Biotype Designations and Insecticide Susceptibility of Southwestern *Bemisia tabaci*

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Abstract

We report biotype identifications and susceptibility to insecticides of whiteflies (Bemisia tabaci) collected from cotton, vegetables, melons and ornamental plans during the 2005 season. No major problems with field performance of insecticides against whiteflies were confirmed in 2005 in Arizona. Whitefly resistance to pyriproxyfen did not increase, relative to levels recorded in 2004. However, we detected pyriproxyfen resistance in all Arizona whitefly samples tested. A single sample collected from cotton in Holtville, CA, had no detectable resistance to pyriproxyfen. Samples from cotton in Buckeye, Coolidge, Scottsdale, and Stanfield, Arizona had the highest levels of resistance, with > 31-45% of eggs surviving diagnostic concentration bioassays of 0.1 ug/ml pyriproxyfen.

Whitefly susceptibility to buprofezin (Applaud®/Courier®) has not changed significantly since 1997. Resistance to synergized pyrethroids (e.g., Danitol® + Orthene®) has decreased strikingly on a statewide basis since 1995, though unacceptably high frequencies of resistant whiteflies were detected in some 2005 collections from all commodities sampled. Whiteflies collected from Arizona cotton, melons, and vegetables continued to be highly susceptible to imidacloprid (Admire®/Provado®). One whitefly collection from poinsettias in Phoenix (05-39) was substantially less susceptibile to imidacloprid, and the related neonicotinoid insecticides, acetamiprid, and thiamethoxam. Regression analysis yielded a significant correlation for whitefly susceptibility to acetamiprid and thiamethoxam. Whiteflies from cotton that were least susceptibile to acetamiprid were also significantly less susceptible to thiamethoxam (Actara®/Centric®/Platinum®).

The most worrisome of our 2005 findings was that 6 out of 13 samples of whitefly-infested poinsettias collected from retail stores in metropolitan Tucson and Phoenix consisted of only the Q biotype of Bemisia tabaci. The plants were infested with very low whitefly numbers and thus we were unable to establish them in laboratory cultures to evaluate their resistance status. The Q biotype is native to Spain and was first detected in the US by our group in 2004 on a sample taken from poinsettias. The Q biotype strain we detected in 2004 was highly resistant to a broad range of insecticides used to manage whiteflies in Arizona. None of the 26 field collections evaluated in 2005 was the Q biotype.

Introduction

The neonicotinoid insecticide, imidacloprid (Admire®/Provado®), and the growth-regulating insecticides (IGRs), buprofezin (Courier®/ Applaud®) and pyriproxyfen (Knack®), serve critical roles in controlling whiteflies (*Bemisia tabaci*) (Gennadius) (aka *argentifolii*) in Arizona's low desert agricultural ecosystems (Dennehy and Williams 1997, Ellsworth and Martinez-Carrillo 2001, Kerns and Palumbo 1995), as well as in other arid regions of the world (Denholm et al. 1998). Imidacloprid has provided successful season-long whitefly control in Arizona vegetables and melons since 1993, and has been used on a high proportion of these crops since its introduction

(Palumbo et al. 2001, 2003). The IGRs, buprofezin and pyriproxyfen, were introduced to Arizona cotton in 1996 after resistance to synthetic pyrethroids and other conventional insecticides reached crisis proportions (Dennehy et al. 1996). Buprofezin and pyriproxyfen have provided the foundation for successful resistance management, their recommended use against whiteflies in cotton being limited to once per season for each. Since 1995, insecticide treatments in Arizona cotton have declined to averages of less than two or three treatments per year (Agnew and Baker 2001, Ellsworth and Martinez-Carrillo 2001, Shanley and Baker 2002, 2003). This represents a dramatic change from 1995, when producers were making 6 to 12 insecticide treatments per acre of cotton. Intensive investments into improved monitoring and management of whiteflies (Ellsworth et al. 1996, Ellsworth and Martinez-Carillo 2001), coupled with highly effective, selective insecticides, have greatly reduced the costs of controlling whiteflies. Sustaining successful whitefly management in Arizona will require avoiding whitefly resistance to insect growth regulators and neonicotinoid insecticides.

B. tabaci has been shown to be capable of developing resistance to imidacloprid, pyriproxyfen, and buprofezin under both laboratory and field exposure conditions. Resistance to imidacloprid and cross-resistance to thiamethoxam and acetamiprid was first demonstrated in the Almeria region of southern Spain (Cahill et al. 1996, Denholm et al. 1998, Rauch and Nauen 2003). Whiteflies with reduced susceptibility to imidacloprid have subsequently been reported from Australia, Brazil, Crete, Germany, Israel, Italy, Mexico and Morocco, (Nauen and Denholm 2005). An up-to 82-fold resistance to imidacloprid was selected by Prabhaker et al. (1997) in the laboratory. Field and greenhouse populations exhibiting strikingly reduced susceptibility to imidacloprid were detected in Arizona in 1998 (Dennehy et al. 1999), though they were much less common in subsequent years (Li et al. 2000).

Whitefly resistance to buprofezin and pyriproxyfen has been extensively characterized in Israel (Horowitz et al. 1994, 1999, 2002) and has resulted in cessation of use of these insecticides in some areas. Resistance to buprofezin was first detected in glasshouses in The Netherlands, and subsequently in northern Europe, Spain and Israel (Denholm et al. 1998). Toscano et al. (2001), reported that California populations evaluated were highly susceptible to both pyriproxyfen and buprofezin from 1997 through 1999. However, first signs of pyriproxyfen resistance were found in Arizona in 1999 (Li et al. 2003).

Biotypes of *B. tabaci* have played a prominent role in whitefly management around the world during the past two decades. The concept of biotypes or host races of *B. tabaci* evolved in the 1950's to describe whiteflies with unique host associations and virus-vector capabilities (Brown et al. 1995; Brown, 2001). Southwestern agricultural producers' first experiences with whitefly biotypes coincided with the widespread global radiation of the B biotype of in the late 1980's. This biotype, which had it origins in the Middle East, Arabian Peninsula, or northern Africa (Kirk et al. 2000) was found to have the widest host range of any whitefly in the genus *Bemisia* (Brown et al. 1995) and intrinsically high tolerance to a broad range of insecticide groups (e.g., Costa et al. 1993, Brown et al. 1995, Denholm et al. 1998). Seemingly overnight, producers were faced with unprecedented infestations of a pest that previously was relatively easy to control. Economic losses to Arizona agriculture associated with introduction of the B biotype (Costa and Brown, 1991) totaled hundreds of millions of dollars (e.g., Ellsworth et al. 1999).

When a second whitefly biotype, the Q biotype (Guirao et al 1997), began to be associated with severe resistance problems (Horowitz et al. 2005) in southern Europe, we recognized it as a serious potential threat to our successful whitefly resistance management program. Thus, in 2001, we initiated routine biotype assessments of whiteflies collected for resistance monitoring throughout Arizona.

In 2004, whiteflies collected from poinsettia plants in Tucson were shown to be the first Q biotype of *B. tabaci* documented in the Americas (Dennehy et al. 2006). The strain, named Poinsettia'04, was resistant to many insecticides critical to whitefly management in Arizona, including insect growth regulators and neonicotinoids. This finding prompted formation of a National Q Biotype Task Force, comprising representatives of the US ornamentals, cotton and vegetable industries (El-Lissy 2006). Task Force surveys conducted in 2005 detected the Q biotype in 21 states, almost exclusively in nurseries (see Osborne 2006). Such multiply-resistant whiteflies pose a clear threat to whitefly management in Arizona and elsewhere in the US.

We cannot predict the future spread or impact of this new pest. However, because we detected the Q biotype prior to it becoming widely established in either field or greenhouse systems in Arizona, we can document its future spread and impact and modify whitefly management recommendations accordingly. In this paper we report results of resistance monitoring and biotype determinations of whiteflies collected from Southwestern vegetables, melons, cotton, and ornamental crops in 2005.

MATERIALS AND METHODS

Collections

Locations from which we obtained collections of *B. tabaci* in 2005 are detailed in Table 1a. Our objective was to obtain a minimum of 5000 individuals from each collection site. Low whitefly densities, field treatments with insecticides, and predation/parasitism prevented testing of some collections with some insecticides. Adult whiteflies were collected in modified plastic vials by vacuuming plant foliage with a Makita® Cordless Vacuum (Model 4071D). Samples were transported to the laboratory in Tucson and were released into cages containing several cotton plants, *Gossypium hirsutum* L. (var. DPL-50), at the five to seven true-leaf stages.

Within one to four weeks of being brought into the laboratory, 10-200 adult whiteflies from each collection were preserved in 95% ethanol in 3 ml microcentrifuge tubes and stored at -20 °C. Bioassays of insecticide susceptibility were typically conducted within 12-36 hours of field collection, except when nymphs were collected. Most samples from greenhouse plants were collected as nymphs on leaves. In such cases, infested leaves were transported back to the laboratory and placed in cages to permit adults to emerge.

Biotype Determinations

For each whitefly sample obtained in 2005 (Table 1a), we performed biotype determinations of 10 adults that had been preserved in alcohol as described above. These were done using molecular primers and the polymerase chain reaction to magnify a specific area of whitefly DNA in the mitochondrial cytochrome oxidase 1 (COI) gene (Brown et al., 2001). The amplified DNA was then sequenced to detect biotype-specific differences in nucleotides.

<u>Extracting genomic DNA from whiteflies</u>. Individual adults were placed on parafilm with 15 µl DNAzol and 5 µl Polyacryl carrier and then homogenized using the rounded edge of a clean 1.5 ml microcentrifuge tube. Homogenate was then transferred to a 1.5 ml microcentrifuge tube containing 0.48 ml DNAzol and 2.5 µl of Proteinase K. The samples were kept at room temperature for 30 minutes before precipitation of DNA with 0.25 ml 100% ethanol. After centrifuging the samples at 13,000 rpm for 10 minutes, supernatant was removed and the resulting DNA pellet was washed with 75% ethanol and centrifuged for 5 minutes at 6,500 rpm. Excess ethanol was removed from tubes and the ethanol wash was repeated. The DNA pellet was allowed to briefly air dry before being re-suspended in 40 µl pre-warmed low TE buffer and stored at –20° C.

