Use of Treated-vial Technique to Determine Efficacy of Several Insecticides Against the Sweetpotato Whitefly, Bemisia tabaci (Gennad.)

S. Sivasupramaniam, S. E. Kelly, D. Cross, J. Brown and T. F. Watson

Abstract

A treated-vial technique was used to bioassay insecticide susceptibility of sweet potato whitefly populatons occurring on different hosts and at different locations in southern Arizona. All insecticides tested proved to be efficacious against the sweetpotato whitefly. Combinations improved efficacy, for example, Orthene to Danitol and DEF to Baythroid. Three important factors appeared to affect efficacy: 1) geographic site; 2) host plant of SPWF; and, 3) time of season. Further detailed experimentation needs to be done to elucidate the reasons for this.

Introduction

A vital part in using resistance data in IPM programs which are developed for crops is the development of monitoring techniques that allow rapid and accurate detection of resistance in the pest. The standard topical application procedure is not suited for the processing of large numbers of field samples. Recently, residual bioassays and diagnostic doses for spider mites and tobacco budworms have been developed and used in resistance detection programs. These field techniques are inexpensive and rapidly conducted.

Moreover, in contrast to topical applications on tobacco budworm larvae, Roush and Luttrell (1989) determined that results with adults in glass vials were in very close agreement (within 10%) with cotton terminal bioassays (on larvae) at standard field rates. Although the pest was tested at different life stages, they feel that the excellent correlation obtained may be because both are residual techniques. Thus, the treated-vial techniques was tested for validity against the sweetpotato whitefly and results are reported.

Experimental Procedure

A glass-vial technique developed in Texas to test for resistance to pyrethroid insecticides in the tobacco budworm was used in the field to determine susceptibility levels of whitefly adults to Danitol, Danitol + Orthene, Baythroid, Baythroid + DEF, and Capture. Tests were conducted in August and September 1991 in Phoenix (on cotton), Maricopa Agricultural Center (on cotton, melon and buffalo gourd) and at the Yuma Valley Agricultural Center (on cotton, okra and peanuts).

Two-dram, screw-cap, glass vials (r=0.65 cm, h=4.5 cm) were used in the study. Desired chemical residues were achieved by evaporating 125ul of the given concentration of the chemical in acetone and rotating the vial to provide uniform coverage. Vials were prepared in advance in the laboratory.

Twenty-five to thirty unsexed whiteflies were aspirated in the field, and directly transferred to the vial. The vials were capped and held out of direct sunlight at 20-30°C for 6 hours.

Both (moribund) and dead whiteflies were considered as responding to the various treatments. The insects were scored as moribund if they could not fly or walk even short distances when the vial was held horizontally and gently taped. This was considered to be a more practical criterion for assessment of mortality.

Data collected in these monitoring studies consisted of date, location, crop, time of collection, and schedule of insecticide spray applied to the field.

Points to Note

* Whiteflies were not fed during the experiment.
* Best results were obtained at the end of 6h. Control mortality remained less than 10%.
* It was initially decided to test whiteflies at 8 rates, in order to construct does-mortality lines and determine the level of resistance in entire populations. However, it was soon obvious that with field populations (mixtures of susceptible and resistant insects, different age groups, and both sexes, the use of dose-mortality lines would be an inappropriate way to analyze data. It has been suggested that it is possible to detect resistance in field populations using 1 or 2 discriminatory doses.

Results and Discussion

Figure 1 presents the results of treated-vial testing of adult sweetpotato whitefly with Danitol. This figure shows the effect of location and time-of-season on susceptibility of SPWF collected from cotton. The Phoenix population, for both collection dates, were more susceptible than either of the Yuma or Maricopa Agricultural Center (MAC) populations. The MAC population at the end of the season (9/11/91) was more resistant to Danitol than that at the earlier date (8/15/91) while the opposite was true with the Yuma populations. An observation of unknown significance relative to this concerns the maturity of the cotton at the two locations; at Yuma, the cotton was older and near time for defoliation while at MAC it was considerably younger.

