New Challenges to Management of Whitefly Resistance to Insecticides in Arizona

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Abstract

We report on susceptibility to insecticides of whiteflies (Bemisia tabaci) collected from cotton, melons and ornamental plants during the 2004 season. No major problems with field performance of insecticides against whiteflies were observed or reported in 2004 in Arizona cotton, vegetables, or melons. However, monitoring revealed further statewide reduction in susceptibility to pyriproxyfen (Knack®) and showed that whiteflies possessing pyriproxyfen resistance could be detected in all low desert areas of the state. Susceptibility to buprofezin (Applaud®/Courier®) has not changed significantly since 1997. Mean susceptibility to synergized pyrethroids (e.g., Danitol® + Orthene®) has increased strikingly on a statewide basis since 1995 though highly resistant whiteflies were detected in some collections from cotton, melons and ornamentals. Whiteflies from throughout Arizona continued to be highly susceptible to imidacloprid (Admire®/Provado®). However, susceptibility to the related neonicotinoid insecticide, acetamiprid (Intruder®) varied widely and was lowest in collections from melons and greenhouse plants. Whiteflies from cotton that were least susceptibile to acetamiprid were significantly less susceptible to a second neonicotinoid, thiamethoxam (Actara®/Centric®/Platinum®). The most worrisome findings of our 2004 studies stemmed from detection of a strain of B. tabaci, at a retail nursery, that was essentially unaffected by pyriproxyfen in egg bioassays. It also possessed strikingly reduced susceptibility to acetamiprid, buprofezin, mixtures of fenpropathrin and acephate, imidacloprid, and thiamethoxam. This strain was found to be a biotype of B. tabaci previously undescribed in the US, the Q biotype. We cannot predict with accuracy the timecourse of future resistance problems or the spread and impact of this new whitefly biotype. However, our findings point to the need to formulate contingency plans for management of resistance, in order to insure that Arizona agriculture does not revisit the severe whitefly control problems experienced in the past.

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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) 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 to12 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, the first signs of pyriproxyfen resistance were seen 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 *B. tabaci* 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). Thus, 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 began routine biotype assessments of whiteflies collected for resistance monitoring throughout Arizona.

Whitefly susceptibility to insecticides is monitored yearly in Arizona in order to detect emerging resistance problems and to permit potential solutions to be developed before the onset of severe economic losses to growers. Each year the Arizona Whitefly Resistance Working Group evaluates our whitefly resistance management recommendations in light of the new monitoring data. In this paper we report results of studies conducted in 2004.

Materials and Methods

Collections

Locations from which we obtained collections of *B. tabaci* in 2004 are detailed in Figure 1a. Our objective was to obtain a minimum of 1000 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. Bioassays were typically conducted within 12-36 hours of field collection. 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.

Bioassays

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 Williams (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.).

Biotype Determinations

We conducted biotype identifications of whitefly samples collected for resistance testing in 2001, 2003, and 2004. This work, conducted collaboratively with Dr. Judith Brown of The University of Arizona, and Drs. Shai Morin and Jeff Fabrick, both formerly with The University of Arizona, was done using methodology developed over the past decade in Dr. Brown's laboratory (Frohlich et al., 1999; Brown, 2001; Berry et al., 2004; Coats et al., 1994; Costa et al., 1993; Kirk et al., 2000; Legg et al., 2002). Further cooperation was provided in 2004 by Dr. Frank Byrne of the University of California, Riverside. Dr. Byrne was the first to test the biotype of the highly resistant whiteflies we collected from poinsettias at a retail store in Tucson. Full details of this work are beyond the scope of this publication. Briefly stated, molecular markers were used to identify small differences in the genetic code of whitefly biotypes. This involved specific molecular primers that magnified a part of the mitochondrial DNA in a gene called cytochrome oxidase 1 (CO1) (Brown et al., 2001). The amplified DNA was then analyzed to detect biotype-specific differences in nucleotide sequences. The analyses conducted by Dr. Byrne in 2004 employed gel electrophoresis of non-specific esterases (Costa and Brown, 1991; Costa et al., 1993**)**. Complete details of this collaborative effort that led to the discovery and characterization of the Q biotype will be published elsewhere.

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 Discussion

Biotype Identifications

All samples except for the Tucson Retail Greenhouse #3 collection (Tables 2-7) were the B biotype of *B. tabaci*. Electrophoresis of non-specific esterases conducted by Dr. Frank Byrne first identified the Tucson Retail Greenhouse collection as the Q biotype. This was subsequently verified in Dr. Judy Brown's laboratory and in the EARML facilities using amplification and sequencing of the CO1 gene.

Pyriproxyfen (Knack®)

Statewide averages: 1996 to 2004. Whitefly susceptibility to pyriproxyfen was first documented in bioassays in 1996, the year that it was registered for use in cotton. A discriminating concentration of 0.1 µg/ml pyriproxyfen was designated and used for monitoring purposes in subsequent years (Figure 1a), on the basis that this concentration caused very high levels of mortality to eggs (Simmons et al. 1990). 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 (Figure 1b, c). Changes over this same period were even more dramatic for mortality observed in bioassays of 0.01 µg pyriproxyfen/ml. Grand mean mortality was > 80% from 1996 to 1998. This fell to < 30% in 2004 (Figure 1b).

Resistance levels in individual field collections in 2004. None of the 48 cultures evaluated from 1996 to 1998 had ≥ 2.0% whiteflies 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 whiteflies tested each of these years. Fifteen of the 18 field collections from cotton tested in 2004 (83%) had >2.0% (corrected) survivorship of 0.1 µg/ml pyriproxyfen (Table 2a). All 11 collections from melons (Table 2b) and all 5 collections from ornamentals (Table 2c) had >2.0% (corrected) survivorship of 0.1 µg/ml pyriproxyfen. This confirms that pyriproxyfen-resistant whiteflies are now detectable in essentially all of the regions sampled.

Contrasts of susceptibility of whiteflies from cotton, melons, and ornamentals revealed small differences in statewide means and ranges of values observed in the different production systems. Collections from ornamentals were numerically the least susceptible of the samples tested (Tables 2a-c). The most resistant collections in cotton came from the central Arizona region between Paloma Ranch and Queen Creek (Figure 1c). The most resistant collections from melons came from Avondale, Harquahala, Marana, and Citrus Park (Table 2b). Of the collections from ornamentals, the most resistant to pyriproxyfen was sampled during the winter from landscape plants outside of the laboratories at the Maricopa Agricultural Center (Table 2c).

The Tucson Retail Greenhouse #3 collection was dramatically less susceptible to pyriproxyfen (Table 2c) than any whiteflies we had evaluated since we began testing IGRs in 1996. Egg mortality in bioassays of 0.1 and 1.0 µg/ml was less than 10% (Table 2c). Subsequent bioassays conducted with pyriproxyfen concentrations of 10 and 100 µg/ml pyriproxyfen yielded corrected egg mortality of less than 20% (data not shown). This strain was placed into isolated culture for further testing and was named Poinsettia'04. Herein, we report only on the data from the initial bioassays conducted immediately after collection.

It is clear from our findings that whiteflies in some areas of Arizona are substantially less susceptible to pyriproxyfen than they were previously. However, this does not mean that pyriproxyfen has failed or will fail imminently. As already stated, we know of no reports of field failures in Arizona cotton. Additionally, we cannot predict the future evolution of resistance with accuracy. It is possible that the increases in resistance that we documented during the past three years (Figure 1a) may be reversed in the coming years. Dr. Peter Ellsworth is currently 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 acceptable to producers.

Buprofezin (Applaud®/Courier®)

With the exception of the Tucson Retail Greenhouse #3 collection (Q biotype), there were negligible differences in susceptibility of whiteflies collected from cotton, melons, and ornamentals (Tables 3a-c). Contrasts of 2004 means with those from previous years (Figure 2) showed that susceptibility of Arizona whiteflies to buprofezin is within the range observed since 1997. As with pyriproxyfen, the Q biotype was dramatically less susceptible to buprofezin than were all other field or greenhouse collections (Table 3a-c). The Q biotype collection had 34.5% mortality in bioassays of 1000 µg/ml buprofezin. All other collections evaluated had >98% mortality in bioassays of this concentration of buprofezin (Table 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 mixed with 1000 µg/ml acephate.

Statewide Averages 1995 to 2004. Levels of resistance to synergized pyrethroid insecticides of whiteflies from Arizona cotton have declined dramatically since 1995. This was demonstrated by strikingly lower mean and range of survivorship observed in recent years in bioassays of fenpropathrin + acephate mixtures (Figures 3a,b). Statewide averages of mean survivorship in discriminating concentration bioassays declined from 45% in 1995 to 21, 17, and 15% in 2002, 2003, and 2004, respectively (Figure 3b).