<u>PCR amplification and sequencing of m(COI) gene</u>. Amplification of the mCOI gene was done with polymerase chain reaction, using 1 µl of template (from extractions) with 29 µl of stock reaction (1.2 µl 10 µM COI primer (forward and back), 1.2 µl 25 mM $Mg(Oac)_2$, 2.4 µl 2.5 mM dNTP, 3.0:l 10x PCR buffer, 19.8 µl dH_2O, 0.2 µl 5 U/µl Taq polymerase). Reactions were denatured at 94 °C for 3 minutes before undergoing 35 cycles (1 min. at 94 °C, 1 min at 52 °C, 2 min at 72 °C) and a final extension for 10 minutes at 72 °C. Samples were held at 4 °C for up to 12 hours before being stored at –20 °C. PCR product was cleaned using QiaQuick spin colums. DNA sequencing was conducted at the University of Arizona Laboratory of Molecular Systematics and Evolution. The resulting sequences were trimmed to ca. 400 to 600 base pairs to provide unambiguous sequences for alignments. Published sequences for *B. tabaci* COI genes were obtained from GenBank using the National Center for Biotechnical Information nucleotide BLAST search. Multiple alignments were performed using DNAMAN

(Lynnon BioSoft, Montrea, Canada) to contrast the DNA sequences obtained from each of the 39 whitefly collections made in 2005 with published sequences for the A, B and Q biotypes of *B. tabaci*.

Resistance Monitoring

Bioassays of susceptibility to six insecticides were conducted on each collection of whiteflies using a prevailing published method for each insecticide evaluated (Table 1b). Bioassay methods for pyriproxyfen and buprofezin were described by Li et al. (2000, 2003). The residual leaf-disk bioassay used for fenpropathrin + acephate mixtures was described by Dennehy and William (1997). All three neonicotinoid insecticides, imidacloprid, thiamethoxam, and acetamiprid, were tested using leaf disk bioassays (Li et al. 2000). The following formulated insecticides were used:, Admire 2F (imidacloprid, Bayer Crop Sciences, Research Triangle Park, NC), Centric 40WG (thiamethoxam, Syngenta Crop Protection, Greensboro, NC), Courier 40SC (buprofezin, Nichino America, Inc., Wilmington, DE), Danitol 2.4EC (fenpropathrin, Valent USA Corp.), Intruder 70WP (acetameprid, DuPont Agricultural Products, Wilmington, DE), Knack 0.86EC (pyriproxyfen, Valent USA Corp. Walnut Creek, CA), Orthene 97S (acephate, Valent USA Corp.).

Data Analyses

For each whitefly collection, mean mortality observed with each concentration of each insecticide evaluated was computed and corrected for control mortality using Abbott's correction (Abbott 1925). Statistical differences in population responses within and between years were evaluated by analysis of variance (ANOVA, Tukey-Kramer HSD test) and non-parametric tests using the JMP-IN statistical analysis program (SAS Institute 2000). Mortality data were subjected to arcsine transformation before analysis. When appropriate, probit analyses of concentration-dependent mortality were conducted using POLO-PC (LeOra Software, 1987) to generate lethal concentration statistics.

RESULTS AND DISCUSSIONS

Biotype Identifications.

All 26 collections of whiteflies obtained from field settings of cotton, vegetables or melons yielded exclusively the B biotype of *Bemisia tabaci* (Table 1a). Thus, we have not detected the Q biotype in field samples in the Southwest, despite over 100 field samples having been analyzed since 2001 (2001=25, 2003=27, 2004=24), 2005=24).

Of the 13 whitefly-infested samples of poinsettia plants obtained in 2005, six were the Q biotype (Table 1a). Analyzable DNA sequences were obtained from 6-10 whiteflies per location (mean 8.6). Interestingly, none of the samples contained mixtures of Q and B biotypes; they were either all B or all Q. These findings indicate that Q biotypes are being actively distributed throughout Arizona via the commercial poinsettia trade. However, this does not mean that other plant types or commodities are not also doing the same.

We were able to verify sources of two of the 2005 poinsettia samples in which we detected Q biotypes. One of these sources, located out of Arizona, was also a large producer of vegetable transplants. In such production facilities, it is possible that Q biotypes were able to move between transplants and ornamental hosts. This finding supports concerns raised within the scientific community that the Q biotype could be further distributed within the US on vegetable transplants. We will continue to monitor biotype and resistance status of whiteflies in vegetables to evaluate the validity of this assumption as it applies to Arizona. However, at this time we have not detected the Q biotype in vegetable fields or any other open-field systems in Arizona.

Resistance Monitoring

Pyriproxyfen (Knack®)

Statewide averages: 1996 to 2005. Whitefly susceptibility to pyriproxyfen was first documented in bioassays in 1996, the year that it received emergency registration for use in cotton. A diagnostic concentration of 0.1 µg/ml pyriproxyfen was designated and used for monitoring purposes (Figure 1a), on the basis that this concentration caused very high mortality to eggs (Simmons et al. 1997). From 1996-98, statewide averages of mortality in bioassays of 0.1 µg/ml pyriproxyfen were ≥ 99.6% (Figure 1b). Substantial numbers of survivors of this concentration were first detected in 1999.

By 2002, approximately 5.5% of whiteflies collected from cotton survived this concentration (Figure 1b, c). Statewide survival of 0.1 µg/ml pyriproxyfen jumped to 15% and 20%, in 2003 and 2004, respectively. However, there was no increase in statewide mean of pyriproxyfen resistance from 2004 to 2005 (Figure 1b, c). Statewide survival of 0.1 µg/ml pyriproxyfen was 19% in 2005. Similarly, survival of 1.0 ug/ml bioassays was 4.6% in 2005, compared to 5.1% in 2004 (Figure 1b).

Resistance levels in individual field collections in 2005. None of 48 whitefly collections evaluated from 1996 to 1998 had ≥ 2.0% of eggs surviving 0.1 µg/ml pyriproxyfen bioassays. Indeed, as detailed above, survivors of 0.1 µg/ml pyriproxyfen bioassays were very rare for the first three years that pyriproxyfen was used, and constituted ≤ 0.4% of eggs tested each of these years. Twenty-three of the 31 collections tested in 2005 (83%) had >2.0% (corrected) survivorship of 0.1 µg/ml pyriproxyfen (Table 2a-c). Although a single sample collected from cotton in Holtville, CA, had no detectable resistance to pyriproxyfen, we detected pyriproxyfen resistance in all Arizona whitefly samples evaluated (Fig. 1c). Samples from cotton in Buckeye, Coolidge, Scottsdale, and Stanfield, Arizona, had the highest levels of resistance, with 37-45% of eggs surviving diagnostic concentration bioassays of 0.1 ug/ml pyriproxyfen.

Our finding of whiteflies in some areas of Arizona that are substantially reduced in susceptible to pyriproxyfen does not necessarily mean that pyriproxyfen has failed or will fail imminently in the field. As noted above, we know of no reports of field failures of whitefly insecticides in Arizona cotton in 2005. Additionally, we cannot predict the future evolution of resistance with accuracy. It is possible that the increases in resistance that we have documented during the past three years (Figure 1b) could be reversed in the future. Dr. Peter Ellsworth is evaluating field performance of pyriproxyfen in large-scale cotton trials supported by Valent USA and the Arizona Cotton Growers Association. We are collaborating with this effort by testing resistance levels before and after treatments are applied. This work strives to identify the level of resistance at which field performance of pyriproxyfen is no longer economically acceptable to producers.

Buprofezin (Applaud®/Courier®)

Whitefly susceptibility to buprofezin (Applaud®/ Courier®) has not changed significantly in Arizona since 1997. Contrasts of 2005 statewide means with those from previous years (Figure 2) showed that susceptibility of Arizona whiteflies to buprofezin was within the range observed since 1997. As in previous years, we recorded negligible differences in mortality in buprofezin bioassays of whiteflies collected in 2005 from cotton, melons, vegetables, and ornamentals (Tables 3a-c).

Fenpropathrin + Acephate (Danitol® + Orthene®)

Ten µg/ml fenpropathrin mixed with 1000 µg/ml acephate was previously shown to kill whiteflies susceptible to this mixture (Dennehy and Williams 1997). Sivasupramaniam et al. (1997) subsequently demonstrated that susceptibility to fenpropathrin + acephate mixtures reflected susceptibility to all synergized pyrethroid mixtures being used against whiteflies in Arizona. In field trials conducted by Simmons and Dennehy (1996), performance of synergized pyrethroid mixtures was acceptable at locations with a frequency of < 20% survivors of 10 µg/ml fenpropathrin + 1000 µg/ml acephate.

Statewide Averages 1995 to 2005. Levels of resistance to synergized pyrethroid insecticides of whiteflies from Arizona cotton have declined dramatically since 1995. This was demonstrated by the consistent downward trend in yearly means of survivorship observed in bioassays of fenpropathrin + acephate mixtures (Figures 3a, b) over the past decade. Statewide averages of mean survivorship in diagnostic concentration bioassays was 45% in 1995 and 21, 15 and 16% in 2002, 2004 and 2005, respectively (Figure 3b).

Resistance levels in individual field collections in 2005. Although the overall frequency of resistance to synergized pyrethroid insecticides declined sharply from 1995 to 2005, each year we found some fields with resistance above critical levels (Figure 3b). Indeed, the percentage of individual cotton fields with ≥ 20% resistant whiteflies has oscillated widely from year to year: the high being 58% in 1996, and the low of 10% occurring in 2001 (Figure 3a). Five of 19 cotton collections evaluated in 2005 had frequencies of resistance exceeding the critical frequency of 20% (Figure 3b). However, unlike the situation in 1995, when survivorship of diagnostic concentration bioassays exceeded 80% for some collections (Figure 3b), all but one cotton sample tested in 2005 had <30% survivorship of diagnostic concentrations. Collections were made late in the season (Table 1a), and thus reflected susceptibility after most whitefly treatments had been applied for the season.

Whiteflies from ornamentals had lower susceptibility to synergized pyrethroids than collections from cotton or melons/vegetables. Mean corrected mortality for all samples tested with 10 µg/ml fenpropathrin + 1000 µg/ml acephate was 83.7, 80.9, and 51.0% for cotton, melons/vegetables, and ornamentals, respectively (Tables 4a-c). Although collections with the highest levels of pyrethroid resistance were predominantly from ornamentals, over 50% of whiteflies from one cotton field near Somerton Arizona (GPS ID 05-06) survived diagnostic concentration bioassays (Table 4a). The most resistant collections from cotton, melons/vegetables, and ornamentals had mean mortality of 47.6, 51.6, and 30.4%, respectively, in bioassays of 10 µg/ml fenpropathrin + 1000 µg/ml acephate (Table 4).