Figure 2 may be indicative of host-plant influence on susceptibility of SPWF to insecticides, in this case Danitol. For example, SPWF collected from okra and peanuts at Yuma were considerably more resistant than those from cotton. The okra population was sampled on a different date and may have had some influence on the results. The melon population at MAC appeared to be more susceptible than that from either cotton or buffalo gourd.

Field trials at Yuma indicated that the combination of Danitol and Orthene was more effective for SPWF control than was either alone. Figure 3 presents data in close agreement with the field results. With the combination, almost identical results were obtained from the two sample dates on cotton (8/15 and 9/11) at MAC while the sample-data effect was strikingly different with Danitol alone, especially at the higher concentrations. The combination was also more effective on SPWF from cotton collected at both Yuma and Phoenix.

Figure 4 shows that most populations, regardless of SPWF host, were more susceptible to the Danitol-Orthene combination than to Danitol alone. This was clearly shown with those from peanuts and buffalo gourd. the okra population appeared to be the most resistant and was the one showing less difference between Danitol alone and the combination.

Baythroid was another insecticide used in the vial testing. Figures 5 and 6 show these results. Figure 5 shows that the Phoenix population from cotton was more susceptible than either the Yuma or MAC population. Relatively little difference was shown between the two sample dates for the Phoenix population. This was also true for the Yuma population. The MAC population was the most resistant, particularly the one collected on 8/15/91. In general, Baythroid was slightly less toxic than was Danitol or Danitol+Orthene. Figure 6 shows that SPWF on okra at Yuma was most resistant to Baythroid, followed by populations on melon and cotton at MAC. Populations showing an intermediate level of tollerance occurred on peanuts at Yuma and buffalo gourd at MAC while the most susceptible population was found on cotton at Yuma.

The incorporation of DEF with Baythroid resulted in much higher toxicity, suggesting that esterases are likely to be involved in resistance to Baythroid. Figure 7 shows that Yuma (9/18) and Phoenix (9/25) population from cotton are less susceptible than populations from cotton in other areas or other dates. Figure 8 shows that populations from Melon at MAC (8/9) were the most resistant and more resistant than cotton populations from MAC (8/15). Populations from peanuts and cotton at Yuma, both sampled on 9/18, were very similar in susceptibility. Of interest here, is the greater susceptibility of populations on okra relative to that of other host populations. This is contrary to results with other chemicals.

A comparison of insecticide efficacy using the treated-vial technique against adult SPWF shows Capture to be a highly toxic compound. Figure 9 shows an extremely high level of mortality at the lowest concentration in all populations except the cotton population at MAC (8/15). Similarly, Figure 10 shows Capture to result in high mortality at the lowest concentration in populations from several hosts. Again, The MAC cotton population (8/15) was the most tolerant.

Figures 11 and 12 show comparable data to that shown in Figures 9 and 10, respectively, with the exception of the type of treated container. In this part of the experiment, treated tubes were compared with the treated vials used in the previously-discussed results. With the tubes lower mortality was obtained than with the vials. This was to be expected since the tubes were larger and the concentration per unit area was less.

Summary Statements and Conclusions

1. If only limited discriminatory dosage concentrations are to be used in a practical monitoring program, it is suggested that two doses be utilized, one giving approximately 50% mortality and another about 80%. In many instances, differences in susceptibility levels are more obvious at higher doses.

2. Susceptibility differences were found between populations of SPWF from different crops, location and dates. A monitoring program would need to be aware of and utilize these variables in formulating recommendations.

3. These data represent baseline values for future resistance monitoring of whiteflies in Arizona and point to the usefulness of discriminating-dose assays for determining resistance development in whiteflies.

4. The treated-vial technique for determination of susceptibility in the whitefly would have utility and practicality at the local level (growers and PCA's) as the vials are easily prepared and distributed.

5. A local, periodic monitoring program would reflect the dynamics of resistance/susceptibility with changing cropping patterns and insecticide use. This would be of utmost importance in the timely implementation of resistance management programs.