Resistance levels in individual field collections in 2004. The range of resistance to synergized pyrethroid insecticides observed within collections made each year from cotton declined sharply from 1995 to 2004 (Figure 3b). However, the yearly percentage of individual cotton fields with ≥ 20% resistant whiteflies oscillated widely from year to year: the high being 58% in 1996, and the low of 10% occurring in 2001 (Figure 3a). Four of 15 cotton collections (27%) evaluated in 2004 had frequencies of resistance exceeding the critical frequency of 20% (Figure 3b). However, unlike the situation in 1995, when survivorship of discriminating concentration bioassays exceeded 80% for some collections (Figure 3b), all samples tested in 2004 had <35% survivorship. Because our collections were made late in the season, they typically reflect the worst-case for within-year resistance levels.

Whiteflies from melons and ornamentals had lower susceptibility to synergized pyrethroids statewide than collections from cotton. Mean corrected mortality for all samples tested with 10 µg/ml fenpropathrin + 1000 µg/ml acephate was 85.6, 74.7, and 71.0% for cotton, melons, and ornamentals, respectively (Tables 4a-c). Individual collections with highest levels of pyrethroid resistance came from melons and ornamentals. The most resistant collections from cotton, melons, and ornamentals had mean mortality of 67.4, 53.7, and 20.8%, respectively, in bioassays of 10 µg/ml fenpropathrin + 1000 µg/ml acephate (Tables 4a-c). The Q biotype collection, Tucson Retail GH #3, had the lowest mortality in bioassays of fenpropathrin and acephate that we have recorded in a decade of monitoring resistance in whiteflies (Table 4c).

Neonicotinoid Insecticides

Imidacloprid (Admire®/Provado®). Whiteflies collected from Arizona cotton in 2004 continued the four year trend of uniformly high susceptibility to imidacloprid (Figure 4a). Differences between collections from cotton were found only at the lowest concentration tested, 1 µg/ml imidacloprid. 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 resistance to imidacloprid are capable of surviving bioassay concentrations of as high as 1000 µg/ml imidacloprid.

Mean susceptibility to imidacloprid of collections from melons and ornamentals was not appreciably different from that of cotton at the concentrations evaluated (Table 5a,b). What was different was that four collections from melons and one collection from ornamentals had 1 to 8% survivors of the 100 and 1000 µg/ml imidacloprid tests. However, the Q biotype collection, Tucson Retail GH #3, was strikingly less susceptible to imidacloprid. Mean corrected mortality of the Q strain was 64.6 and 79.3 in tests of 100 and 1000 µg/ml imidacloprid, respectively (Figure 4a).

Acetamiprid (Intruder®) and Thiamethoxam (Actara®/Centric®/Platinum®). Acetamiprid and thiamethoxam were both less toxic than imidacloprid and more variable in toxicity to whiteflies collected from cotton, melons, and ornamentals (Tables 6-7). Irrespective of production system from which the whiteflies were obtained, mean mortality in bioassays of 10 µg/ml acetamiprid or thiamethoxam varied widely between collections. Regression analysis of the 14 whitefly collections from cotton (Figure 4b) revealed a significant and high correlation (p<0.0001, R^2 = 0.806) between mortality observed in bioassays of 10 µg/ml thiamethoxam versus 10 µg/ml acetamiprid. Surprisingly, imidacloprid tests yielded non-significant correlations with thiamethoxam or acetamiprid (data not shown). The Q biotype collection was dramatically less susceptible to both acetamiprid and thiamethoxam than was any of the field strains tested (Tables 6-7). Difference in potency of imidacloprid versus acetamiprid and thiamethoxam may reflect differences in bioassays and may not necessarily reflect differences in field performance.

Conclusions

No major problems with field performance of insecticides against whiteflies were observed or reported in 2004 in Arizona. However, our findings of widespread and increasing whitefly resistance to pyriproxyfen in Arizona underscores the need to formulate contingency plans for responding to possible field resistance problems. The newly described Q biotype detected in Arizona was virtually immune to pyriproxyfen and synergized pyrethroids, and strikingly reduced in susceptibility to buprofezin, imidacloprid, acetamiprid and thiamethoxam. At the present time this new biotype has been detected only in glasshouse settings in the US. Research is currently being done to evalaute a wide range of alternatives for its control. Further increases in pyriproxyfen resistance in the B biotype and/or spread of the Q biotype into field systems in Arizona could disrupt a decade of successful management of whiteflies in cotton, melon, and vegetable systems.

In the past, when resistance caused insecticides to fail, there have been lengthy delays before research was completed to formulate new control recommendations and before replacement insecticides were registered. Agricultural producers commonly have had to experience widespread failures of insecticides before research was initiated to confirm that they had a problem. This outcome has serious financial implications for producers, especially with severe economic pests such as whiteflies. In cotton, for example, multiple years of discounted prices can result from a single year in which buyers experience whitefly-related stickiness. By monitoring resistance prior to the onset of field problems, we strive to minimize resistance-related costs to producers and to sustain integrated management that is based on selective insecticides. Thus, our motivation for reporting the early progression of resistance is to keep producers aware of changes occurring. The sooner we are able to detect new resistance problems in the field, the more likely we will be to have the needed time to isolate and manage the problem.

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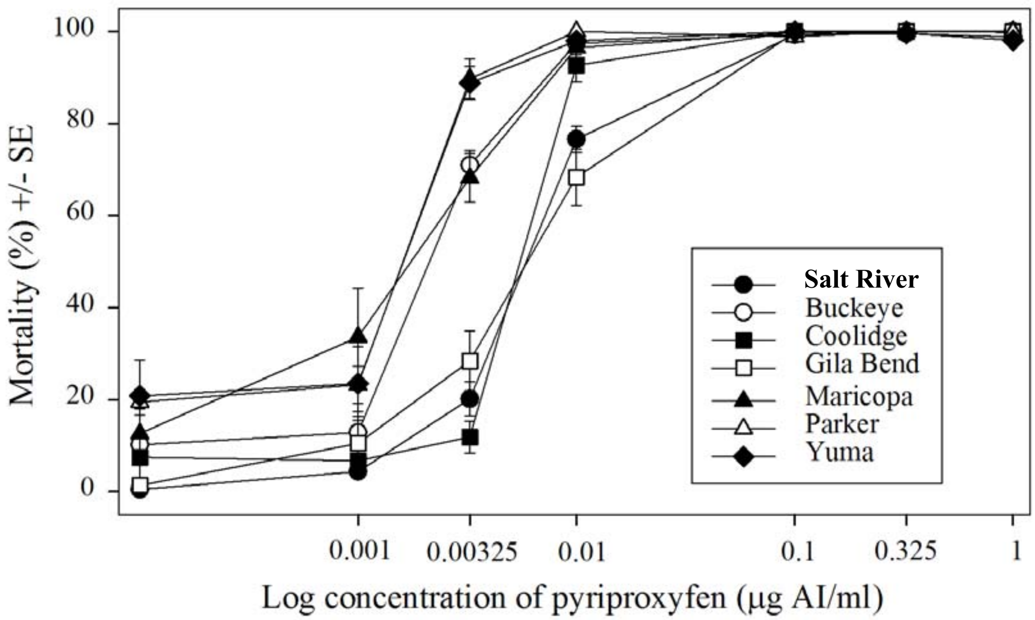

Figure 1a. Susceptibility to pyriproxyfen (Knack®) of 1996 collection of *Bemisia tabaci* made in Arizona cotton fields. LC_{50}s of all populations tested were below 0.01 µg/ml pyriproxyfen and survivors of 0.1 µg/ml bioassays were very rare. (From Li et al. 2003).

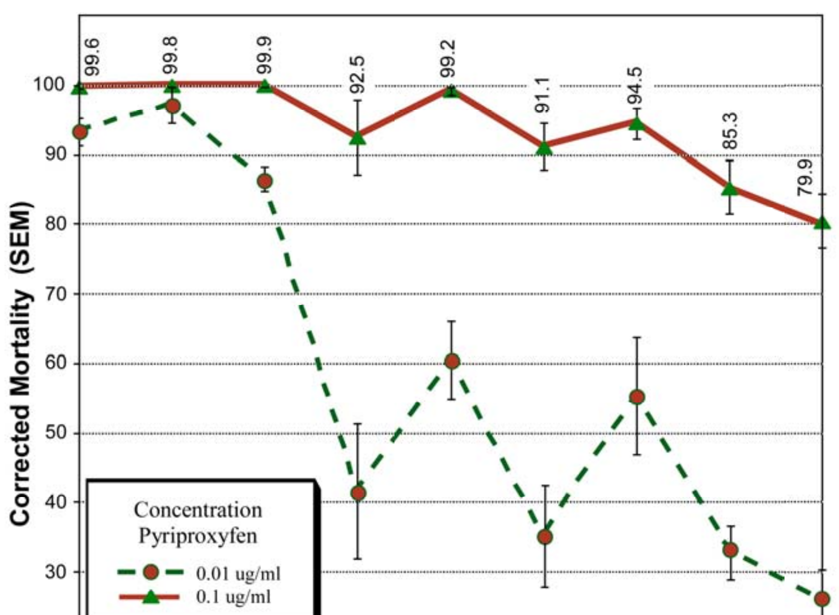

Figure 1b. Arizona whiteflies collected in 2004 continued the downward trend in susceptibility to pyriproxyfen (Knack®). Shown are statewide averages of susceptibility to pyriproxyfen of whiteflies from cotton for 1996-2004, as determined by bioassays of 0.01 and 0.1 µg pyriproxyfen/ml. The overall proportions of whiteflies surviving discriminating concentration bioassays of 0.1 µg pyriproxyfen/ml increased from 5.5% in 2002, to 14.7 in 2003, and 20.1% in 2004.