Neonicotinoid Insecticides

Imidacloprid (Admire®/Provado®). Whiteflies collected from Arizona cotton and melons/vegetables in 2005 continued the five year trend of uniformly high susceptibility to imidacloprid (Figure 4a). Reports in the literature (e.g., Nauen and Denholm 2005) and our past experience in Arizona (Dennehy et al. 1999) have shown that whiteflies possessing severe resistance to imidacloprid are capable of surviving bioassay concentrations of as high as 1000 µg/ml imidacloprid. Low percentages of whiteflies from melons/vegetables and cotton in 2005 survived either 100 or 1000 µg/ml bioassays of imidacloprid (Table 5a, b). However, susceptibility of one sample from ornamentals (Table 5c) was noticeably lower and the mean mortality of samples from ornamentals was decidedly lower than cotton and melons/vegetables, especially at the bioassay concentrations of 1.0 and 10 µg/ml imidacloprid.

Acetamiprid (Intruder®) and Thiamethoxam (Actara®/Centric®/Platinum®). Bioassays of acetamiprid and thiamethoxam were less toxic and more variable in toxicity than imidacloprid on a concentration-by-concentration basis (Tables 6-7). However, such differences could stem from bioassay methodology and may not reflect differences in efficacy of treatments in the field. Mean mortality in bioassays of 10 µg/ml acetamiprid or thiamethoxam varied widely between collections from cotton and melons/vegetables; this concentration killed as few as 5% or as many as 90% of whiteflies. Interestingly, mean mortality in bioassays of whiteflies from ornamentals did not differ substantially from cotton or melons/vegetables. Regression analysis of the whitefly collections from cotton in 2004 (n=14) and 2005 (n=19) revealed a significant and high correlation (R^2=0.620, p<0.0001, df = 32,1, F=50.2) between mortality observed in bioassays of 10 µg/ml thiamethoxam versus 10 µg/ml acetamiprid (Figure 4b). Surprisingly, imidacloprid tests yielded non-significant correlations with thiamethoxam or acetamiprid (data not shown).

CONCLUSIONS

No major problems with field performance of insecticides against whiteflies were observed or reported in 2005 in Arizona. Whiteflies resistant to pyriproxyfen existed in all regions of Arizona producing cotton, vegetables and melons, as well as in greenhouse-produced ornamentals. However, the frequency of pyriproxyfen-resistant whiteflies statewide did not increase from 2004 to 2005 and at this time does not appear to be impairing field performance of pyriproxyfen in cotton. All whitefly collections tested were susceptible to buprofezin. Resistance to pyrethroids, as indicated by bioassays with fenpropathrin + acephate, remained at relatively low levels statewide and unchanged from 2005. Susceptibility of field-collected whiteflies to the neonicotinoid, imidacloprid, remained high and unchanged on a statewide basis. However, the trend continued for whiteflies from greenhouse ornamentals to be less susceptible to imidacloprid than field collections. Large differences in mortality at specific bioassay concentrations were observed for the neonicotinoid insecticides, thiamethoxam and acetamiprid. This was true for collections from all commodities sampled.

The Q biotype of *B. tabaci* was detected in six of 13 poinsettia populations tested in 2005 and in these six cases, it was the only whitefly biotype detected. Thus we have clear evidence that the Q biotype continues to be transported into and within the State of Arizona on ornamental plants. However, at the present time this new biotype has been detected only in glasshouse settings in Arizona. None of 26 field collections evaluated in 2005 were the Q biotype.

ACKNOWLEDGMENTS

We thank the staff of the Arizona Cotton Research and Protection Council for assistance with field collections. These studies were funded by the Arizona Cotton Growers Association and Cotton Incorporated. Laboratory facilities of the Extension Arthropod Resistance Management Laboratory were provided by the University of Arizona. Greenhouse facilities. were provided by the University of Arizona Campus Agricultural Center. We thank Peter Ellsworth and John Palumbo for critical leadership of the Cross-Commodity Coordinating Committee and cotton and vegetable IPM programs.

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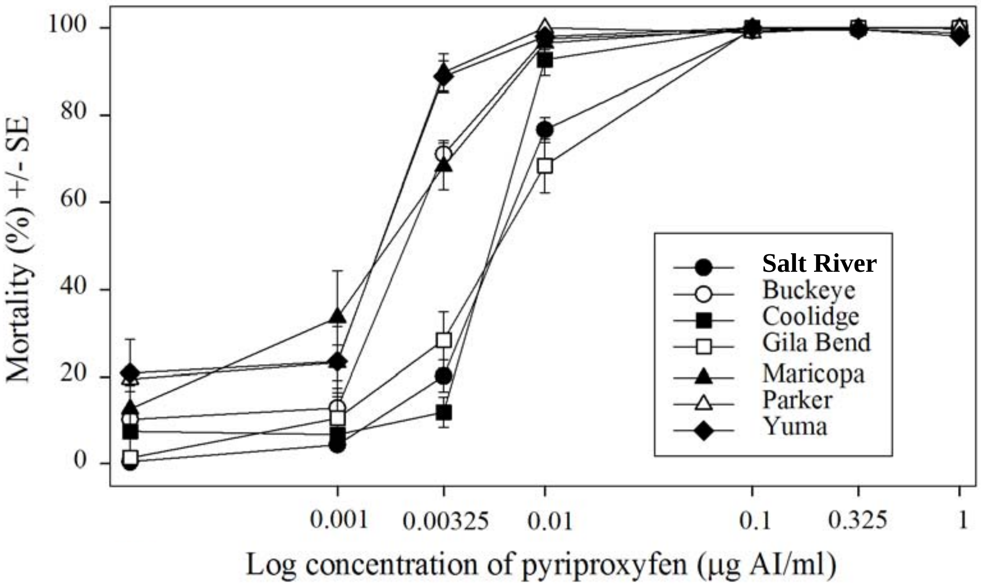

Figure 1a. Susceptibility to pyriproxyfen (Knack®) of whiteflies (*Bemisia tabaci*) collected in 1996 from Arizona cotton fields. LC_{50}s of all populations tested were below 0.01 µg/ml pyriproxyfen and survivors of 0.1 µg/ml bioassays were very rare. (From Li et al. 2003).

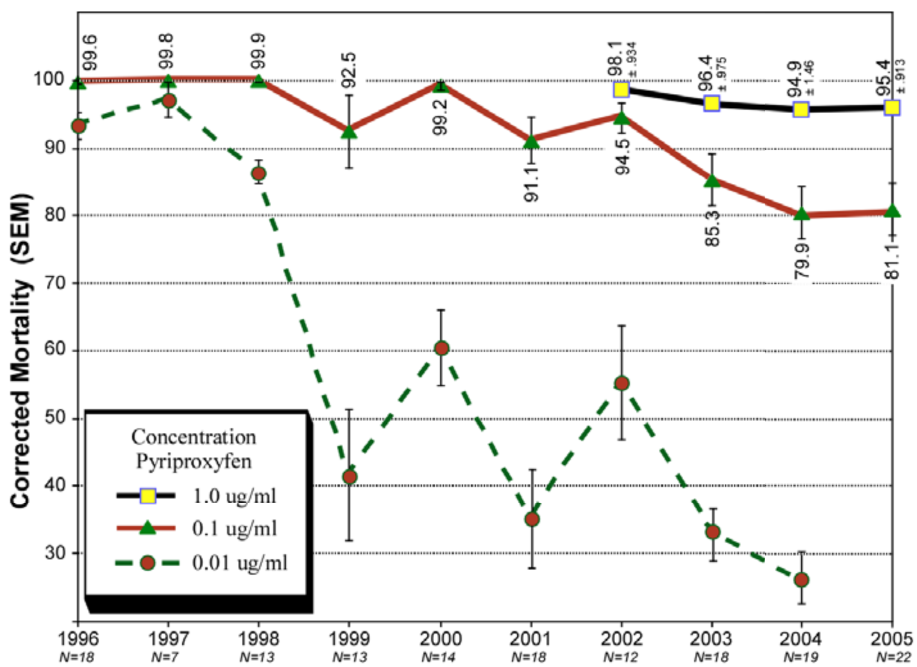

Figure 1b. Arizona whiteflies collected in cotton in 2005 were not significantly different in susceptibility to pyriproxyfen (Knack®) than they were in 2005. Shown are statewide averages of susceptibility from 1996-2005, as determined by egg bioassays with pyriproxyfen. The overall proportions of whiteflies surviving diagnostic concentration bioassays of 0.1 µg pyriproxyfen/ml was 5.5% in 2002, 14.7 in 2003, 20.1% in 2004, and 18.9% in 2005. No failures of pyriproxyfen have been confirmed in Arizona fields at the time of this writing.