References

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

2. Roush, R. T. and R. G. Luttrell. 1989. Expression of resistance to pyrethroid insecticides in adults and larvae of tobacco budworm (Lepidoptera: Noctuiidae): Implications for resistance monitoring. J. Econ. Entomol. 82: 1303-1310.

Table 1. Chemicals and concentrations used in a vial bioassay to determine efficacy against the sweetpotato whitefly (1991).

Chemical	Concentration Range (ug/vial)	Mixture Ratio
Danitol	0.0125 - 1.25	---
Danitol + Orthene	0.0625 - 3.75	1:1
Baythroid	0.0625 - 3.75	---
Baythroid + DEF	0.002 - 0.014	1:5
Capture[1]	0.01 - 3.00	---
Capture[2]	0.01 - 3.00	---

[1] Vials prepared by FMC Corporation.
[2] Tubes prepared by FMC Corporation.

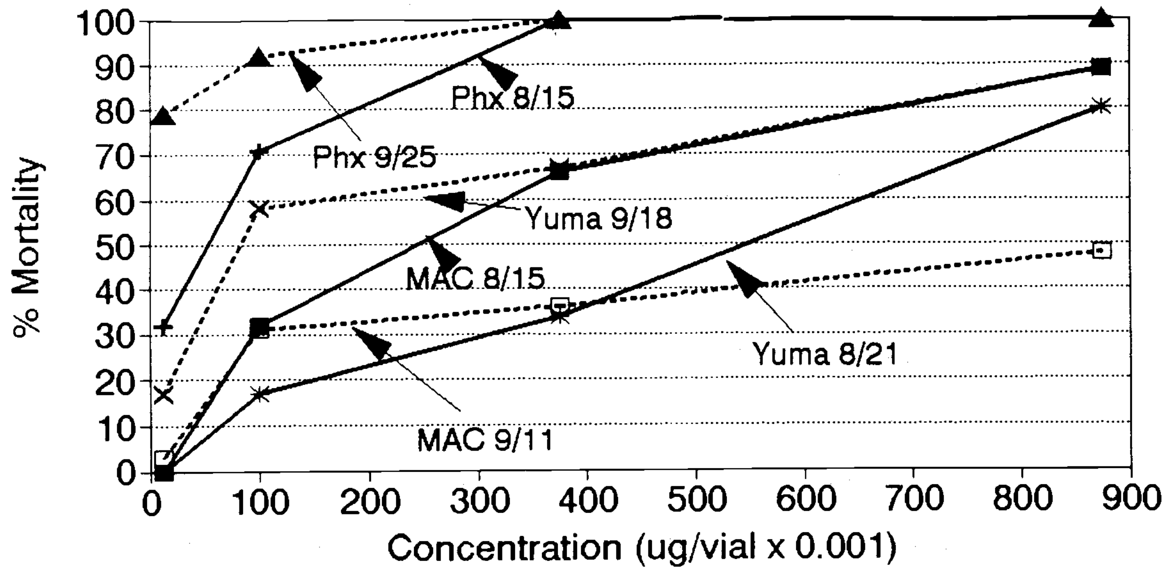

Fig. 1. Temporal and location effects on susceptibility of the sweetpotato whitefly exposed to Danitol.