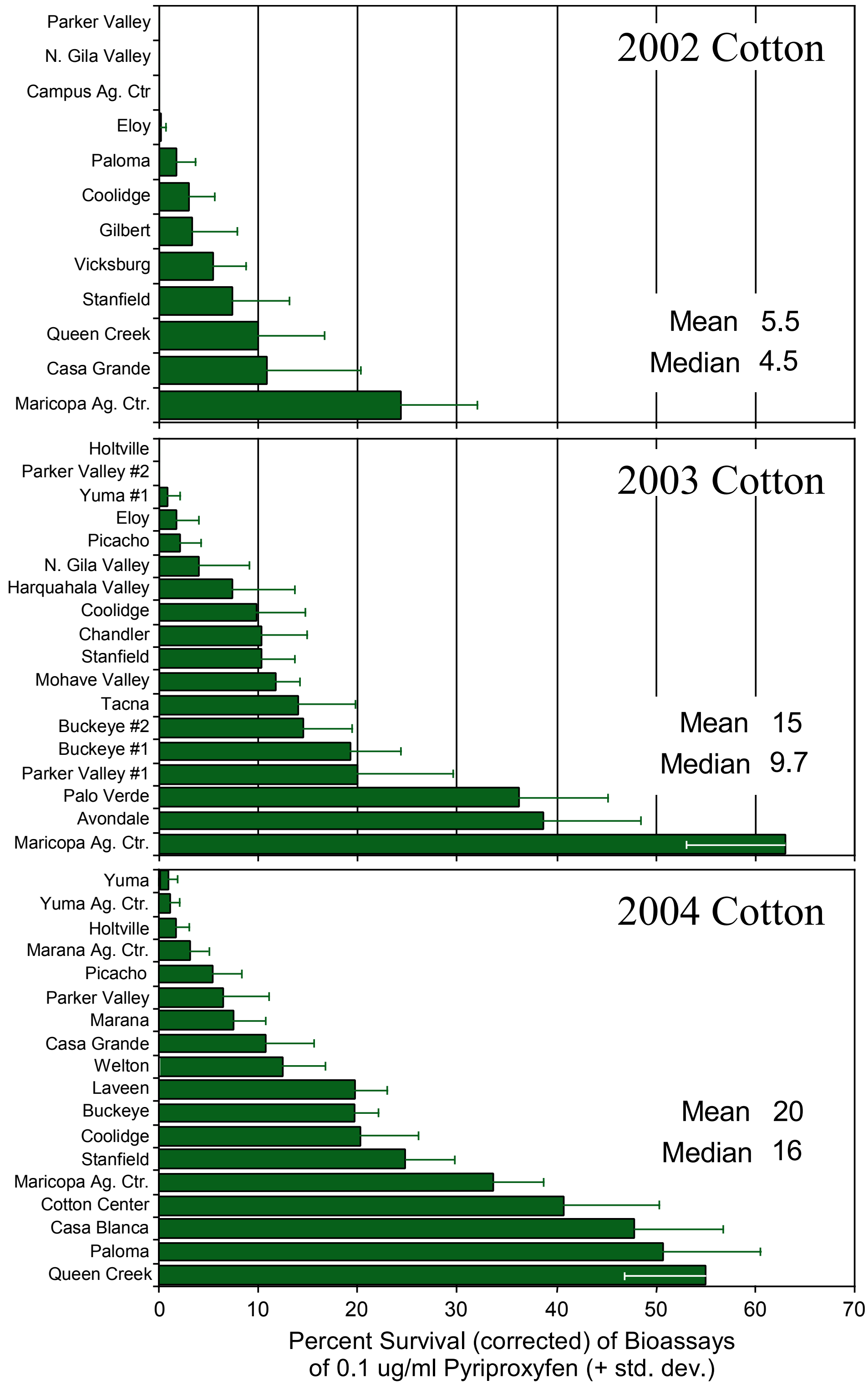

Figure 1c. Survival of discriminating-concentration bioassays of pyriproxyfen (Knack®) has increased significantly each of the past three years. In 2005, the highest levels of resistance were found in central Arizona samples collected from Paloma to Queen Creek.

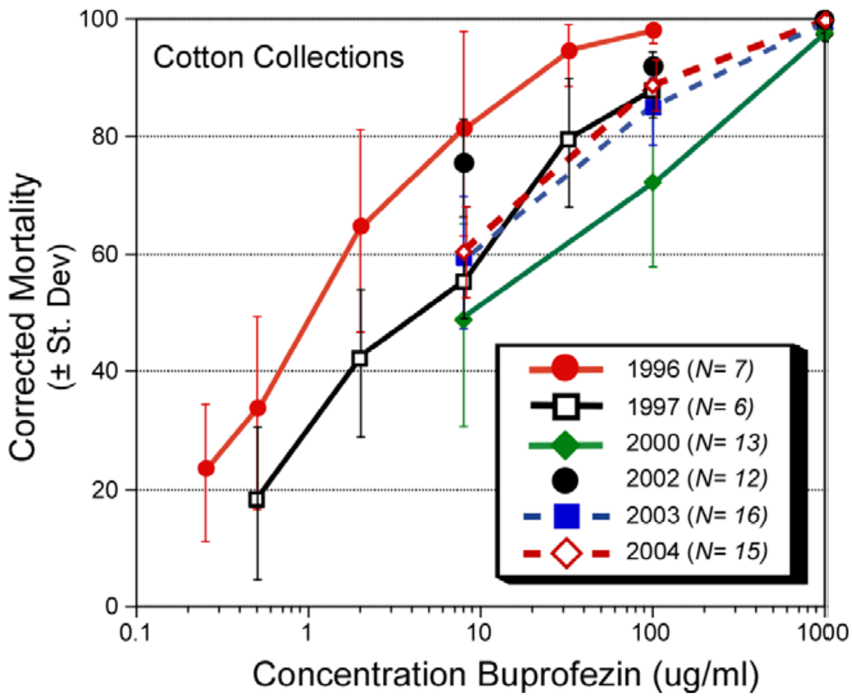

Figure 2. Whiteflies from Arizona cotton revealed no signs of resistance to buprofezin in 2004 (Courier®/Applaud®). Shown are grand mean corrected mortality (± standard deviation) values of whiteflies collected from Arizona cotton from 1996 through 2004 and bioassayed with buprofezin. Susceptibility declined moderately from 1996 to 2000 but has remained intermediate to this range in subsequent years.

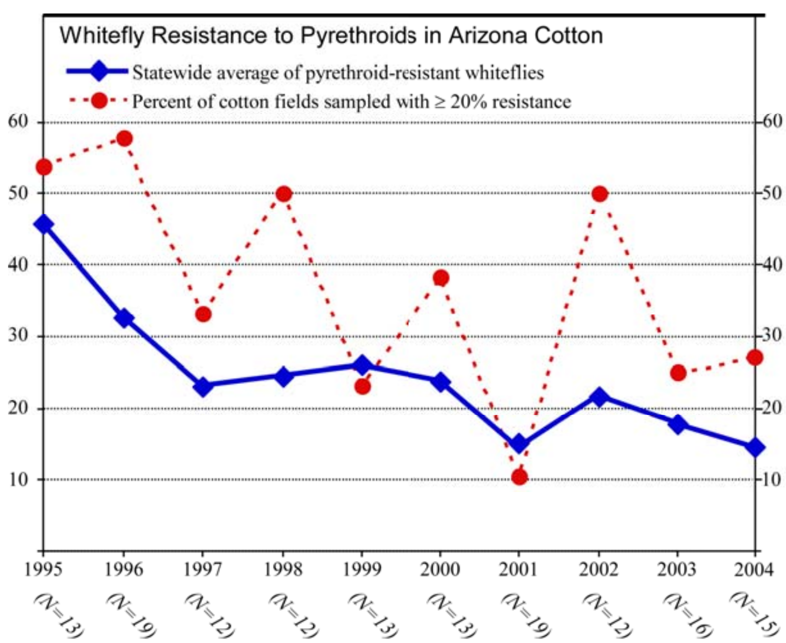

Figure 3a. Statewide averages of whitefly survival in bioassays of 10 µg/ml fenpropathrin (Danitol®) + 1000 µg/ml acephate (Orthene®) since 1995 (solid line). Resistance to synergized pyrethroids remained comparatively low in 2004. However, in some years, as many as half of Arizona fields evaluated (dashed line) had resistance levels above the critical frequency of 20% and, thus, too high to obtain adequate efficacy from synergized pyrethroids. The number of populations evaluated each year is noted.