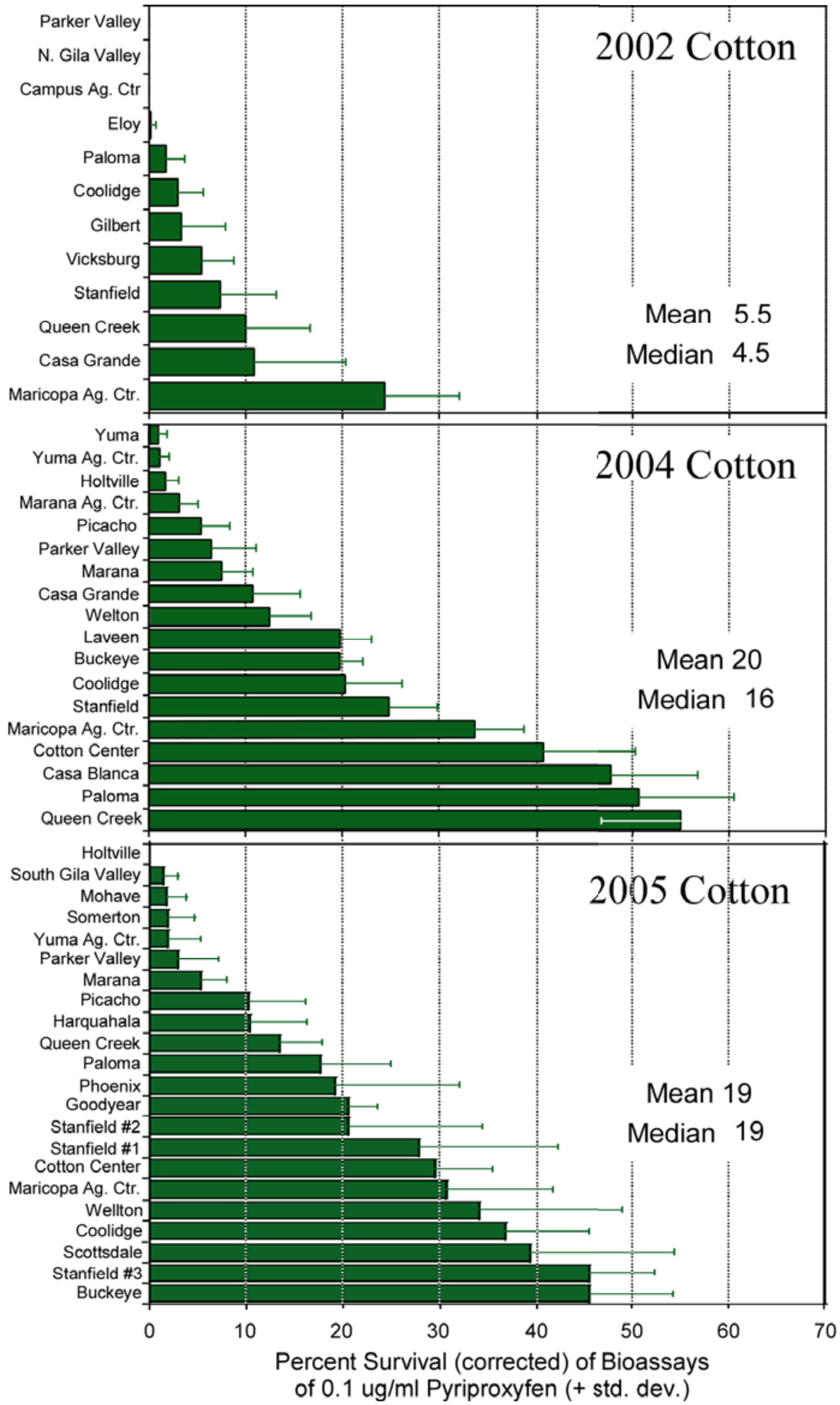

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Figure 1c. Although there have been no confirmed failures of field treatments of pyriproxyfen, whiteflies with resistance to this insecticide were detected in all samples collected from Arizona cotton in 2004 and 2005 and comprised >40% of individuals tested at the locations with the highest levels of resistance.

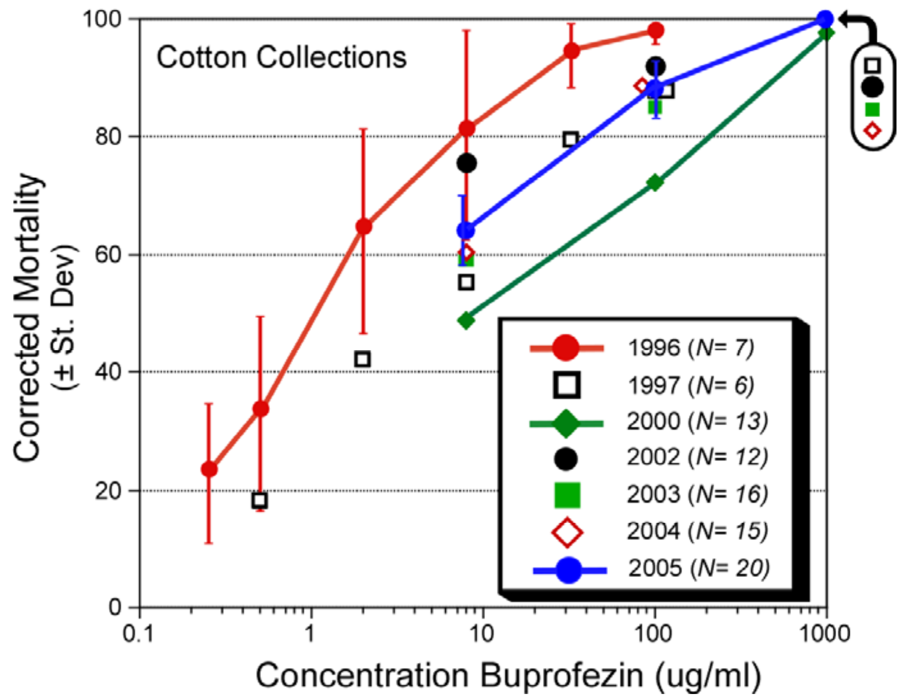

Figure 2. Whiteflies from Arizona cotton revealed no signs of resistance to buprofezin in 2005 (Courier®/Applaud®). Shown are grand mean corrected mortality (± standard deviation) values of whiteflies collected from Arizona cotton from 1996 through 2005 and bioassayed with buprofezin. Susceptibility declined moderately from 1996 to 2000 but has remained intermediate to this range in subsequent years.

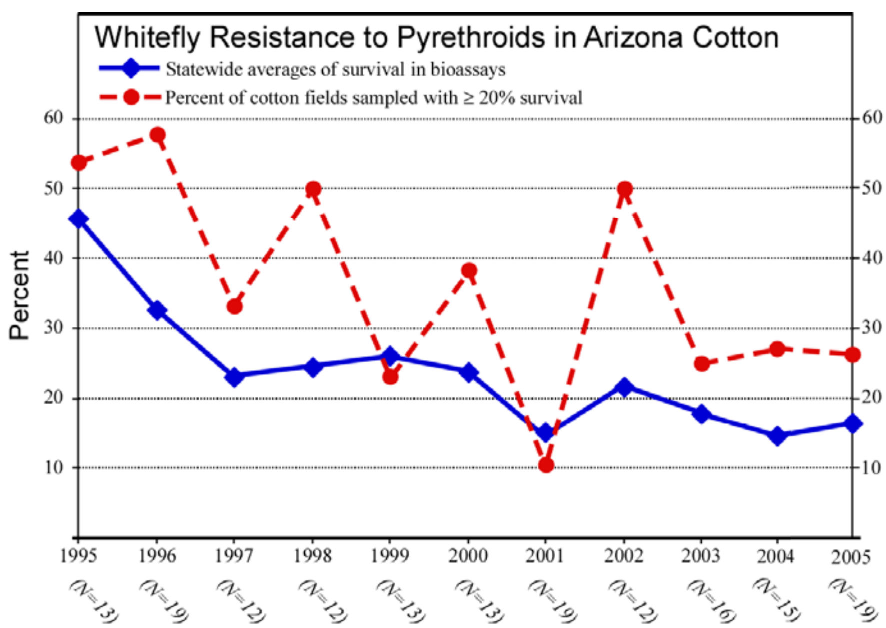

Figure 3a. Statewide averages of whitefly survival in bioassays of 10 µg/ml fenpropathrin (Danitol®) + 1000 µg/ml acephate (Orthene®) since 1995 (solid line). Resistance to synergized pyrethroids declined dramatically over this period and remained relatively low from 2003 to 2005. The dashed line denotes the proportion of fields in which resistance was too high to obtain adequate performance from synergized pyrethroids. This determination is based on a critical frequency of 20% survivors of diagnostic concentrations. The number of populations evaluated each year is noted.

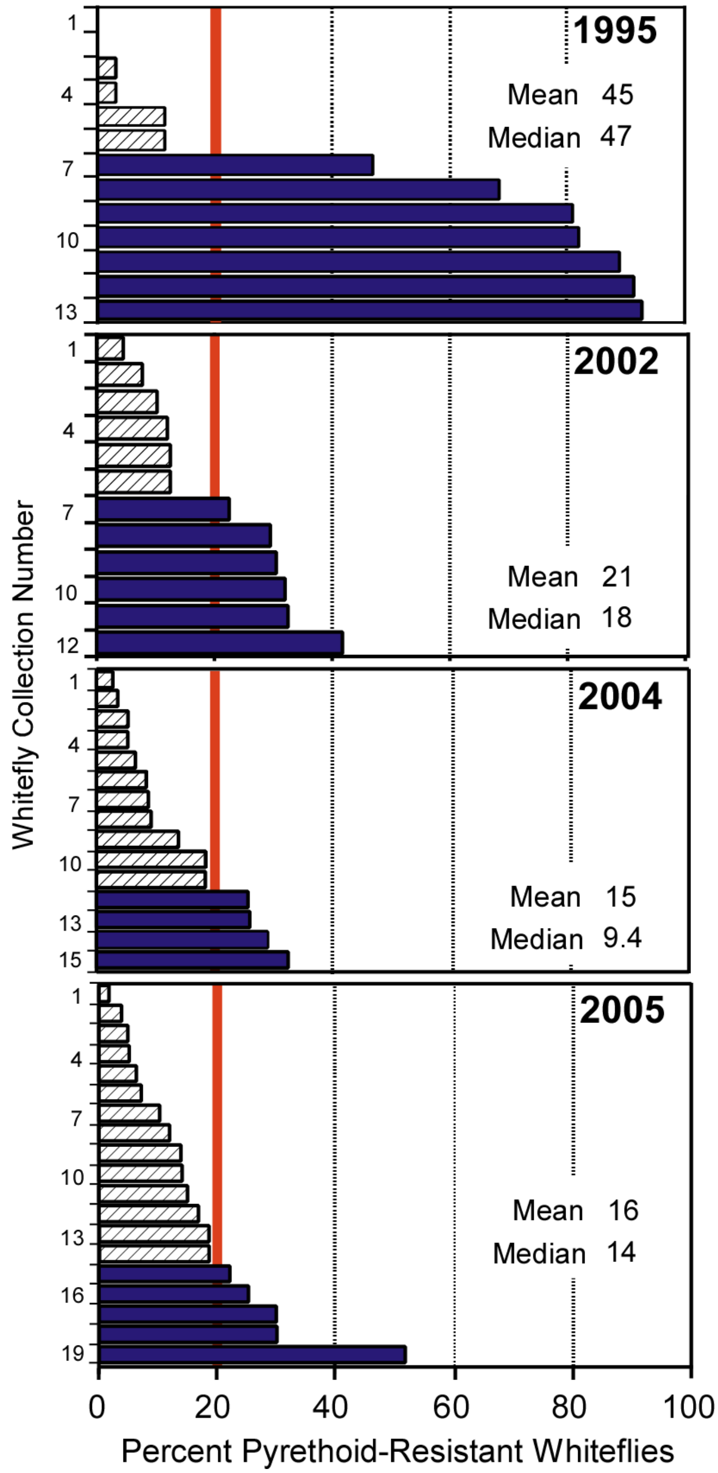

Figure 3b. Susceptibility to synergized pyrethroid insecticides of *Bemisia* collected from cotton in 1995 contrasted with 2002, 2004, and 2005. Bars show the mean percentage of whiteflies from each sample site surviving 10 µg/ml fenpropathrin (Danitol®) + 1000 µg/ml acephate (Orthene®). The mean and median values noted are composite statistics for all samples tested within each year. The vertical line at 20% indicates the critical frequency above which resistance demonstrably impairs field performance of synergized pyrethroids. In 2005, only 5 of 19 whitefly populations (26%) tested from cotton exceeded the critical frequency for this resistance. All samples were collected late in the production season and typically after whitefly treatments were applied.