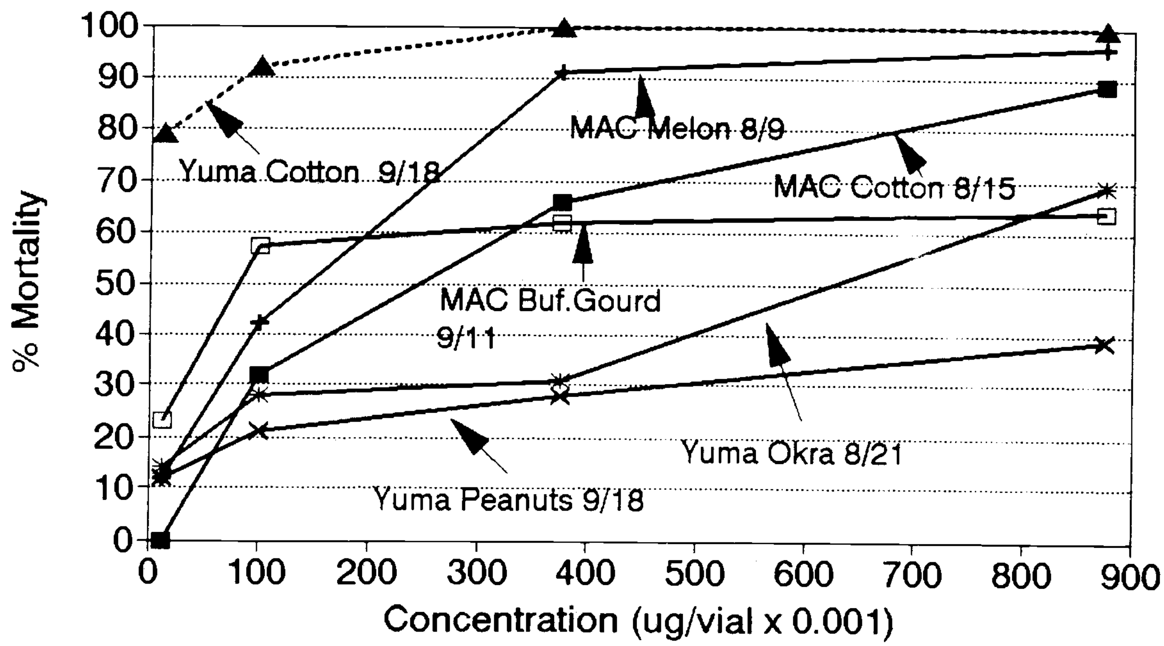

Fig.2. Effect of host-plant and location on the susceptibility of the sweet potato whitefly exposed to Danitol.

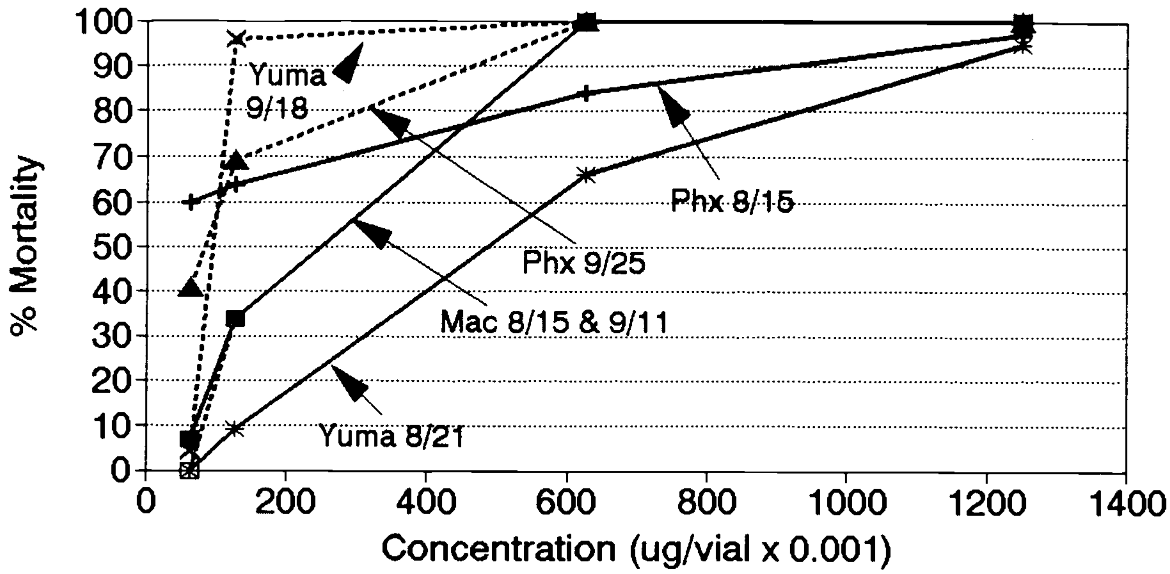

Fig. 3. Temporal and location effects of a Danitol-Orthene mixture against the sweetpotato whitefly.