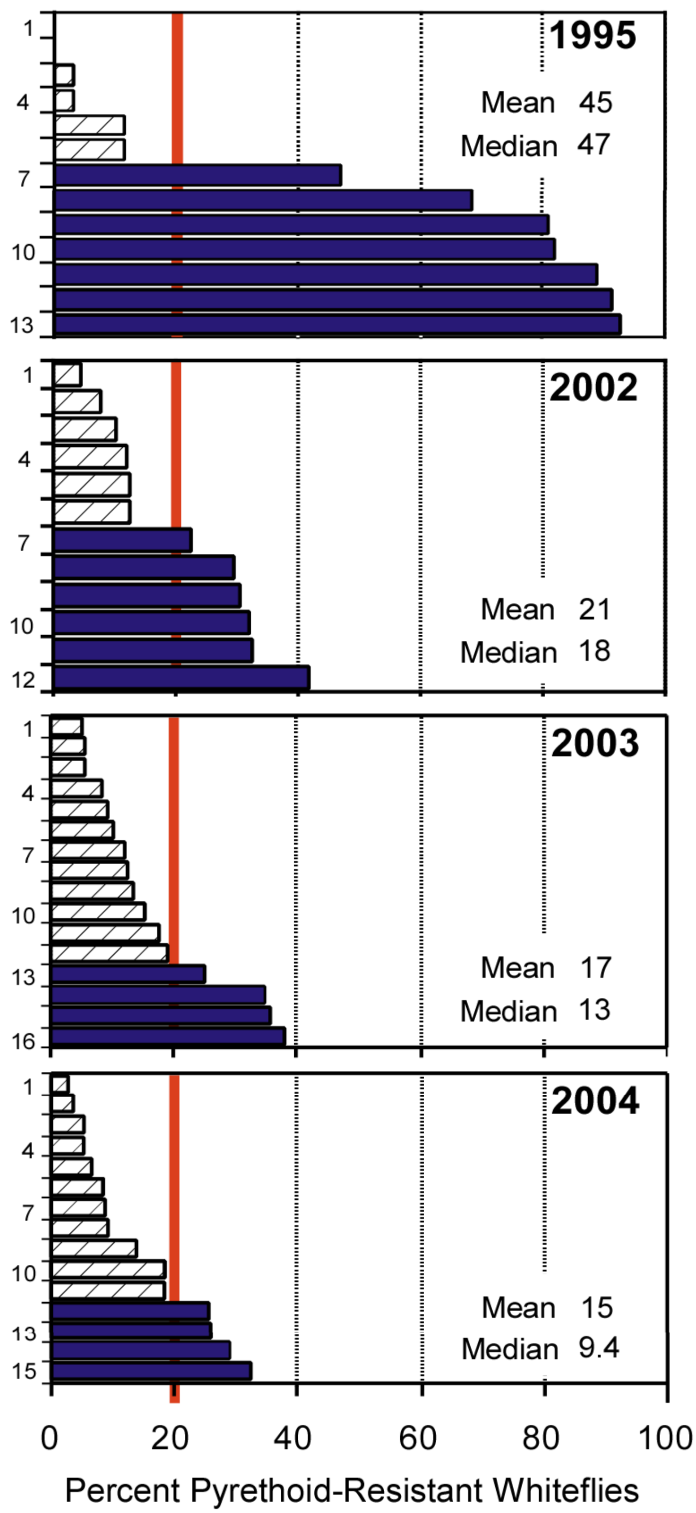

Figure 3b. Susceptibility to synergized pyrethroid insecticides of *Bemisia* collected from cotton in 1995 contrasted with 2002 to 2004. Shown is the percentage of whiteflies statewide surviving 10 µg/ml fenpropathrin (Danitol®) + 1000 µg/ml acephate (Orthene®). The vertical line at 20% indicates the critical frequency above which resistance demonstrably impairs field performance. In 2004 only 4 of 15 whitefly populations collected from cotton exceeded the critical frequency for resistance.

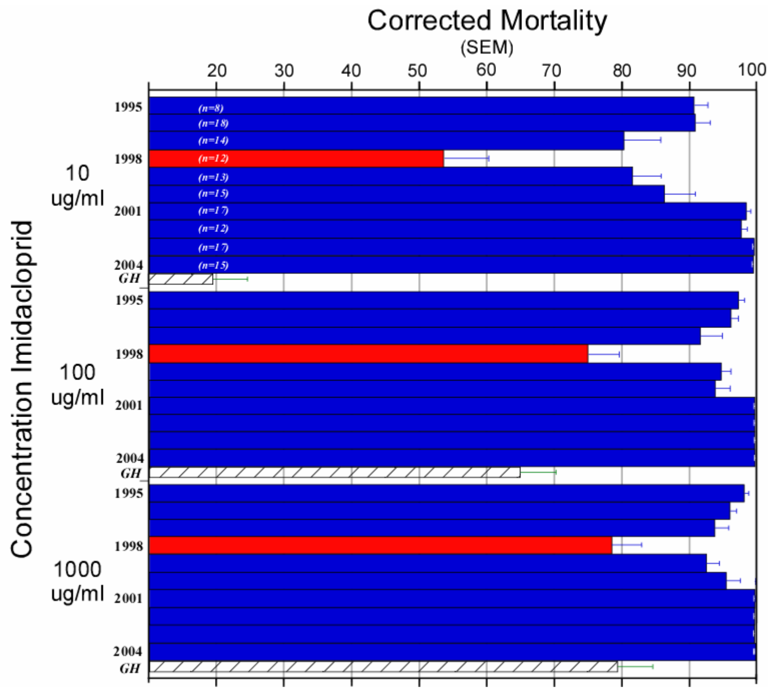

Figure 4a. Whiteflies from Arizona cotton were highly susceptible to imidacloprid (Admire®/Provado®) in 2004. Values from 1995 to 2004 are statewide averages of mortality in bioassays. Susceptibility declined sharply from 1995 to 1998 but was fully regained in subsequent years. The hatched bars labeled GH are the responses of the Q biotype of *Bemisia tabaci,* collected from poinsettia in December, 2004.

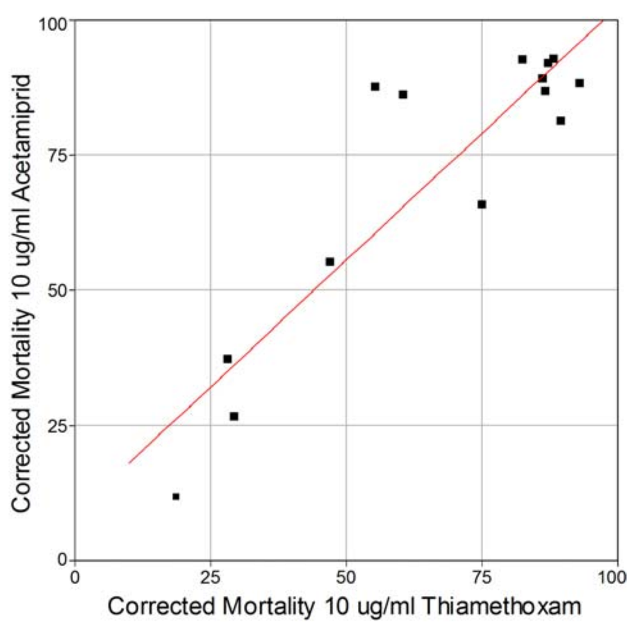

Figure 4b. Evidence of strong correlation in susceptibility to thiamethoxam and acetamiprid in whiteflies collected from cotton in 2004. Approximately 80% of the variation in mortality observed in 10 µg/ml acetamiprid bioassays was explained by the predictor variable of mortality in 10 µg/ml thiamethoxam bioassays (R^2=0.806). Data points shown are mean corrected mortalities for 14 collections from cotton. The regression was highly significant (*P<0.0001).*

Table 1a. Locations from which whiteflies were collected in 2004 and brought to the EARML facilities in Tucson for rearing and testing.