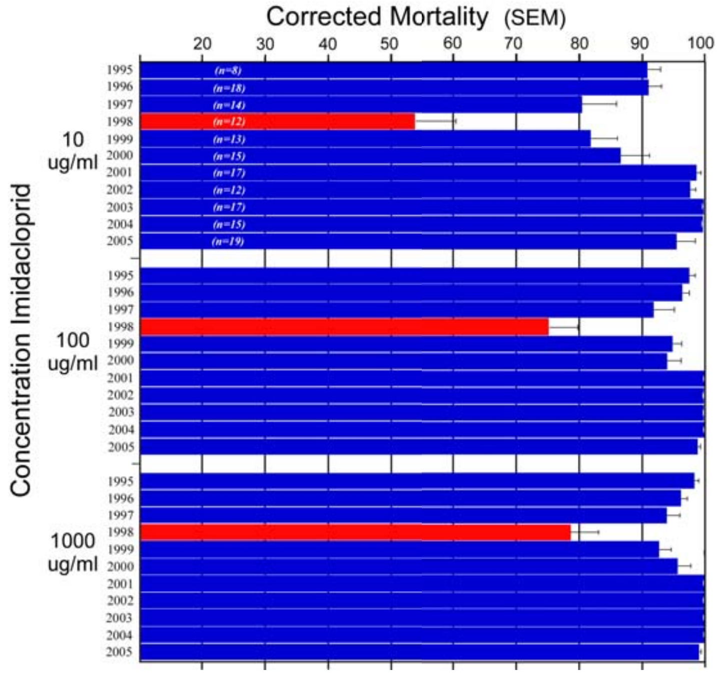

Figure 4a. Whiteflies from Arizona cotton continued to be highly susceptible to imidacloprid (Admire®/Provado®) in 2005. Values shown are statewide averages of mortality observed in bioassays of all samples collected from cotton. Susceptibility declined sharply from 1995 to 1998 but was fully regained in subsequent years. Sample sizes are shown.

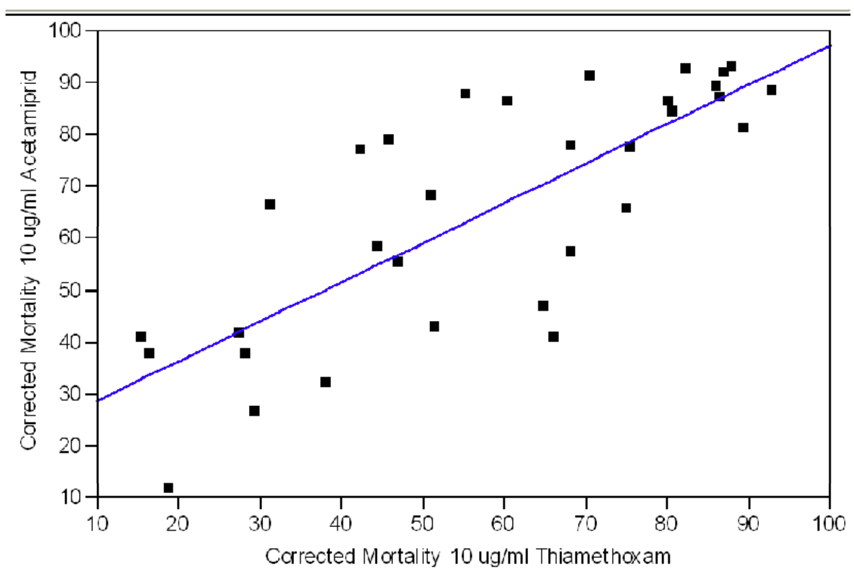

Figure 4b. Linear regression demonstrating strong correlation in susceptibility to thiamethoxam and acetamiprid in whiteflies collected from cotton in 2004 and 2005. Approximately 62% of the variation in mortality observed in 10 µg/ml acetamiprid bioassays was explained by the predictor variable of mortality in 10 µg/ml thiamethoxam bioassays (R^2=0.62). Data points shown are mean corrected mortalities for 14 collections made in 2004 and 19 made in 2005. The regression was highly significant (*P<0.0001; df=32,1, F 50.2).*

Table 1a. Collection dates, locations, and biotype designations of whiteflies evaluated in 2005.

Location	*GPS ID*	*Host*	*Collection Date*	*Biotype*[1/]
1. Palo Verde Vly, CA	05-25	Cabbage	23-Oct-05	B
2. Texas Hill, AZ	05-27	Cabbage	24-Oct-05	B
3. Wellton, Ax	05-01	Cotton	21-Jun-05	B
4. Buckeye, AZ	05-02	Cotton	5-Jul-05	B
5. Maricopa Ag. Center, AZ	05-03	Cotton	22-Aug-05	B
6. Phoenix, AZ	05-04	Cotton	22-Aug-05	B
7. Somerton, AZ	05-06	Cotton	19-Aug-05	B
8. Queen Creek, AZ	05-08	Cotton	29-Aug-05	B
9. Cotton Center, AZ	05-09	Cotton	29-Aug-05	B
10. Stanfield, AZ #1	05-10	Cotton	29-Aug-05	B
11. Mohave Vly, AZ	05-11	Cotton	5-Sep-05	B
12. Parker Vly, AZ	05-12	Cotton	5-Sep-05	B
13. Stanfield, AZ #2 (RR)	05-13	Cotton	5-Sep-05	B
14. Holtville, CA	05-17	Cotton	11-Sep-05	B
15. South Gila Valley, AZ	05-19	Cotton	12-Sep-05	B
16. Stanfield, AZ #3 (RR)	05-20	Cotton	13-Sep-05	B
17. Marana, AZ	05-21	Cotton	26-Sep-05	B
18. Picacho, AZ	05-22	Cotton	26-Sep-05	B
19. Harquahala Vly, AZ	05-102	Cotton	18-Jul-05	B
20. Goodyear, AZ	05-103	Cotton	22-Jul-05	B
21. Yuma Ag. Center, AZ	05-104	Cotton	25-Jul-05	B
22. Paloma, AZ	05-106	Cotton	3-Oct-05	B
23. Coolidge, AZ	05-107	Cotton	11-Oct-05	B
24. Scottsdale, AZ	05-108	Cotton	11-Oct-05	B
25. Litchfield Park, AZ	05-101	Melons	18-Jul-05	B
26. Somerton, AZ	05-105	Melons	25-Jul-05	B
27. Tucson, AZ	05-28	Poinsettia	23-Nov-05	B
28. Tucson, AZ	05-29	Poinsettia	23-Nov-05	B
29. Phoenix, AZ	05-38	Poinsettia	21-Dec-05	B
30. Phoenix, AZ	05-39	Poinsettia	21-Dec-05	Q
31. Phoenix, AZ	05-40	Poinsettia	21-Dec-05	B
32. Tucson, AZ	05-109	Poinsettia	14-Nov-05	B
33. Tucson, AZ	05-110	Poinsettia	14-Nov-05	B
34. Tucson, AZ	05-111	Poinsettia	29-Nov-05	Q
35. Tucson, AZ	05-112	Poinsettia	5-Dec-05	Q
36. Tucson, AZ	05-113	Poinsettia	13-Dec-05	B
37. Tucson, AZ	05-114	Poinsettia	16-Dec-05	Q
38. Tucson, AZ	05-115	Poinsettia	15-Dec-05	Q
39. Tucson, AZ	05-116	Poinsettia	16-Dec-05	Q

[1/] None of the collections evaluated in 2005 contained mixtures of biotypes; they were either uniformly B or Q. A total of 10 individuals from each collection were evaluated for biotype, of which 6-10 yielded analyzable DNA sequences (mean 8.6). See Materials and Methods for details of analyses.

Table 1b. Summary of bioassay methods employed for each insecticide tested against whiteflies in 2005.

	Pyriproxyfen	***Imidacloprid***	***Fenpropathrin***	***Buprofezin***	***Thiamethoxam***	***Acetamiprid***
Formulation	Knack 0.86EC	Admire 2F	Danitol 2.4EC, Orthene 97S	Courier 40SC	Centric 40WG	Intruder 70WP
Concentrations µg/ml	control, 0.01, 0.1, 1.0	control, 1, 10, 100, 1000	control, 10, 100 (+1000 acepahte)	control, 8, 100, 1000	control, 1, 10, 100, 1000	control, 1, 10, 100, 1000
Replications	6 plant reps, >20 eggs/leaf	10 vial reps, 25 adults/vial	6 vial reps, 25 adults/vial	6 plant reps, >20 nymphs/plant	6 vial reps, 25 adults/vial	6 vial reps, 25 adults/vial
Method	Seedling in vial, dipped after oviposition	Seedling, 24h hydropnc uptake, infest leaf-disc	Leaf-disc, dipped before infestation	Infested seedling in vial, dipped	Leaf-disc, dipped before infestation	Leaf-disc, dipped before infestation
Stage treated	egg	adult	adult	N1 (crawler) stage	adult	adult
Treatment Method	leaf-dip, 20s	24h hydroponic uptake	leaf-dip, 10s	leaf-dip 20s	leaf-dip 10s	leaf-dip 10s
Duration	7 days exposure	48h exposure	48h exposure	9 days exposure	48h exposure	48h exposure
Notes	24h ovip period, followed by 20s leaf dip, read 7 days after dipping.	Small seedling (2-4 true leaf stage), cut stem above root line. Put into imda soln for 24h.	Small seedling (2-4 true leaf stage), cut leaf discs and dip for 10s into soln.	24h ovip period, followed by 8 days to develop to N1, 20s leaf dip, read 9 days after dipping.	Small seedling (2-4 true leaf stage), cut leaf discs and dip for 10s into soln.	Small seedling (2-4 true leaf stage), cut leaf discs and dip for 10s into soln.

