteroptera: Miridae). J. Econ. Entomol. 89: 1053-1059.

Sosa-Gomez, D. R., I. C. Corso, and L. C. Morales. 2001. Insecticide resistance to endosulfan, monocrotophos and methamidophos in the Neotropical brown stink bug, *Euschistus heros* (Fabr.). Neotrop. Entomol. 30: 317Ð320.

Tindall, K., and Fothergill, K. 2011. First records of *Piezodorus guilddinii* in Missouri. Southwest. Entomol. 36:203-205.

Traxler, G., and S. Godoy-Avila**.** 2004. Transgenic Cotton in Mexico. *AgBioForum*, 7: 57-62.

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