Location	*GPS ID*	*Host*	*Collection Date*
1. Casa Blanca, AZ	04-121	cotton	9/10/04
2. Casa Grande, AZ	04-124	cotton	9/20/04
3. Coolidge, AZ	04-122	cotton	9/10/04
4. Cotton Center, AZ	04-127	cotton	10/4/04
5. Holtville, CA	04-07	cotton	8/1/04
6. Laveen, AZ	04-128	cotton	10/18/04
7. Marana, AZ	04-130	cotton	10/19/04
8. Maricopa Agric. Center, AZ	04-119	cotton	8/18/04
9. Paloma, AZ	04-132	cotton	10/22/04
10. Parker Valley, AZ	04-15	cotton	9/26/04
11. Picacho, AZ	04-123	cotton	9/20/04
12. Queen Creek, AZ	04-120	cotton	8/30/04
13. Stanfield, AZ	04-126	cotton	10/4/04
14. Yuma, AZ	04-118	cotton	8/3/04
15. Yuma Agric. Center, AZ	04-117	cotton	8/3/04
16. Avondale, AZ	04-115	melons	6/22/04
17. Citrus Park, AZ	04-113	melons	6/14/04
18. Coolidge, AZ	04-116	melons	7/21/04
19. Harquahala Valley, AZ #1	04-114	melons	6/14/04
20. Harquahala Valley, AZ #2	04-125	melons	9/24/04
21. Marana Agric. Center, AZ	04-10	melons	8/24/04
22. Palo Verde Valley, CA	04-01	melons	6/22/04
23. Somerton, AZ	04-111	melons	6/3/04
24. Stanfield, AZ	04-112	melons	6/12/04
25. Wellton, AZ	04-109	melons	6/3/04
26. Yuma Agric. Center, AZ	04-110	melons	6/3/04
27. Maricopa Agric. Center, AZ	04-108	lantana	6/2/04
28. Phoenix, AZ, Wholesale GH	04-101	ruellia	2/10/04
29. Tucson, AZ, Retail GH #1	04-09	hibiscus	7/6/04
30. Tucson, AZ, Retail GH #2	04-104	lantana	4/12/04
31. Tucson, AZ, Retail GH #3	04-134	poinsettia	12/10/04
32. Tucson, AZ, Retail GH #4	04-135	poinsettia	12/10/04

Table 1b. Summary of bioassay methods employed for each insecticide tested against whiteflies in 2004.

	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 2004.

Collection #	Collection site	Host	Corrected Percent Mortality/Concentration Pyriproxyfen (µg/ml) 0	stdev	0.01	stdev	0.1	stdev	1	stdev	Biotype
04-03	Buckeye	cotton	4.76	4.75	28.8	10.8	80.2	7.03	95.5	2.25	B
04-121	Casa Blanca	cotton	4.49	3.52	6.74	4.36	52.1	8.46	*76.5*	7.94	B
04-124	Casa Grande	cotton	4.24	3.72	42.1	16.4	89.3	5.02	96.8	2.04	B
04-122	Coolidge	cotton	3.01	3.12	38.0	14.7	79.8	12.5	96.4	3.79	B
04-127	Cotton Center	cotton	3.43	4.00	20.5	7.36	59.2	7.40	89.1	2.66	B
04-07	Holtville, CA	cotton	7.71	7.89	4.83	5.94	98.5	1.50	100	0.00	B
04-128	Laveen	cotton	12.4	13.1	28.9	12.6	80.3	8.05	95.8	4.87	B
04-130	Marana	cotton	4.74	6.13	35.0	8.35	92.6	3.28	100	0.00	B
04-129	Marana Agric. Center	cotton	3.34	4.01	54.7	13.5	96.9	1.93	99.3	1.04	B
04-119	Maricopa Agric. Center	cotton	5.94	8.64	17.5	18.1	66.4	10.3	95.0	2.72	B
04-132	Paloma	cotton	15.6	9.81	4.79	7.58	49.2	11.2	84.5	5.94	B
04-15	Parker Valley	cotton	7.41	5.21	16.9	10.9	93.6	4.75	99.5	0.950	B
04-123	Picacho	cotton	6.87	5.51	60.8	17.9	94.7	3.06	98.8	1.10	B
04-120	Queen Creek	cotton	5.69	6.56	*3.50*	5.10	*44.8*	9.53	89.7	6.87	B
04-126	Stanfield	cotton	11.8	6.14	11.1	10.3	75.2	8.45	93.9	2.41	B
04-02	Wellton	cotton	*2.90*	2.83	11.9	10.4	87.7	4.44	97.5	1.77	B
04-118	Yuma	cotton	10.5	15.2	45.6	8.16	99.3	1.13	100	0.00	B
04-117	Yuma Agric. Center	cotton	6.77	6.29	39.2	12.1	99.0	0.960	100	0.00	B
		N	18		18		18		18		
		mean	**6.76**		**26.2**		**79.9**		**94.9**		
		median	5.82		24.7		84.0		96.6		
		minimum	2.90		3.50		44.8		76.5		
		std dev	3.63		17.9		18.3		6.35		
04-131*	**UA Campus Agric. Ctr.**		**15.8**	**3.91**	**4.20**	**3.99**	**16.2**	**2.34**	**58.0**	**9.34**	**B**

** this collection came from an experimental greenhouse in which the cotton had been treated 2 times with Knack.*

Table 2b. Susceptibility to pyriproxyfen (Knack®) of *B. tabaci* collected from melons in 2004.

			Corrected Percent Mortality/Concentration Pyriproxyfen (µg/ml)								
Collection #	Collection site	Host	**0**	stdev	**0.01**	stdev	**0.1**	stdev	**1**	stdev	Biotype
04-115	Avondale	melons	4.05	7.23	4.93	4.84	37.3	17.5	73.2	6.50	B
04-113	Citrus Park	melons	5.76	4.23	2.96	2.57	58.6	6.72	89.0	5.59	B
04-116	Coolidge	melons	13.1	7.96	19.1	17.5	90.4	8.12	98.9	1.19	B
04-114	Harquahala Valley #1	melons	38.8	4.22	15.9	13.3	90.9	7.15	99.3	1.71	B
04-125	Harquahala Valley #2	melons	4.17	4.76	5.60	6.76	55.9	7.62	84.5	4.43	B
04-10	Marana Ag. Center	melons	8.49	6.45	5.99	5.72	63.1	8.18	95.5	1.54	B
04-01	Palo Verde Valley, CA	melons	7.76	9.28	12.9	24.5	81.9	6.50	100	0.000	B
04-111	Somerton	melons	7.27	4.11	39.7	16.4	97.5	4.36	100	0.000	B
04-112	Stanfield	melons	4.75	10.5	19.0	11.8	85.7	4.98	92.9	8.46	B
04-109	Wellton	melons	9.01	9.92	13.6	13.3	87.3	2.67	93.7	3.67	B
04-110	Yuma Agric. Center	melons	4.18	4.68	18.2	11.0	97.3	2.58	99.8	0.590	B
		N	11		11		11		11		
		mean	**9.76**		**14.4**		**76.9**		**93.3**		
		median	7.27		13.6		85.7		95.5		
		minimum	4.05		2.96		37.3		73.2		
		std dev	10.0		10.4		19.9		8.49		

Table 2c. Susceptibility to pyriproxyfen (Knack®) of *B. tabaci* collected from greenhouse or ornamental plants in 2004.

			Corrected Percent Mortality/Concentration Pyriproxyfen (µg/ml)								
Collection #	Collection site	Host	**0**	stdev	**0.01**	stdev	**0.1**	stdev	**1**	stdev	Biotype
04-108	Maricopa Agric. Center	ornamental	6.78	4.59	1.11	2.73	33.0	11.3	55.7	9.65	B
04-101	Phoenix Area GH	ruellia	6.66	5.92	2.11	2.73	46.0	13.9	86.9	6.42	B
04-09	Tucson Retail GH #1	hibiscus	*3.96*	3.82	25.2	12.9	98.3	1.91	97.8	2.95	B
04-104	Tucson Retail GH #2	lantana	8.54	5.33	7.39	6.35	96.2	1.49	100	0.000	B
04-135	Tucson Retail GH #4	poinsettia	2.86	3.50	5.52	4.99	95.7	4.04	99.7	0.630	B
		N	5		5		5		5		
		mean	**5.76**		**8.3**		**73.8**		**88.0**		
		median	6.66		5.52		95.7		97.8		
		minimum	2.86		1.11		33.0		55.7		
		std dev	2.30		9.8		31.7		18.9		
04-134	***Tucson Retail GH #3***	***poinsettia***	***26.4***	***6.49***	***0.000***	***0.000***	***2.38***	***5.40***	***7.87***	***15.1***	***Q***

Table 3a. Susceptibility to buprofezin (Courier®/Applaud®) of *B. tabaci* collected from cotton in 2004.