Table 2a. Susceptibility to pyriproxyfen (Knack®) of *B. tabaci* collected from cotton in 2005.

		Corrected Mortality/Concentration Pyriproxyfen (ug/ml)								
Collection #	Collection site	**0**	stdev	**0.1**	stdev	**1**	stdev	**10**	stdev	Biotype
05-02	Buckeye	12.0	10.2	*54.5*	8.63	89.9	7.23			B
05-107	Coolidge	13.9	9.16	63.2	8.54	90.4	13.3	100	0.000	B
05-09	Cotton Center	16.9	12.3	70.5	5.80	87.4	8.97	100	0.000	B
05-103	Goodyear	7.19	7.77	79.5	2.84	92.4	11.1			B
05-102	Harquahala	6.65	6.05	89.6	5.67	96.2	1.40			B
05-17	Holtville	*5.48*	4.83	100	0.000	99.7	0.459	100	0.000	B
05-21	Marana	6.41	2.79	94.8	2.66	99.0	1.55	100	0.000	B
05-03	Maricopa Ag. Center	8.74	9.86	69.3	10.8	96.0	2.87			B
05-11	Mohave	5.68	4.07	98.3	2.07	99.7	0.676	100	0.000	B
05-106	Paloma	10.2	9.67	82.3	7.03	98.2	2.70	100	0.000	B
05-12	Parker Valley	7.60	4.18	97.1	4.01	97.8	3.81	99.9	0.337	B
05-22	Picacho	17.7	8.10	90.0	5.76	96.1	2.40	99.9	0.342	B
05-08	Queen Creek	8.23	4.43	86.6	4.29	98.1	1.28	100	0.000	B
05-108	Scottsdale	10.9	8.65	60.7	15.0	92.9	5.64	99.4	1.18	B
05-06	Somerton	6.31	5.38	98.2	2.76	100.0	0.000	100	0.000	B
05-19	South Gila Valley	6.67	4.56	98.6	1.57	98.8	1.01	100	0.000	B
05-10	Stanfield #1	5.62	3.75	72.2	14.3	93.5	3.06	100	0.524	B
05-13	Stanfield #2 (RR)	15.4	9.00	79.4	13.7	96.8	3.54	99.9	0.338	B
05-20	Stanfield #3 (RR)	10.1	3.63	54.6	6.80	*85.5*	5.63	*98.5*	0.935	B
05-04	USDA-APHIS (Phx)	8.41	8.56	80.8	12.7	98.2	1.99			B
05-01	Wellton	9.62	6.13	65.9	14.7	91.6	8.10			B
05-104	Yuma Ag. Center	9.96	11.3	98.2	3.22	99.9	0.331	100	0.000	B
	N	22		22		22		16		
	mean	**9.53**		**81.1**		**95.4**		**99.8**		
	median	8.58		81.5		96.5		100.0		
	minimum	5.48		54.5		85.5		98.5		
	std dev	3.65		15.3		4.28		0.389		

Table 2b. Susceptibility to pyriproxyfen (Knack®) of *B. tabaci* collected from vegetables melons in 2005.

Collection #	Collection site	Crop	Corrected Mortality/Concentration Pyriproxyfen (ug/ml) 0	stdev	0.01	stdev	0.1	stdev	1	stdev	Biotype
05-101	Litchfield	melons	*5.46*	7.38	81.2	16.8	96.5	2.60			B
05-25	Palo Verde	brassicae	5.78	5.67	66.8	18.2	*88.4*	5.54	99.6	0.912	B
05-105	Somerton	melons	6.79	4.34	97.8	2.05	99.2	1.21	*99.2*	0.452	B
05-27	Texas Hill	cabbage	8.64	4.18	*65.4*	9.91	95.9	3.26	99.5	1.03	B
		N	4		4		4		4		
		mean	**6.67**		**77.8**		**95.0**		**99.5**		
		median	6.29		74.0		96.2		99.5		
		minimum	5.46		65.4		88.4		99.2		
		std dev	1.43		15.1		4.65		0.227		

Table 2c. Susceptibility to pyriproxyfen (Knack®) of *B. tabaci* collected from greenhouse-grown poinsettias in 2005.

Collection #	Collection site	Host	0	stdev	0.01	stdev	0.1	stdev	1	stdev	Biotype
05-109	Tucson	poinsettia	10.1	7.61	64.5	12.3	98.4	2.33	99.4	1.57	B
05-110	Tucson	poinsettia	13.6	4.77	89.0	6.89	99.5	0.937	100.0	0.000	B
05-29	Tucson	poinsettia	*2.77*	3.84	49.6	11.9	82.5	11.7	96.4	1.84	B
05-39	Phoenix	poinsettia	5.75	9.27	*26.9*	16.3	*53.8*	9.65	*78.5*	38.6	B
05-113	Tucson	poinsettia	4.48	6.17	30.5	5.67	63.8	16.4	94.1	6.53	B
		N	5		5		5		5		
		mean	**7.35**		**52.1**		**79.6**		**93.7**		
		median	5.75		49.6		82.5		96.4		
		minimum	2.77		26.9		53.8		78.5		
		std dev	4.44		25.6		20.5		8.81		

Table 3a. Susceptibility to buprofezin (Courier®/Applaud®) of *B. tabaci* collected from cotton in 2005.

		Corrected Mortality/Concentration Buprofezin (ug/ml)								
Collection #	Collection site	**0**	stdev	**8**	stdev	**100**	stdev	**1000**	stdev	Biotype
05-02	Buckeye	31.1	32.6	*49.1*	6.89	80.3	4.88	99.8	0.435	B
05-107	Coolidge	*6.51*	4.12	71.8	20.4	88.7	6.68	100	0.000	B
05-09	Cotton Center	25.9	15.4	68.4	16.6	85.2	5.10	100	0.000	B
05-103	Goodyear	25.4	16.7	64.0	21.2	85.6	12.8	100	0.000	B
05-102	Harquahala	17.7	9.76	61.0	11.97	85.6	8.64	99.5	0.935	B
05-17	Holtville	10.3	7.29	64.3	11.8	90.9	1.92	99.6	0.559	B
05-21	Marana	10.7	3.88	68.9	5.87	85.2	5.68	100	0.000	B
05-03	Maricopa Ag. Cente	10.6	5.25	55.9	9.40	*79.7*	7.01	99.0	1.76	B
05-11	Mohave	17.8	20.6	58.3	10.4	93.2	4.71	100	0.000	B
05-106	Paloma	11.3	4.96	71.0	12.8	90.2	9.08	100	0.000	B
05-12	Parker Valley	11.9	4.82	58.4	3.52	87.3	7.85	99.8	0.488	B
05-22	Picacho	13.8	2.14	63.9	7.67	90.7	5.41	99.8	0.395	B
05-08	Queen Creek	14.5	8.16	62.0	6.26	90.4	5.71	99.9	0.268	B
05-108	Scottsdale	9.83	8.88	70.8	17.8	93.0	6.80	100	0.000	B
05-06	Somerton	15.2	6.41	59.5	9.17	93.4	3.32	99.7	0.795	B
05-19	South Gila Valley	11.8	6.96	60.3	8.80	80.9	4.44	99.3	1.04	B
05-10	Stanfield	18.1	8.35	64.3	7.59	92.4	5.49	99.7	0.543	B
05-04	USDA-Aphis	21.0	17.2	74.7	7.74	93.2	3.76	99.4	0.889	B
05-01	Wellton	22.6	8.41	66.3	6.19	91.3	3.57	*98.0*	1.48	B
05-104	Yuma Ag. Center	19.4	6.00	67.6	6.55	91.9	1.79	100	0.000	B
	N	20		20		20		20		
	mean	**16.3**		**64.0**		**88.4**		**99.7**		
	median	14.8		64.1		90.3		99.8		
	minimum	6.51		49.1		79.7		98.0		
	std dev	6.43		6.21		4.49		0.484		

Table 3b. Susceptibility to buprofezin (Courier®/Applaud®) of *B. tabaci* collected from vegetables and melons in 2005.

			Corrected Mortality/Concentration Buprofezin (ug/ml)								
Collection #	Collection site	Host	**0**	stdev	**8**	stdev	**100**	stdev	**1000**	stdev	Biotype
05-101	Litchfield	melons	15.0	8.06	68.9	17.8	*81.6*	3.80	100	0.000	B
05-25	Palo Verde	brassicae	8.65	2.97	62.5	5.85	94.6	3.67	100	0.000	B
05-105	Somerton	melons	16.7	10.5	68.7	11.4	82.7	3.79	100	0.000	B
05-27	Texas Hill	cabbage	*3.56*	3.59	*59.1*	5.56	93.0	1.97	100	0.000	B
		N	4		4		4		4		
		mean	**11.0**		**64.8**		**88.0**		**100.0**		
		median	11.8		65.6		87.9		100		
		minimum	3.56		59.1		81.6		100		
		std dev	6.05		4.84		6.76		0.000		

Table 3c. Susceptibility to buprofezin (Courier®/Applaud®) of *B. tabaci* collected from greenhouses-grown poinsettias in 2005.

