2005 Beltwide Cotton Conferences, New Orleans, Louisiana - January 4 - 7, 2005

RESPONSE OF ADULTS OF BIOTYPE A SWEET POTATO WHITEFLY, BEMISIA TABACI (GENNADIUS) (HOMOPTERA; ALEYRODIDAE) TO THREE CLASSES OF INSECTICIDES

Dan A. Wolfenbarger and D. G. Riley
Certified Entomologist
Brownsville, TX

Abstract

Historical data from 1993 indicated that whitefly adults of biotype A were resistant to organophosphorus insecticides acephate, azinphosmethyl, methyl parathion and profenofos. LC50s were >20 µg/vial or mortalities did not exceed 50%. An LC50 of >20 µg/vial, after 3 h, is proposed as a resistance threshold for all insecticides tested against this biotype. Biotype A was resistant to amitraz which killed <50% of the adults at >20 µg/vial. The biotype was susceptible to the cyclopropane pyrethroid bifenthrin; LC50.s of dead + moribund ranged from 0.0027 to 0.15 µg/vial. LC50s of bifenthrin in the dead category ranged from 0.057 to 95.15 µg/vial; 17% of LC50s for bifenthrin indicated resistance. LC50s of the cyclodiene endosulfan and the organophosphorus methamidophos were about equal and indicated susceptibility. LC50s of both insecticides for dead + moribund ranged from 0.06 to 18.14 µg/vial, while the LC50s for dead ranged from 9.2 to 56.5 µg/vial. LC50s for dead + moribund were susceptible. LC50s for dead indicated that 50% were resistant and 50% were susceptible. The biotype was identified by nonspecific esterase activity.

Introduction

In 1946 the sweetpotato whitefly, *Bemisia tabaci* (Gennadius). was identified by morphological characters in the Lower Rio Grande Valley (LRGV) (Norman, et al. 1992 and Sparks, et al. 1992). Biotype A became a pest of cotton and cucurbits in CA, AZ and Mexico before 1980 and has never been identified in the LRGV, only *B. tabaci*. Biotype B became a serious pest of cotton and cucurbits in CA and AZ before 1989, largely displacing biotype A in these areas (Brown et al. 1995). There are presently no morphological differences that distinguish adults, eggs and larvae of *B. tabaci* and *B. argentifolia* (Brown, et al. 1995). The two species are separated morphologically by setae in the pupal stage and these are polymorphic (Brown et al. 1995). Species identification was never an important consideration in the LRGV prior to 1990 because populations of whitefly, *B. tabaci*, were rarely present in large numbers on any one crop. *B. tabaci* was a secondary pest of cotton in CA, but became a primary pest from 1964 to 1989 after resistance to the organophosphorus insecticide dimethoate was determined (Prabacher et al. 1985 and 1989). Populations of biotype B were not identified on any crop in the LRGV until 1990-1991 when molecular or biochemical analysis were used to separate the biotypes (Costa and Brown 1990 and 1991 and Gawel and Bartlett 1993). From the 1960s to 1990 acephate, dimethoate, methamidophos and methyl parathion were the most widely used organophosphorus insecticides in the LRGV and the Americas against *B. tabaci*. Since 1990-1991 only biotype B has been identified on cabbage, cotton, cantaloupe, squash and cucumbers in the LRGV based on whitefly samples identified by nonspecific esterase activity (Costa and Brown 1990 and 1991, Brown 1993 and Brown et al. 1995) or RAPD-PCR (Gawel and Bartlett 1993). Crosses of biotype A and B do not produce female progeny (Costa and Brown 1993). The mechanism of displacement from *B. tabaci* to biotype B is unknown.

In the USA biotype A was more resistant than biotype B to insecticides of the organophosphorus and pyrethroid class (Cahill et al. 1993). Biotype A was bioassayed in 1982 and biotype B was bioassayed in 1988. They discussed cause or coincidence of biotypes and stated that there was no simple nor universal solution for managing resistance in biotypes A or B with the use of insecticides.