			Corrected Percent Mortality/Concentration Buprofezin (µg/ml)								
Collection #	Collection site	Host	**0**	stdev	**8**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-121	Casa Blanca	cotton	9.52	7.00	55.7	7.96	*80.1*	8.31	*98.8*	1.30	B
04-124	Casa Grande	cotton	17.0	6.76	52.6	8.89	84.0	4.62	99.7	0.490	B
04-122	Coolidge	cotton	12.7	8.10	66.5	8.93	80.2	4.31	99.4	1.25	B
04-127	Cotton Center	cotton	6.94	6.15	64.1	10.9	92.3	5.34	100	0.000	B
04-07	Holtville, CA	cotton	26.0	11.5	48.4	4.27	83.9	4.20	100	0.000	B
04-128	Laveen	cotton	11.2	5.85	65.9	3.28	89.7	5.44	100	0.000	B
04-130	Marana	cotton	12.8	22.8	61.4	16.4	94.7	6.25	100	0.000	B
04-119	Maricopa Agric. Ctr.	cotton	12.2	7.80	58.3	7.94	91.9	5.95	99.9	1.30	B
04-132	Paloma	cotton	6.47	5.31	69.4	6.09	87.4	7.28	99.8	0.320	B
04-15	Parker	cotton	8.65	1.67	63.9	12.8	83.6	5.06	100	0.000	B
04-123	Picacho	cotton	10.1	6.22	68.2	8.60	89.0	5.35	100	0.000	B
04-120	Queen Creek	cotton	18.2	7.38	68.5	9.63	86.8	8.16	99.8	0.470	B
04-126	Stanfield	cotton	9.32	7.91	71.8	5.94	90.1	2.44	100	0.000	B
04-118	Yuma	cotton	11.7	7.11	56.8	6.92	86.4	6.43	99.2	1.26	B
04-117	Yuma Agric. Ctr.	cotton	*4.01*	1.44	*44.7*	10.8	83.0	10.5	99.8	0.390	B
		N	15		15		15		15		
		mean	**11.8**		**61.1**		**86.9**		**99.8**		
		median	11.2		63.9		86.8		99.9		
		minimum	4.01		44.7		80.1		98.8		
		std dev	5.40		8.09		4.41		0.354		

Table 3b. Susceptibility to buprofezin (Courier®/Applaud®) of *B. tabaci* collected from melons in 2004.

			Corrected Percent Mortality/Concentration Buprofezin (µg/ml)								
Collection #	Collection site	Host	**0**	stdev	**8**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-115	Avondale	melons	11.4	7.81	57.5	7.50	87.7	6.38	98.9	1.24	B
04-113	Citrus Park	melons	*7.51*	5.81	63.2	7.71	82.9	4.56	99.9	0.150	B
04-116	Coolidge	melons	33.5	18.6	64.1	27.0	79.7	14.8	100	0.000	B
04-114	Harquahala Vly #1	melons	8.04	3.17	43.8	9.80	72.6	7.83	99.8	0.550	B
04-125	Harquahala Vly #2	melons	14.7	17.0	62.8	8.84	81.7	6.55	100	0.000	B
04-10	Marana	melons	17.9	10.9	63.9	12.1	77.1	9.18	100	0.000	B
04-01	Palo Verde Vly, CA	melons	13.4	5.21	53.3	7.24	82.7	7.83	100	0.000	B
04-111	Somerton	melons	9.36	5.07	47.9	6.65	71.4	13.2	100	0.000	B
04-112	Stanfield	melons	14.3	9.20	60.9	6.12	84.0	8.39	99.9	0.200	B
04-109	Wellton	melons	12.4	8.51	56.7	15.5	77.6	5.61	100	0.000	B
04-110	Yuma Agric. Center	melons	16.3	12.4	56.7	6.41	72.2	7.86	100	0.000	B
		N	11		11		11		11		
		mean	**14.4**		**57.3**		**79.1**		**99.9**		
		median	13.4		57.5		79.7		100		
		minimum	7.51		43.8		71.4		98.9		
		std dev	7.13		6.75		5.35		0.331		

Table 3c. Susceptibility to buprofezin (Courier®/Applaud®) of *B. tabaci* collected from greenhouses or ornamental plants in 2004.

			Corrected Percent Mortality/Concentration Buprofezin (µg/ml)								
Collection #	Collection site	Host	**0**	stdev	**8**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-108	Maricopa Agric. Ctr.	ornamental	20.1	9.07	55.3	9.43	73.5	9.44	100	0.000	B
04-101	Phoenix Area GH	ruellia	15.9	12.2	71.3	6.77	80.5	13.4	100	0.000	B
04-104	Tucson GH #2	lantana	9.95	6.25	63.3	11.5	93.5	1.81	99.6	0.600	B
		N	3		3		3		3		
		mean	**15.3**		**63.3**		**82.5**		**99.9**		
		median	15.9		63.3		80.5		100		
		minimum	9.95		55.3		73.5		99.6		
		std dev	5.10		7.99		10.1		0.208		
04-134	***Tucson GH #3***	***poinsettia***	***20.4***	***6.24***	***4.14***	***5.61***	***17.1***	***23.6***	***34.5***	***27.1***	***Q***

Table 4a. Susceptibility to mixtures of fenpropathrin (Danitol®) + acephate (Orthene®) of *B. tabaci* collected from cotton in 2004.

			Corrected Percent Mortality/Concentration Fenpropathrin (µg/ml) + 1000 µg/ml Acephate						
Collection #	Collection site	Host	**0**	stdev	**10**	stdev	**100**	stdev	Biotype
04-121	Casa Blanca	cotton	8.60	14.6	81.5	10.0	*93.2*	6.81	B
04-124	Casa Grande	cotton	6.82	8.24	90.7	4.63	100	0.000	B
04-122	Coolidge	cotton	5.57	3.74	86.0	6.68	98.0	2.24	B
04-127	Cotton Center	cotton	7.07	4.67	93.2	5.11	99.3	1.76	B
04-07	Holtville, CA	cotton	4.80	2.54	74.1	10.4	98.8	2.86	B
04-128	Laveen	cotton	6.86	6.44	74.5	13.9	94.7	2.68	B
04-130	Marana	cotton	4.42	4.59	94.2	4.97	96.7	4.07	B
04-132	Paloma	cotton	3.94	4.59	96.1	3.23	99.1	2.12	B
04-15	Parker Valley	cotton	3.40	3.96	*67.4*	9.35	93.6	4.59	B
04-123	Picacho	cotton	13.3	8.26	97.0	3.65	100	0.000	B
04-120	Queen Creek	cotton	*1.83*	2.01	94.1	4.87	100	0.000	B
04-119	Somerton	cotton	6.51	5.73	81.6	8.70	96.7	5.19	B
04-126	Stanfield	cotton	8.76	4.47	90.8	7.29	96.3	5.32	B
04-118	Yuma	cotton	3.96	5.82	91.3	7.88	98.3	4.25	B
04-117	Yuma Agric. Center	cotton	4.22	3.93	71.0	11.3	96.1	3.46	B
		N	15		15		15		
		mean	**6.00**		**85.6**		**97.4**		
		median	5.57		90.7		98.0		
		minimum	1.83		67.4		93.2		
		std dev	2.80		9.87		2.29		

Table 4b. Susceptibility to mixtures of fenpropathrin (Danitol®) + acephate (Orthene®) of *B. tabaci* collected from melons in 2004.

		Corrected Percent Mortality/Concentration Fenpropathrin (µg/ml)+ 1000 µg/ml Acephate							
Collection #	Collection site	Host	**0**	stdev	**10**	stdev	**100**	stdev	Biotype
04-115	Avondale	Melons	1.74	7.93	73.3	9.73	94.5	3.27	B
04-113	Citrus Park	Melons	*0.000*	0.000	90.2	15.0	99.0	2.55	B
04-116	Coolidge	Melons	1.67	2.79	54.8	10.6	82.0	6.72	B
04-114	Harquahala Valley #1	Melons	3.12	4.01	74.0	11.8	94.7	4.85	B
04-125	Harquahala Valley #2	Melons	10.7	9.81	92.2	4.88	100	0.000	B
04-10	Marana Agric. Center	Melons	5.92	6.97	89.4	6.15	98.5	2.35	B
04-01	Palo Verde Valley, CA	Melons	1.33	3.27	68.1	4.62	84.7	13.2	B
04-111	Somerton	Melons	3.42	5.88	53.7	18.4	79.3	8.50	B
04-112	Stanfield	Melons	0.830	2.04	83.3	12.1	96.7	6.08	B
04-109	Wellton	Melons	1.75	2.96	78.7	11.6	91.8	7.18	B
04-110	Yuma Agric. Center	Melons	*0.000*	0.000	63.5	7.73	86.2	14.3	B
		N	11		11		11		
		mean	**2.77**		**74.7**		**91.6**		
		median	1.74		74.0		94.5		
		minimum	0.000		53.7		79.3		
		std dev	3.14		13.6		7.31		

Table 4c. Susceptibility to mixtures of fenpropathrin (Danitol) + acephate (Orthene) of *B. tabaci* collected from greenhouse or ornamental plants in 2004.

			Corrected Percent Mortality/Concentration Fenpropathrin (µg/ml)+ 1000 µg/ml Acephate						
Collection #	Collection site	Host	**0**	stdev	**10**	stdev	**100**	stdev	Biotype
04-108	Maricopa Agric. Center	ornamental	3.50	3.86	87.3	6.43	94.9	6.16	B
04-101	Phoenix Area GH	Ruellia	4.69	5.69	78.3	9.50	88.7	5.11	B
04-104	Tucson Retail GH #2	Lantana	14.0	5.64	20.8	19.3	93.0	4.97	B
04-135	Tucson Retail GH #4	Poinsettia	2.70	2.13	97.8	3.85	100	0.000	B
		N	4		4		4		
		mean	**6.22**		**71.0**		**94.1**		
		median	4.10		82.8		93.9		
		minimum	2.70		20.8		88.7		
		std dev	5.24		34.4		4.68		
04-134	***Tucson Retail GH #3***	***Poinsettia***	***3.32***	***2.75***	***4.84***	***6.49***	***7.61***	***8.53***	***Q***

Table 5a. Susceptibility to imidacloprid (Admire/Provado) of *B. tabaci* collected from cotton in 2004.