			Corrected Mortality/Concentration Buprofezin (ug/ml)								
Collection #	Collection site	Host	**0**	stdev	**8**	stdev	**100**	stdev	**1000**	stdev	Biotype
05-109	Tucson	poinsettia	8.38	5.13	58.0	10.22	*83.8*	5.70	100	0.000	B
05-110	Tucson	poinsettia	6.90	2.88	*53.2*	5.20	87.0	2.62	99.9	0.276	B
05-29	Tucson	poinsettia	*4.87*	4.97	62.7	8.75	85.5	7.67	100	0.000	B
05-39	Phoenix	poinsettia	5.49	2.51	72.5	9.77	90.7	5.16	*99.7*	0.319	B
05-113	Tucson	poinsettia	6.68	4.88	65.0	17.6	92.7	3.39	99.9	0.350	B
		N	5		5		5		5		
		mean	**6.46**		**62.3**		**87.9**		**99.9**		
		median	6.68		62.7		87.0		100		
		minimum	4.87		53.2		83.8		99.7		
		std dev	1.36		7.30		3.68		0.112		

Table 4a. Susceptibility to mixtures of fenpropathrin (Danitol®) + acephate (Orthene®) of *B. tabaci* collected from cotton in 2005.

		Corrected Mortality/Concentration Fenpropathrin (ug/ml)+ 1000 ug/ml Acephate						
Collection #	Collection site	**0**	stdev	**10**	stdev	**100**	stdev	Biotype
05-02	Buckeye	10.7	7.26	86.1	13.7	94.1	5.38	B
05-107	Coolidge	18.1	13.0	89.8	6.08	100	0.000	B
05-09	Cotton Center	26.9	13.8	93.7	12.2	100	0.000	B
05-103	Goodyear	*0.833*	2.04	85.2	8.56	91.8	10.8	B
05-102	Harquahala	16.2	5.80	96.1	3.05	100	0.000	B
05-17	Holtville	7.31	2.59	69.9	7.30	95.5	5.26	B
05-21	Marana	4.49	5.64	92.6	4.81	98.5	2.38	B
05-03	Maricopa Ag. Center	8.55	7.02	98.1	2.90	93.6	5.40	B
05-11	Mohave	2.52	4.50	83.0	4.41	98.2	4.41	B
05-106	Paloma	9.77	8.57	94.4	5.09	98.2	2.86	B
05-12	Parker Valley	2.36	4.10	78.2	14.6	83.0	11.3	B
05-22	Picacho	5.53	5.44	94.7	3.76	99.3	1.80	B
05-08	Queen Creek	4.78	6.65	75.1	7.23	85.7	4.57	B
05-108	Scottsdale	3.21	3.73	85.7	6.84	96.4	3.22	B
05-06	Somerton	1.71	2.65	*47.6*	10.5	*55.8*	11.2	B
05-19	South Gila Valley	2.59	2.85	80.7	9.63	90.9	8.23	B
05-10	Stanfield	2.50	2.75	88.3	7.78	97.4	2.89	B
05-01	Wellton	8.27	6.15	81.2	9.54	96.5	6.30	B
05-104	Yuma Ag. Center	5.90	5.81	70.1	17.1	80.3	5.25	B
	N	19		19		19		
	mean	**7.49**		**83.7**		**92.4**		
	median	5.53		85.7		96.4		
	minimum	0.833		47.6		55.8		
	std dev	6.67		12.1		10.6		

Table 4b. Susceptibility to mixtures of fenpropathrin (Danitol®) + acephate (Orthene®) of *B. tabaci* collected from vegetables and melons in 2005.

			Corrected Mortality/Concentration Fenpropathrin (ug/ml)+ 1000 ug/ml Acephate						
Collection #	Collection site	Crop	**0**	stdev	**10**	stdev	**100**	stdev	Biotype
05-101	Litchfield	melons	5.81	4.85	96.1	3.36	99.3	1.73	B
05-25	Palo Verde	brassicae	*1.59*	3.89	82.8	6.75	*85.2*	6.44	B
05-105	Somerton	melons	2.39	3.90	*51.6*	13.8	92.9	7.61	B
05-27	Texas Hill	cabbage	2.35	2.58	93.2	4.24	98.1	3.03	B
		N	4		4		4		
		mean	**3.04**		**80.9**		**93.9**		
		median	2.37		88.0		95.5		
		minimum	1.59		51.6		85.2		
		std dev	1.89		20.4		6.40		

Table 4c. Susceptibility to mixtures of fenpropathrin (Danitol) + acephate (Orthene) of *B. tabaci* collected from greenhouse-grown poinsettias in 2005.

			Corrected Mortality/Concentration Fenpropathrin (ug/ml)+ 1000 ug/ml Acephate						
Collection #	Collection site	Crop	**0**	stdev	**10**	stdev	**100**	stdev	Biotype
05-109	Tucson	poinsettia	5.92	6.71	47.5	13.3	92.1	8.23	B
05-110	Tucson	poinsettia	1.67	2.58	43.0	21.3	78.2	15.7	B
05-29	Tucson	poinsettia	*1.36*	3.40	55.6	13.6	74.8	8.95	B
05-39	Phoenix	poinsettia	2.46	2.70	*30.4*	14.9	*56.3*	18.5	B
05-113	Tucson	poinsettia	8.17	2.70	78.5	10.1	83.8	10.1	B
		N	5		5		5		
		mean	**3.92**		**51.0**		**77.1**		
		median	2.46		47.5		78.2		
		minimum	1.36		30.4		56.3		
		std dev	2.99		17.9		13.3		

Table 5a. Susceptibility to imidacloprid (Admire/Provado) of *B. tabaci* collected from cotton in 2005.

		Corrected Mortality/Concentration Imidacloprid (ug/ml)										
Collection #	Collection site	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
05-02	Buckeye	4.53	3.76	*47.8*	14.8	90.1	3.04	94.6	3.82	97.6	2.08	B
05-107	Coolidge	26.1	14.4	94.0	5.76	100	0.000	100	0.000	100	0.000	B
05-09	Cotton Center	11.3	7.80	97.8	2.91	100	0.000	100	0.000	100	0.000	B
05-103	Goodyear	2.99	4.27	56.9	12.5	86.5	9.48	98.2	2.36	98.5	2.45	B
05-102	Harquahala	3.86	4.42	86.9	7.37	98.0	2.87	100	0.000	100	0.000	B
05-17	Holtville	*0.851*	1.80	88.1	7.04	98.5	2.44	100	1.39	100	0.000	B
05-21	Marana	19.1	13.2	95.6	5.89	100	0.000	100	0.000	100	0.000	B
05-03	Maricopa Ag. Center	19.5	16.9	75.1	13.7	97.6	5.11	100	0.000	100	0.000	B
05-11	Mohave	3.85	5.15	62.4	11.7	95.8	3.74	100	0.000	99.0	3.29	B
05-106	Paloma	2.93	4.12	91.7	6.14	100	0.000	100	0.000	100	0.000	B
05-12	Parker Valley	5.29	3.71	80.7	14.8	99.5	1.67	100	0.000	100	0.000	B
05-22	Picacho	12.8	8.69	81.8	11.9	97.8	3.75	100	0.000	100	0.000	B
05-08	Queen Creek	6.76	9.10	97.8	5.20	99.5	1.70	100	0.000	100	0.000	B
05-108	Scottsdale	10.2	8.21	86.5	10.2	100	0.000	100	0.000	100	0.000	B
05-06	Somerton	1.77	2.30	66.6	14.3	82.5	9.77	94.8	4.05	*93.3*	7.36	B
05-19	South Gila Valley	4.62	4.70	81.2	9.02	95.0	5.68	99.1	1.89	98.9	2.42	B
05-10	Stanfield	6.83	5.95	85.3	10.6	99.5	1.62	100	0.000	100	0.000	B
05-01	Wellton	3.51	4.37	55.3	12.3	*77.1*	6.81	*93.0*	7.69	96.9	4.72	B
05-104	Yuma Ag. Center	4.95	3.64	67.0	18.5	96.8	4.85	100	0.000	99.4	1.37	B
	N	19		19		19		19		19		
	mean	**7.98**		**78.9**		**95.5**		**98.9**		**99.1**		
	median	4.95		81.8		98.0		100		100		
	minimum	0.851		47.8		77.1		93.0		93.3		

Table 5b. Susceptibility to imidacloprid (Admire/Provado) of *B. tabaci* collected from vegetables and melons in 2005.

Collection	Collection site	Host	Corrected Mortality/Concentration Imidacloprid (ug/ml) 0	stdev	1	stdev	10	stdev	100	stdev	1000	stdev	Biotype
05-101	Litchfield	melons	6.49	3.96	84.2	27.3	100	0.00	100	0.000	100	0.000	B
05-25	Palo Verde	brassicae	4.86	9.14	57.0	12.6	98.1	4.63	99.5	1.66	100	0.000	B
05-105	Somerton	melons	*3.83*	4.36	*51.9*	21.2	96.0	4.18	100	0.000	100	0.000	B
05-27	Texas Hill	cabbage	5.72	6.56	60.5	26.6	*92.1*	9.75	*99.3*	2.10	100	0.000	B
		N	4		4		4		4		4		
		mean	**5.23**		**63.4**		**96.5**		**99.7**		**100**		
		median	5.29		58.8		97.0		100		100		
		minimum	3.83		51.9		92.1		99.3		100		
		std dev	1.14		14.3		3.37		0.348		0.000		

Table 5c. Susceptibility to imidacloprid (Admire/Provado) of *B. tabaci* collected from greenhouse or ornamental plants in 2005.

Collection	Collection site	Host	Corrected Mortality/Concentration Imidacloprid (ug/ml) 0	stdev	1	stdev	10	stdev	100	stdev	1000	stdev	Biotype
05-109	Tucson	poinsettia	3.48	6.25	11.3	9.81	87.3	11.9	100	1.56	100	0.000	B
05-110	Tucson	poinsettia	3.61	4.29	*2.99*	3.85	85.2	11.9	98.6	3.02	98.7	2.73	B
05-29	Tucson	poinsettia	3.61	4.01	30.9	15.9	88.5	9.55	98.3	3.81	97.6	4.01	B
05-39	Phoenix	poinsettia	*0.560*	1.76	8.32	10.7	*42.3*	16.2	*88.7*	8.83	*78.9*	15.3	B
		N	4		4		4		4		4		
		mean	**2.82**		**13.4**		**75.8**		**96.3**		**93.8**		
		median	3.55		9.83		86.3		98.4		98.1		
		minimum	0.560		2.99		42.3		88.7		78.9		
		std dev	1.50		12.2		22.4		5.07		9.97		

Table 6a. Susceptibility to Thiamethoxam (Actera/Centric/Platinum) of *B. tabaci* collected from cotton in 2005.