The toxicity of different classes of insecticides in laboratory bioassays against populations of biotype A maintained in the laboratory in the LRGV. In 1990-1991 only biotype B was identified in the LRGV. The toxicity of different classes of insecticides used against biotype B to protect the crops is well documented (Loera-Gallardo et al. 1998 and Wolfenbarger et al. 1998). If, in the future, biotype A is determined to be a distinct species or the biotype designation is confirmed and there is some adaptive advantage of the biotype A over the biotype B it could be important to document whether biotype A differed greatly in insecticide susceptibility from biotype B (Perring et al. 1996). This report documents only toxicity data for biotype A, a laboratory colony.

Materials and Methods

In 1993, live forms of biotype A were sent to D. G. Riley, Texas Agricultural Experiment Station, Weslaco, TX from J. K. Brown, Arizona Agricultural Experiment Station, Tucson, AZ. Biotype A was identified by J. K Brown, Arizona Agricultural Experiment Station, Tucson, AZ with nonspecific assay for esterases (Costa and Brown 1990 and 1991, Brown 1993 and Brown et al. 1995). Populations were maintained on cotton in the greenhouse at the experiment station in Weslaco where the bioassays were made.

The vial bioassay for adults was conducted as described by Gage, et al. (1992), Staetz et al. (1992), Tan et al. (1996) and Wolfenbarger et al. (1998). Adults were placed in vials coated with insecticides. Dead + moribund and dead category were determined 3 h after placing the adults in the vials. Dead and moribund adults were placed on a black surface and counted. The live adults remained on the glass surface of the vials and were counted. Doses, as µg/vial, for acephate, azinphosmethyl, bifenthrin, endosulfan, methamidophos, methyl parathion and profenofos ranged from 0.00625 to 62.5, 0.125 to 250.0, 0.00625 to 0.625, 0.0625 to 62.5, 0.625 to 125.0, 0.000125 to 75.0 and 0.00625 to 12.5, respectively.

LC50s and 95% confidence intervals (CI), expressed as µg/vial, and slope ± standard error (SE) were calculated for the dead + moribund and dead categories (SAS 1988). Equal LC50s indicate overlapping 95% CI of the LC50s. The two categories were used to describe toxicity of the three classes of insecticides to biotype A. A resistance threshold of LC50 of 20 µg/vial was proposed for biotype A based on the observed LC50s. This threshold defines a critical point between resistance and susceptibility to insecticides of all classes for this biotype in the LRGV. It is provided as a relative value to indicate shifts to either resistance or susceptibility and should be used for discussion of these and any other LC50s.

Results and Discussion

LC50s of bifenthrin and endosulfan for dead + moribund adults of biotype A ranged from 0.0063 to 0.15 and 0.06 to 18.14 µg/vial, respectively (Table 1). The biotype showed susceptibility to both of these insecticides because all LC50s were less than the resistance threshold. LC50s of bifenthrin and endosulfan for dead ranged from 0.057 to 95.15 and 9.2 to 56.85 µg/vial, respectively. For this category LC50s of endosulfan to adults were 161-fold greater and equal to LC50s of bifenthrin at the lowest and greatest LC50, respectively. The addition of moribund category to those that were dead greatly reduced the LC50s compared to LC50s for the dead. The biotype was both resistant and susceptible to endosulfan based on the dead category. The average LC50s for dead adults treated with bifenthrin and endosulfan were 24.1 and 25.8 µg/vial greater, respectively, than for the dead + moribund category, 0.05 and 8.8 µg/vial, respectively.

This trend did not hold for methamidophos. LC50s for the dead + moribund and dead categories of the organophosphorus (OP) insecticide were equal and susceptible (Table 1) compared to the other four OP insecticides tested.

Biotype A was resistant to the OP insecticides azinphosmethyl, acephate, profenofos and methyl parathion based on dead + moribund adults since most mortalities were <50% at >20 µg/vial and had non-significant regressions. For acephate and profenofos, slope ± SE, percent mortality at dose and number tested were 0.17 ± 0.11, 38% at 62.5 µg/vial for 290 adults and 0.16 ± 0.14, 26% at 62.5 µg/vial for 61 adults. Azinphosmethyl showed 67% and 0% mortality at 125.0 and 62.5 µg/vial against 129 adults, respectively. Methyl parathion showed 100% and 0% mortality at 62.5 and 6.25 µg/vial against 69 adults, respectively.