			Corrected Percent Mortality/Concentration Imidacloprid (µg/ml)										
Collection #	Collection site	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-121	Casa Blanca	cotton	2.16	3.01	87.8	10.2	98.9	2.43	99.9	1.08	100	0.000	B
04-124	Casa Grande	cotton	8.49	8.18	91.2	8.35	99.0	3.24	100	0.000	100	0.000	B
04-122	Coolidge	cotton	3.08	3.98	96.4	3.80	98.5	2.79	100	0.000	100	0.000	B
04-127	Cotton Center	cotton	10.1	7.73	99.5	1.46	100	0.000	100	0.000	100	0.000	B
04-07	Holtville, CA	cotton	8.86	12.5	88.0	14.3	96.8	8.17	100	0.000	100	0.000	B
04-128	Laveen	cotton	*1.71*	2.82	82.6	12.4	98.1	3.28	100	0.000	99.5	1.53	B
04-130	Marana	cotton	5.35	4.81	97.7	3.48	100	0.000	100	0.000	99.6	1.39	B
04-119	Maricopa Agric. Ctr.	cotton	7.26	7.41	75.7	12.1	98.4	2.02	99.6	1.26	100	0.000	B
04-132	Paloma	cotton	5.47	6.46	95.9	8.17	100	0.000	100	0.000	100	0.000	B
04-15	Parker Valley	cotton	6.70	7.39	91.0	10.0	100	0.000	100	0.000	100	0.000	B
04-123	Picacho	cotton	5.47	5.02	97.0	3.48	100	0.000	100	0.000	100	0.000	B
04-120	Queen Creek	cotton	1.98	5.07	*66.1*	14.9	99.5	1.47	*99.6*	1.34	100	0.000	B
04-126	Stanfield	cotton	5.97	3.49	98.3	3.68	99.6	1.20	100	0.000	100	0.000	B
04-118	Yuma	cotton	3.72	4.52	85.3	23.8	97.6	5.67	100	0.000	*99.4*	1.82	B
04-117	Yuma Agric. Center	cotton	4.19	5.10	84.3	23.3	*96.2*	6.63	100	0.000	100	0.000	B
		N	15		15		15		15		15		
		mean	**5.36**		**89.1**		**98.8**		**99.9**		**99.9**		
		median	5.47		91.0		99.0		100		100		
		minimum	1.71		66.1		96.2		99.6		99.4		
		std dev	2.59		9.38		1.23		0.147		0.209		

Table 5b. Susceptibility to imidacloprid (Admire/Provado) of *B. tabaci* collected from melons in 2004.

			Corrected Percent Mortality/Concentration Imidacloprid (µg/ml)										
Collection #	Collection site	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-115	Avondale	melons	2.30	2.47	95.8	5.33	99.5	1.47	100	0.000	100	0.000	B
04-113	Citrus Park	melons	0.830	2.64	98.6	4.56	100	0.000	100	0.000	100	0.000	B
04-116	Coolidge	melons	1.57	2.77	50.5	14.6	83.5	5.54	95.2	4.39	95.4	4.37	B
04-114	Harquahala Valley #1	melons	*0.670*	2.11	44.2	17.9	88.0	11.9	96.8	5.49	99.3	2.12	B
04-125	Harquahala Valley #2	melons	4.67	6.82	86.2	6.89	99.6	1.33	100	0.000	100	0.000	B
04-10	Marana Agric. Center	melons	8.26	7.21	100	0.000	100	0.000	100	0.000	100	0.000	B
04-01	Palo Verde Valley, CA	melons	1.90	2.55	89.8	8.05	100	0.000	100	0.000	100	0.000	B
04-111	Somerton	melons	3.38	6.51	87.0	20.7	98.6	3.06	100	0.000	92.2	11.1	B
04-112	Stanfield	melons	2.99	3.33	72.1	23.3	95.7	5.07	100	0.000	100	0.000	B
04-109	Wellton	melons	9.39	8.39	94.3	4.44	99.3	2.33	100	0.000	100	0.000	B
04-110	Yuma Agric. Center	melons	5.42	6.45	89.9	5.72	95.7	5.52	99.5	1.67	97.9	3.43	B
		N	11		11		11		11		11		
		mean	**3.76**		**82.6**		**96.3**		**99.2**		**98.6**		
		median	2.99		89.8		99.3		100		100		
		minimum	0.670		44.2		83.5		95.2		92.2		
		std dev	2.91		19.0		5.57		1.64		2.57		

Table 5c. Susceptibility to imidacloprid (Admire/Provado) of *B. tabaci* collected from greenhouse or ornamental plants in 2004.

			Corrected Percent Mortality/Concentration Imidacloprid (µg/ml)										
Collection #	Collection site	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-108	Maricopa Agric. Center	ornamental	2.85	2.52	95.0	5.20	97.9	4.04	100	0.000	100	0.000	B
04-101	Phoenix Area GH	ruellia	4.73	4.70	40.2	19.6	93.3	7.45	99.3	2.07	97.2	4.90	B
04-104	Tucson Retail GH #2	lantana	1.01	2.47	56.2	12.0	98.6	2.23	100	0.000	100	0.000	B
04-135	Tucson Retail GH #4	poinsettia	3.14	5.44	61.7	20.2	91.6	7.41	99.4	2.04	100	0.000	B
		N	4		4		4		4		4		
		mean	**2.93**		**63.3**		**95.4**		**99.7**		**99.3**		
		median	3.00		58.9		95.6		100		100		
		minimum	1.01		40.2		91.6		99.3		97.2		
		std dev	1.53		23.0		3.44		0.384		1.40		
04-134	***Tucson Retail GH #3***	***poinsettia***	***3.38***	***6.51***	***1.24***	***3.03***	***18.8***	***15.7***	***64.6***	***18.2***	***79.3***	***14.5***	***Q***

Table 6a. Susceptibility to Thiamethoxam (Actera/Centric/Platinum) of *B. tabaci* collected from cotton in 2004.

			Corrected Percent Mortality/Concentration Thiamethoxam (µg/ml)										
Collection #	Collection site	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-121	Casa Blanca	cotton	6.29	5.24	28.2	16.5	89.5	6.24	99.3	1.82	100	0.000	B
04-124	Casa Grande	cotton	2.64	3.18	34.9	15.7	86.7	6.55	99.3	1.61	100	0.000	B
04-122	Coolidge	cotton	3.76	2.54	67.3	20.0	93.1	5.66	99.4	1.57	100	0.000	B
04-127	Cotton Center	cotton	4.72	4.67	17.8	8.06	55.3	23.2	90.0	9.19	100	0.000	B
04-07	Holtville, CA	cotton	2.03	3.25	*3.75*	4.22	*18.7*	7.13	*72.0*	11.9	99.3	1.74	B
04-128	Laveen	cotton	3.34	2.64	15.4	13.7	60.5	7.11	89.1	9.60	98.6	2.79	B
04-130	Marana	cotton	33.5	4.10	34.4	15.1	86.2	6.57	98.6	2.23	100	0.000	B
04-119	Maricopa Agric. Ctr.	cotton	2.54	2.79	10.5	8.58	47.1	13.1	77.2	11.1	*97.4*	4.29	B
04-132	Paloma	cotton	7.50	5.24	19.5	15.8	87.2	10.1	99.1	2.32	100	0.000	B
04-15	Parker Valley	cotton	7.72	4.69	37.3	19.0	82.6	17.9	100	0.000	100	0.000	B
04-123	Picacho	cotton	3.75	3.38	62.7	20.2	88.2	6.77	99.4	1.57	100	0.000	B
04-120	Queen Creek	cotton	*1.92*	2.11	17.3	15.8	75.0	15.7	98.8	1.88	100	0.000	B
04-126	Stanfield	cotton	2.50	4.18	5.22	6.92	29.4	16.4	82.5	12.5	99.2	1.99	B
04-118	Yuma	cotton	2.50	6.12	12.8	9.72	28.2	9.50	81.2	11.5	97.5	2.91	B
		N	14		14		14		14		14		
		mean	**6.05**		**26.2**		**66.3**		**91.8**		**99.4**		
		median	3.55		18.7		78.8		98.7		100		
		minimum	1.92		3.75		18.7		72.0		97.4		
		std dev	8.12		19.6		26.2		9.83		0.934		

Table 6b. Susceptibility to Thiamethoxam (Actera/Centric/Platinum) of *B. tabaci* collected from melons in 2004.