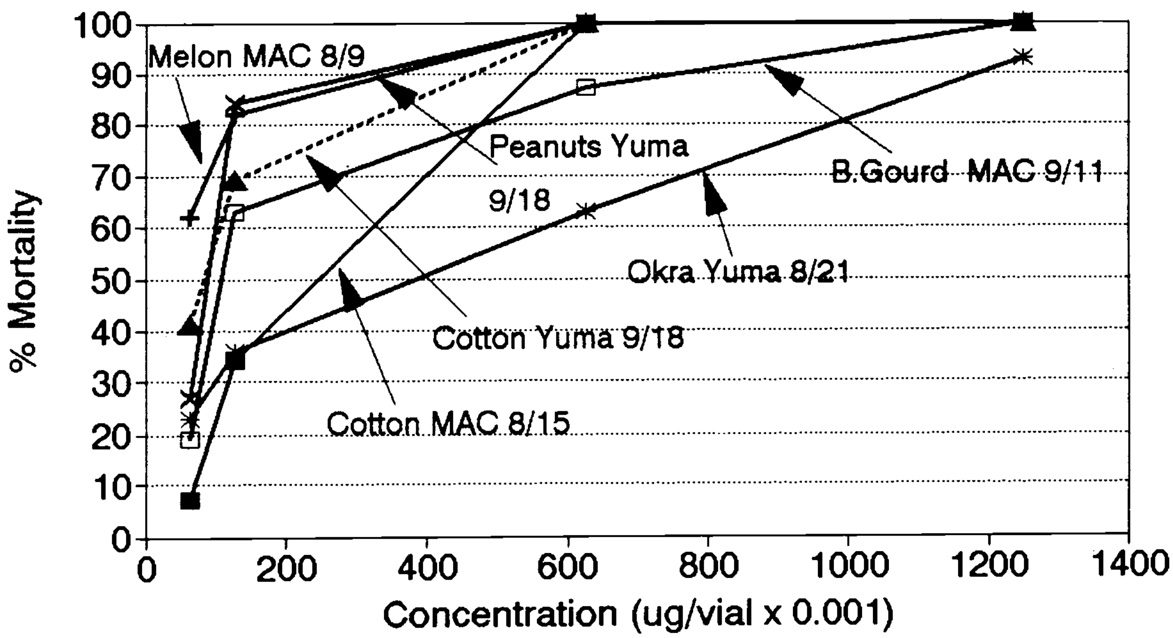

Fig. 4. Effect of host-plant and location on the susceptibility of the sweet potato whitefly exposed to a mixture of Danitol and Orthene.