		Corrected Mortality/Concentration Thiamethoxam (ug/ml)										
Collection #	Collection site	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
05-02	Buckeye	12.0	7.35	36.6	20.9	65.1	17.0	88.0	8.22	100	0.000	B
05-107	Coolidge	33.5	12.1	23.0	17.4	70.7	9.46	100	0.000	100	0.000	B
05-09	Cotton Center	2.65	4.56	*1.99*	2.50	51.5	9.64	84.2	11.2	99.3	1.82	B
05-103	Goodyear	10.1	7.44	13.6	14.3	66.2	15.3	91.0	7.33	98.3	4.13	B
05-102	Harquahala	14.3	3.21	24.3	18.8	42.5	13.4	91.6	2.97	96.1	5.46	B
05-17	Holtville	4.18	3.78	18.7	17.8	31.3	6.13	95.9	5.00	100	0.000	B
05-21	Marana	3.93	5.56	53.1	16.0	80.7	9.29	95.8	3.73	100	0.000	B
05-03	Maricopa Ag. Center	4.05	3.61	17.9	13.0	68.3	4.51	87.1	2.62	98.2	2.76	B
05-11	Mohave	14.2	9.33	19.6	21.8	51.0	14.3	95.9	4.46	100	0.000	B
05-106	Paloma	13.7	10.3	55.6	18.8	80.3	12.0	98.1	2.92	100	0.000	B
05-12	Parker Valley	*0.694*	1.70	6.61	4.83	44.6	14.6	85.8	8.28	100	0.000	B
05-22	Picacho	8.69	7.43	24.1	18.0	75.5	11.3	95.8	5.20	100	0.000	B
05-08	Queen Creek	5.75	5.86	32.1	15.7	80.7	11.6	99.1	2.28	100	0.000	B
05-108	Scottsdale	8.41	4.98	22.0	11.6	68.3	9.76	92.0	8.47	100	0.000	B
05-06	Somerton	4.05	3.61	6.58	9.95	*15.6*	10.7	*58.4*	17.3	98.3	2.63	B
05-19	South Gila Valley	3.33	6.06	2.69	2.89	16.4	6.62	63.8	22.5	100	0.000	B
05-10	Stanfield	2.61	2.88	17.8	12.4	46.0	11.8	89.2	7.56	100	0.000	B
05-01	Wellton	5.90	5.61	8.31	5.70	38.2	17.2	71.8	11.1	*91.2*	8.67	B
05-104	Yuma Ag. Center	2.31	4.07	12.4	8.25	27.6	15.3	83.6	16.4	96.1	3.33	B
	N	19		19		19		19		19		
	mean	**8.13**		**20.9**		**53.7**		**87.7**		**98.8**		
	median	5.75		18.7		51.5		91.0		100		
	minimum	0.694		1.99		15.6		58.4		91.2		
	std dev	7.52		15.0		21.3		11.6		2.248		

Table 6b. Susceptibility to Thiamethoxam (Actera/Centric/Platinum) of *B. tabaci* collected from vegetables and melons in 2005.

			Corrected Mortality/Concentration Thiamethoxam (ug/ml)										
Collection #	Collection sit	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
05-101	Litchfield	melons	11.2	6.88	*1.25*	1.77	37.7	4.3	72.6	15.120	*88.4*	2.230	B
05-25	Palo Verde	brassicae	*2.34*	2.57	35.0	22.1	51.8	9.7	98.2	2.80	100	0.000	B
05-105	Somerton	melons	4.09	3.74	1.64	2.6	*4.97*	6.36	*43.6*	11.2	97.6	2.620	B
05-27	Texas Hill	cabbage	2.65	4.30	24.4	20.7	60.3	18.5	97.6	3.67	100	0.000	B
		N	15		15		15		15		15		
		mean	**5.07**		**15.6**		**38.7**		**78.0**		**96.5**		
		median	3.37		13.0		44.7		85.1		98.8		
		minimum	2.34		1.25		4.97		43.6		88.4		
		std dev	4.15		16.9		24.3		25.8		5.53		

Table 6c. Susceptibility to Thiamethoxam (Actera/Centric/Platinum) of *B. tabaci* collected from greenhouse-grown poinsettias in 2005.

			Corrected Mortality/Concentration Thiamethoxam (ug/ml)										
Collection #	Collection sit	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
05-109	Tucson	poinsettia	7.85	12.3	2.73	4.23	16.8	9.72	82.4	13.6	100	0.000	B
05-110	Tucson	poinsettia	1.67	2.59	1.62	1.78	16.5	8.35	55.7	13.1	100	0.000	B
05-29	Tucson	poinsettia	1.19	2.92	*1.57*	2.48	18.2	11.6	77.9	19.7	99.9	2.75	B
05-39	Phoenix	poinsettia	*0.000*	0.000	4.05	5.83	*2.50*	2.75	*48.1*	26.5	*94.2*	4.94	B
		N	15		15		15		15		15		
		mean	**2.68**		**2.49**		**13.5**		**66.0**		**98.5**		
		median	1.43		2.18		16.6		66.8		100		
		minimum	0.000		1.57		2.50		48.1		94.2		
		std dev	3.52		1.17		7.36		16.7		2.88		

Table 7a. Susceptibility to acetamiprid (Intruder) of *B. tabaci* collected from cotton in 2005.

		Corrected Mortality/Concentration Acetamiprid (ug/ml)										
Collection #	Collection site	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
05-02	Buckeye	4.96	4.52	12.1	10.2	46.7	13.0	74.1	10.7	95.7	4.11	B
05-107	Coolidge	33.5	12.1	46.4	15.1	90.9	9.63	100	0.000	100	0.000	B
05-09	Cotton Center	2.65	4.56	*0.232*	0.568	42.5	29.6	79.5	11.7	100	0.000	B
05-103	Goodyear	10.1	7.44	26.9	27.7	40.7	10.5	88.5	8.34	97.4	2.81	B
05-102	Harquahala	10.6	6.46	11.1	12.1	77.0	9.04	90.6	3.44	99.3	1.83	B
05-17	Holtville	4.18	3.78	6.48	5.50	66.1	11.8	99.1	2.13	100	0.000	B
05-21	Marana	3.93	5.56	20.3	14.3	84.2	11.5	100	0.000	100	0.000	B
05-03	Maricopa Ag. Center	4.05	3.61	28.8	14.0	57.0	25.2	100	0.000	98.3	2.63	B
05-11	Mohave	14.2	9.33	29.1	20.4	68.0	24.3	98.6	3.40	100	0.000	B
05-106	Paloma	14.5	9.33	34.0	14.2	86.2	11.6	99.0	2.39	100	0.000	B
05-12	Parker Valley	*0.694*	1.70	4.53	5.81	58.3	19.1	91.4	4.34	98.5	3.57	B
05-22	Picacho	8.69	7.43	7.92	7.04	77.4	6.96	99.1	2.24	100	0.000	B
05-08	Queen Creek	5.75	5.86	17.6	13.9	83.8	11.85	100	0.000	100	0.000	B
05-108	Scottsdale	8.41	4.98	15.1	13.0	77.7	17.2	98.6	3.43	100	0.000	B
05-06	Somerton	4.05	3.61	3.50	3.40	40.7	9.74	78.5	6.13	92.4	6.07	B
05-19	South Gila Valley	3.33	6.06	3.26	4.39	37.5	6.24	80.0	38.4	99.1	2.22	B
05-10	Stanfield	2.61	2.88	33.6	12.2	78.8	10.1	100	0.000	100	0.000	B
05-01	Wellton	5.90	5.61	8.38	8.51	*31.8*	22.5	*62.4*	9.17	*83.3*	8.38	B
05-104	Yuma Ag. Center	2.34	4.07	19.0	15.2	41.4	19.2	85.7	7.52	97.8	2.41	B
	N	14		14		14		14		14		
	mean	**7.60**		**17.3**		**62.5**		**90.8**		**98.0**		
	median	4.96		15.1		66.1		98.6		100		
	minimum	0.694		0.232		31.8		62.4		83.3		
	std dev	7.40		12.8		19.6		11.2		4.06		

Table 7b. Susceptibility to acetamiprid (Intruder) of *B. tabaci* collected from vegetables and melons in 2005.

			Corrected Mortality/Concentration Thiamethoxam (ug/ml)										
Collection #	Collection site	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
05-101	Litchfield	melons	10.7	3.43	*4.54*	5.63	*25.3*	12.9	*69.9*	11.7	*93.4*	5.47	B
05-25	Palo Verde	brassicae	*2.34*	2.57	26.5	14.2	76.9	4.64	100	0.00	100	0.000	B
05-105	Somerton	melons	4.09	3.74	8.18	10.2	42.2	17.3	86.4	8.76	99.1	2.13	B
05-27	Texas Hill	cabbage	2.65	4.30	13.1	11.1	62.6	7.53	100	0.00	100	0.000	B
		N	15		15		15		15		15		
		mean	**4.93**		**13.1**		**51.7**		**89.1**		**98.1**		
		median	3.37		10.6		52.4		93.2		99.6		
		minimum	2.34		4.54		25.3		69.9		93.4		
		std dev	3.89		9.63		22.7		14.3		3.18		

Table 7c. Susceptibility to acetamiprid (Intruder) of *B. tabaci* collected from greenhouse or ornamental plants in 2004.

			Corrected Mortality/Concentration Thiamethoxam (ug/ml)										
Collection #	Collection site	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
05-109	Tucson	poinsettia	7.28	6.83	7.13	7.46	64.3	21.9	98.3	2.72	100	0.000	B
05-110	Tucson	poinsettia	2.59	2.84	*0.976*	1.54	27.5	24.0	94.0	3.65	*99.1*	2.10	B
05-29	Tucson	poinsettia	1.19	2.92	3.41	5.62	56.5	13.4	96.1	4.26	100	0.000	B
05-39	Phoenix	poinsettia	*0.000*	0.000	1.63	2.52	*25.7*	7.77	*85.4*	8.26	99.2	2.04	B
		N	15		15		15		15		15		
		mean	**2.77**		**3.29**		**43.5**		**93.5**		**99.6**		
		median	1.89		2.52		42.0		95.1		100		
		minimum	0.000		0.976		25.7		85.4		99.1		
		std dev	3.19		2.76		19.8		5.62		0.488		