			Corrected Percent Mortality/Concentration Thiamethoxam (µg/ml)										
Collection #	Collection site	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-115	Avondale	melons	2.83	3.91	16.5	5.34	80.8	10.7	100	0.000	100	0.000	B
04-113	Citrus Park	melons	*0.000*	0.000	5.57	8.65	55.6	17.2	99.1	2.27	100	0.000	B
04-116	Coolidge	melons	3.42	4.26	12.2	7.29	48.0	7.00	71.8	11.9	97.1	3.16	B
04-114	Harquahala Valley #1	melons	3.27	4.19	11.5	10.8	50.1	11.5	91.7	3.83	98.3	2.63	B
04-125	Harquahala Valley #2	melons	2.82	3.14	21.6	15.2	70.0	14.5	96.2	2.98	100	0.000	B
04-10	Marana Agric. Center	melons	7.00	4.61	63.0	11.0	97.5	4.12	100	0.000	100	0.000	B
04-01	Palo Verde Valley, CA	melons	0.000	0.000	16.0	10.5	68.6	15.9	99.3	1.70	100	0.000	B
04-112	Stanfield	melons	0.000	0.000	2.31	2.54	26.7	13.7	74.4	7.38	100	0.000	B
04-109	Wellton	melons	3.19	4.66	34.0	19.7	70.8	10.2	98.7	2.06	99.3	1.62	B
04-110	Yuma Agric. Center	melons	5.18	4.12	7.41	9.72	33.3	7.32	89.4	13.3	98.2	2.77	B
		N	10		10		10		10		10		
		mean	**2.77**		**19.0**		**60.1**		**92.1**		**99.3**		
		median	3.01		14.1		62.1		97.4		100		
		minimum	0.000		2.31		26.7		71.8		97.1		
		std dev	2.30		17.9		21.6		10.6		1.04		

Table 6c. Susceptibility to Thiamethoxam (Actera/Centric/Platinum) of *B. tabaci* collected from greenhouse or ornamental plants in 2004.

			Corrected Percent Mortality/Concentration Thiamethoxam (µg/ml)										
Collection #	Collection site	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-108	Maricopa Agric. Center	ornamental	8.98	6.00	22.0	15.9	49.2	7.92	84.8	9.12	96.8	5.08	B
04-101	Phoenix Area GH	ruellia	2.22	5.44	21.0	4.13	80.1	15.9	93.0	9.06	100	0.000	B
04-104	Tucson Retail GH #2	lantana	8.69	5.39	*0.000*	0.000	30.0	18.6	76.9	7.94	98.5	3.73	B
04-135	Tucson Retail GH #4	poinsettia	1.71	2.65	16.2	14.2	71.4	7.22	98.5	2.39	100	0.000	B
		N	4		4		4		4		4		
		mean	**5.40**		**14.8**		**57.7**		**88.3**		**98.8**		
		median	5.46		18.6		60.3		88.9		99.2		
		minimum	1.71		0.000		30.0		76.9		96.8		
		std dev	3.97		10.2		22.6		9.41		1.54		
04-134	***Tucson Retail GH #3***	***poinsettia***	***1.42***	***2.21***	***3.53***	***3.42***	***3.51***	***3.47***	***11.5***	***4.86***	***78.3***	***15.0***	***Q***

Table 7a. Susceptibility to acetamiprid (Intruder) of *B. tabaci* collected from cotton in 2004.

			Corrected Percent Mortality/Concentration Acetamiprid (µg/ml)										
Collection #	Collection site	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-121	Casa Blanca	cotton	5.33	5.26	20.7	16.4	81.2	4.18	97.4	2.15	*96.9*	2.72	B
04-124	Casa Grande	cotton	1.08	2.63	13.4	5.96	86.7	8.99	97.4	1.99	100	0.000	B
04-122	Coolidge	cotton	5.21	6.83	10.2	11.3	88.3	9.82	98.6	2.19	100	0.000	B
04-127	Cotton Center	cotton	1.26	1.96	22.2	13.5	87.6	6.98	97.6	2.84	97.6	1.97	B
04-07	Holtville, CA	cotton	*0.670*	1.63	*2.33*	2.98	*11.8*	4.48	*83.8*	6.07	98.5	2.36	B
04-128	Laveen	cotton	2.46	4.63	15.7	7.75	86.1	13.1	98.5	2.32	98.8	1.86	B
04-130	Marana	cotton	0.880	2.15	33.6	21.6	89.0	12.1	100	0.000	100	0.000	B
04-119	Maricopa Agric. Ctr.	cotton	2.54	2.79	17.5	12.5	55.1	6.99	89.6	7.28	100	0.000	B
04-132	Paloma	cotton	4.22	6.13	22.0	17.7	91.8	12.4	98.2	2.79	100	0.000	B
04-15	Parker Valley	cotton	2.94	3.43	28.1	14.4	92.6	7.09	100	0.000	100	0.000	B
04-123	Picacho	cotton	3.26	4.51	12.3	11.7	92.8	9.70	98.6	2.11	100	0.000	B
04-120	Queen Creek	cotton	2.54	3.13	23.1	11.6	65.7	22.9	95.8	4.62	100	0.000	B
04-126	Stanfield	cotton	0.760	1.86	2.63	3.18	26.6	12.1	86.0	11.4	97.0	4.24	B
04-118	Yuma	cotton	1.32	2.15	4.23	4.19	37.3	17.8	89.9	7.02	99.3	1.65	B
	N		14		14		14		14		14		
	Mean		**2.46**		**16.3**		**70.9**		**95.1**		**99.1**		
	median		2.50		16.6		86.4		97.5		100		
	minimum		0.670		2.33		11.8		83.8		96.9		
	std dev		1.59		9.45		27.4		5.41		1.20		

Table 7b. Susceptibility to acetamiprid (Intruder) of *B. tabaci* collected from melons in 2004.

			Corrected Percent Mortality/Concentration Acetamiprid (µg/ml)										
Collection #	Collection site	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-115	Avondale	melons	0.670	1.63	28.0	19.9	90.9	11.1	100	0.000	100	0.000	B
04-113	Citrus Park	melons	2.94	7.20	7.33	11.7	73.7	6.72	99.2	2.00	100	0.000	B
04-116	Coolidge	melons	4.15	2.07	4.36	4.07	44.2	14.8	85.8	8.30	99.2	1.94	B
04-114	Harquahala Vly #1	melons	*0.000*	0.000	9.92	8.01	58.3	12.8	90.6	8.24	96.1	2.33	B
04-125	Harquahala Vly	melons	0.000	0.000	3.81	3.27	60.0	22.6	86.1	14.0	98.2	1.99	B
04-10	Marana Agric. Ctr.	melons	7.97	15.8	56.3	16.8	99.3	1.77	100	0.000	100	0.000	B
04-01	Palo Verde Vly, CA	melons	4.03	6.20	22.6	17.5	85.9	10.1	100	0.000	100	0.000	B
04-112	Stanfield	melons	3.30	3.62	*0.000*	0.000	43.2	14.3	95.1	5.69	97.1	3.36	B
04-109	Wellton	melons	3.71	5.54	47.2	19.5	92.5	2.43	98.6	2.19	100	0.000	B
04-110	Yuma Agric. Ctr.	melons	4.04	4.87	25.1	17.1	70.3	21.5	93.9	6.04	100	0.000	B
		N	10		10		10		10		10		
		mean	**3.08**		**20.4**		**71.8**		**94.9**		**99.1**		
		median	3.51		16.3		72.0		96.8		100		
		minimum	0.000		0.000		43.2		85.8		96.1		
		std dev	2.41		19.2		20.1		5.68		1.45		

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

Collection #	Collection site	Host	**0**	stdev	**1**	stdev	**10**	stdev	**100**	stdev	**1000**	stdev	Biotype
04-108	Maricopa Agric. Ctr.	ornamental	8.98	6.00	17.0	14.9	61.2	12.8	89.5	6.41	97.4	2.94	B
04-101	Phoenix Area GH	ruellia	2.22	5.44	7.26	8.30	42.5	9.19	96.3	3.83	97.5	3.91	B
04-104	Tucson GH #2	lantana	8.69	5.39	19.8	18.5	61.2	25.0	97.2	6.88	100	0.000	B
04-135	Tucson GH #4	poinsettia	0.760	1.86	7.78	9.07	84.6	4.88	99.2	1.96	100	0.000	B
		N	4		4		4		4		4		
		mean	**5.16**		**12.9**		**62.4**		**95.6**		**98.7**		
		median	5.46		12.4		61.2		96.8		98.7		
		minimum	0.760		7.26		42.5		89.5		97.4		
		std dev	4.28		6.44		17.2		4.19		1.47		
04-134	***Tucson GH #3***	***poinsettia***	***3.14***	***3.87***	***3.64***	***5.04***	***1.93***	***4.37***	***25.8***	***8.34***	***62.0***	***24.6***	***Q***