On 18 August and 1 September the LC50s for bifenthrin in the dead condition were 133 and 35,241 fold greater than LC50s of dead + moribund, respectively. For bifenthrin on 29 September LC50s of dead and dead + moribund were equal.

On 4 August and 1 September LC50s of endosulfan for dead and dead + moribund were equal. On 29 September LC50 of dead was 948 fold greater than LC50s of dead + moribund.

Slopes of bifenthrin and methamidophos for dead + moribund were always greater than shown for the dead. Slopes of endosulfan for dead +moribund were also steeper than shown for the dead on 4 August, while slopes for dead were steeper than shown for the dead + moribund on 1 and 29 September. Slopes showed greater variation for endosulfan than for bifenthrin.

In summary, the LC50S and slopes for bifenthrin and endosulfan were not greatly different than those reported for biotype B (Wolfenbarger et al. 1998). This suggests there was no major difference between biotypes A and B in terms of insecticide susceptibility that could have contributed to an adaptive advantage. Shifts in the biotype populations in the LRGV were probably related to reproductive differences (Perring 1996) rather than insecticide resistance.

References

Bellows, T. S., Jr., T. M. Perring, R. J. Gill and D. H. Headrace. 1994 Description of a species of *Bemisia* (Hemiptera:Aleyrodidae). Ann. Entomol. Soc. Am. 87: 195-206.

Brown, J. K., D. R. Frolich and R. C. Russell. 1995. The sweet potato or silver leaf whiteflies: biotypes of *Bemisia tabaci* or species complex? Annual Review of Entomology 40: 511-534.

Brown, J. K. 1993. Evaluation critica sobre los biotipos de mosca blanca en America, de 1989 a 1992. *In* Las Moscas Blancas (Homoptera: Aleyrodidae) en America Centro y el Caribe. Seria Technia Informe Tecnico. No. 205: 1-9.

Costa, H. S. and J. K. Brown. 1990. Variability in biological characteristics, isozyme patterns and virus transmission among populations of *Bemisia tabaci* Genn. in Arizona. Pytopathology 80: 888.

Costa, H. S. and J. K. Brown. 1991. Variation in biological characteristics and in esterase patterns among populations of *Bemisia tabaci* Genn. and the association of one population with silver leaf symptom development. Entomol. Exp. Appl. 61:211-219.

Costa, H. S. and J. K. Brown, S. Sivasupramiam and S. Bird. 1993. Regional distribution, insecticide resistance and reciprocal crosses between A and B biotypes of *Bemisia tabaci*. Insect Sci. Appl. 14:255-266.

Cahill, M., F. Byrne, L. Birne, J. Denholm and A. Devonshire. Spring 1993. Insecticide Resistance in *Bemisia tabaci*: An International Perspective. Resistant Pest Management Newsletter. 5(1): 16-18.

Gage, E. V., D. G. Riley, D. A. Wolfenbarger, C. A. Staetz, K. A Boyler. 1992. Vial bioassay for contact insecticides for the adult whitefly: *Bemisia tabaci* (Gennadius). pp 42-50. Proc. First Annual Southwest Ornamental Pest Management workshop

Gawel, N. J. and A. C. Bartlett. 1993. Characterization of differences between whiteflies using RAPD-PCR. Insect Molecular Biology. Vol. 33-38.

Loera-Gallardo, J., D. A. Wolfenbarger and D. G. Riley. 1998. Insecticidal mixture interactions against B-strain sweetpotato whitefly (Homoptera: Aleyrodidae). J. Entomol. Science 33:407-411.

Norman, J. W., Jr., A. N. Sparks, Jr. and D. G. Riley. 1992. Sweet potato whiteflies in the Lower Rio Grande Valley. pp.687-691. *In* (P. Dugger and D. Richter ed.) Proceedings Cotton Insect Research and Control Conference. National Cotton Council, Memphis, TN.

Prabacher, N., D.L. Coudriet and D. E. Meyerdirk. 1985. Insecticide resistance in the sweet potato whitefly (*Bemisia tabaci* (Homoptera: Aleyrodidae). J. Econ. Entomol. 78:748-752.

Perring, T. M. 1996. Biological differences of two species of *Bemisia* that contribute to adaptive advantage. pp. 3-16. *In* (Gerling and Mayer, eds.) Bemisia 1995: Taxonomy, Biology, Damage, Control and Management. Intercept Ltd. Andover, Hants, UK. 702 pp.

Prabacher, N., N. C. Toscano and D. L. Coudriet. 1989. Susceptibility of the immature and adult stages of the sweetpotato whitefly. J. Econ. Entomol. 82:983-988.

Prabacher, N., D. L.. Coudriet and D. E. Meyerdirk. 1985. Insecticide resistance in the sweet potato whitefly (*Bemisia tabaci* (Homoptera: Aleyrodidae). J. Econ. Entomol. 78: 748-752.

Russell, L. N. 1975. Collection Report of *Bemisia tabaci* (Gennadius) in the United States. U. S. Department of Agriculture Cooperative Economic Insect Report 25 (1): 229-230.

SAS, 1988. Technical Report P-179. Release 6.09 SAS Institute, Inc. pp 255.

Sparks, A. N., Jr., J. W. Norman, Jr. and D. G. Riley. 1992. Management of sweetpotato whitefly in the lower Rio Grande Valley. Pp 691-692. *In* (P. Dugger and D. Richter ed.). Proceedings of Cotton Insect Research and Control Conference. National Cotton Council. Memphis, TN.

Staetz, C. A., K. A. Boyler, E. V. Gage, D. G. Riley and D. A. Wolfenbarger. 1992. Vial bioassay for contact insecticides for adult whiteflies, *Bemisia tabaci*. pp. 704-707. *In* (P. Dugger and D. Richter ed.) Cotton Insect Research and Control Conference. National Cotton Council, Inc., Memphis, TN.

Tan, Wei-Jai., D. G. Riley and D. A. Wolfenbarger. 1996. Quantification and genetic analysis of bifenthrin resistance in the silverleaf whitefly. Southw. Entomol. 21: 265-275.

Wolfenbarger, D. A., D. G. Riley, C. A. Staetz, G. L. Leibee, G. A. Herzog and E. V. Gage. 1998. Response of sweet potato whitefly to bifenthrin and endosulfan by vial bioassay in the southern United States. J. Entomol. Sci. 33: 412-420.

Table 1. Glass vial bioassay of insecticides in the laboratory for toxicity of insecticides against biotype A *Bemisia tabaci* adults from cotton. Weslaco, TX. 1993.

Date	Insects		Slope ± SE	LC50 [µg/vial]	[95% CI]
	Condition	Number tested			
			Bifenthrin		
8-18	Dead + Moribund	69	3.13 ± 0.68	0.0063	0.0044-0.0091
	Dead	106	1.06 ± 0.49	0.84	∞-∞
9-1	Dead + Moribund	115	1.71 ± 0.69	0.0027	∞-∞
	Dead	320	0.41 ± 0.19	95.15	∞-∞
9-8	Dead	112	1.04 ± 0.44	0.16	∞-∞
9-29	Dead + Moribund	175	1.27 ± 0.42	0.15	0.019-1.48
	Dead	131	1.17 ± 0.24	0.057	0.02-0.19
			Endosulfan		
8-4	Dead + Moribund	60	2.25 ± 0.75	18.14	∞-∞
	Dead	68	1.76 ± 0.57	24.83	∞-∞
8-25	Dead	101	3.01 ± 1.04	20.2	∞-∞
9-1	Dead +	240	0.97 ± 0.44	8.07	∞-∞

	Moribund Dead	240	1.80 ± 0.5	17.88	7.5-81.5
9-29	Dead + Moribund Dead	77	0.31 ± 0.061	0.06	∞-∞
10-6	Dead	116	0.87 ± 0.25	56.85	14.57-756.6
8-18	Dead + Moribund Dead	118	1.3 ± 0.55	9.2	∞-∞
			Methamidophos		
9-8		148	0.93 ± 0.39	15.38	∞-∞
		50	1.3 ± 0.35	6.53	2.49-28.75