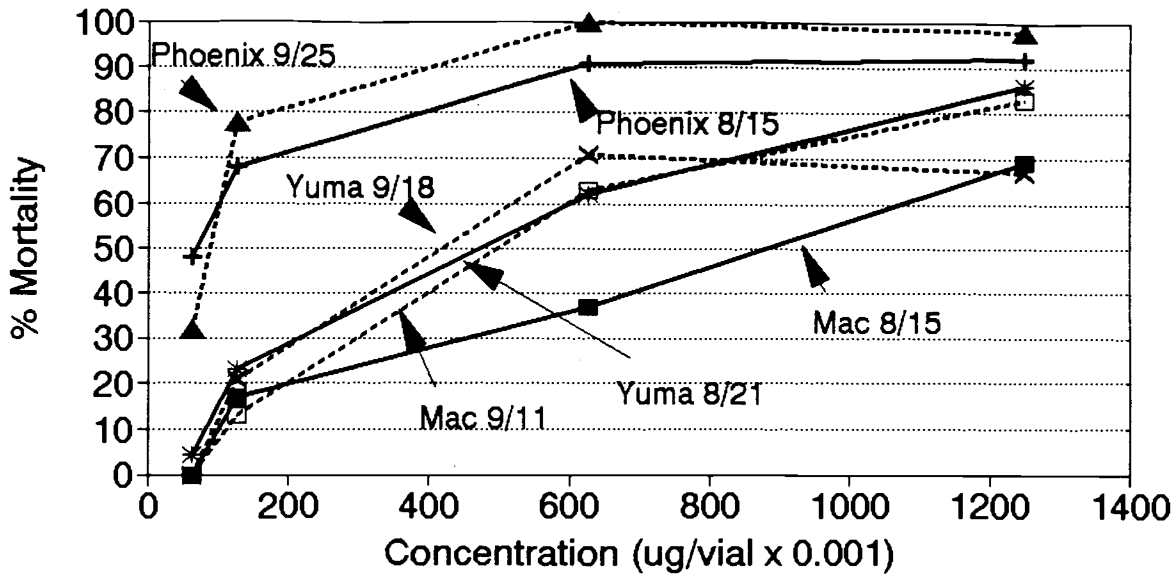

Fig.5. Temporal and location effects on susceptibility of the sweetpotato whitefly exposed to Baythroid.

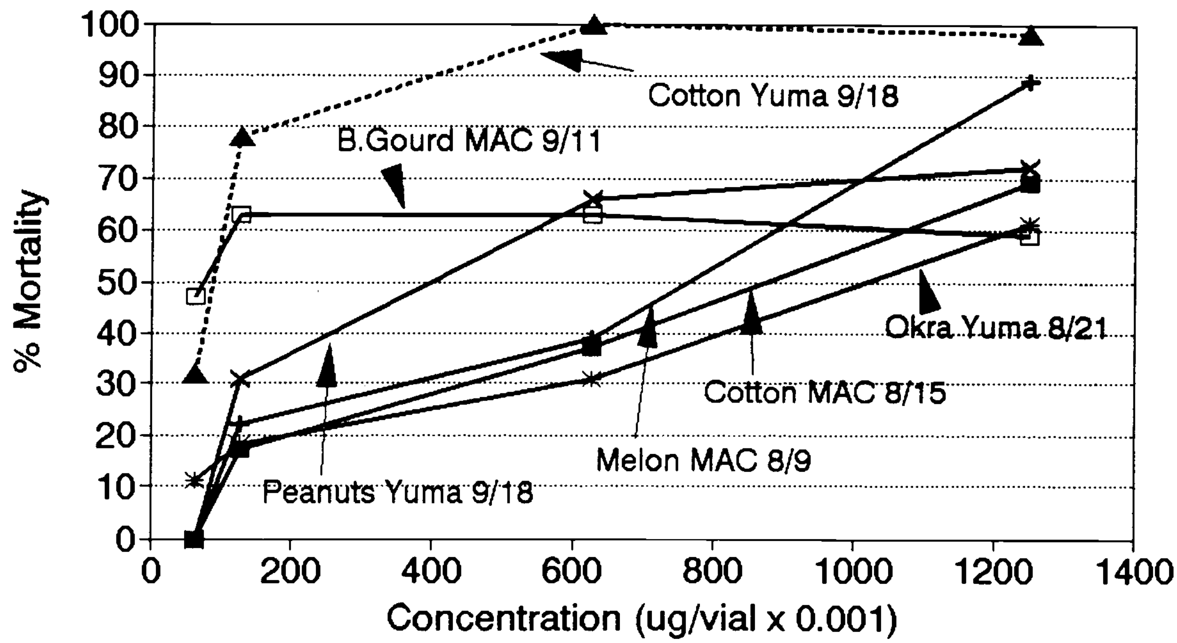

Fig.6. Effect of host-plant and location on the susceptibility of the sweet potato whitefly exposed to Baythroid.

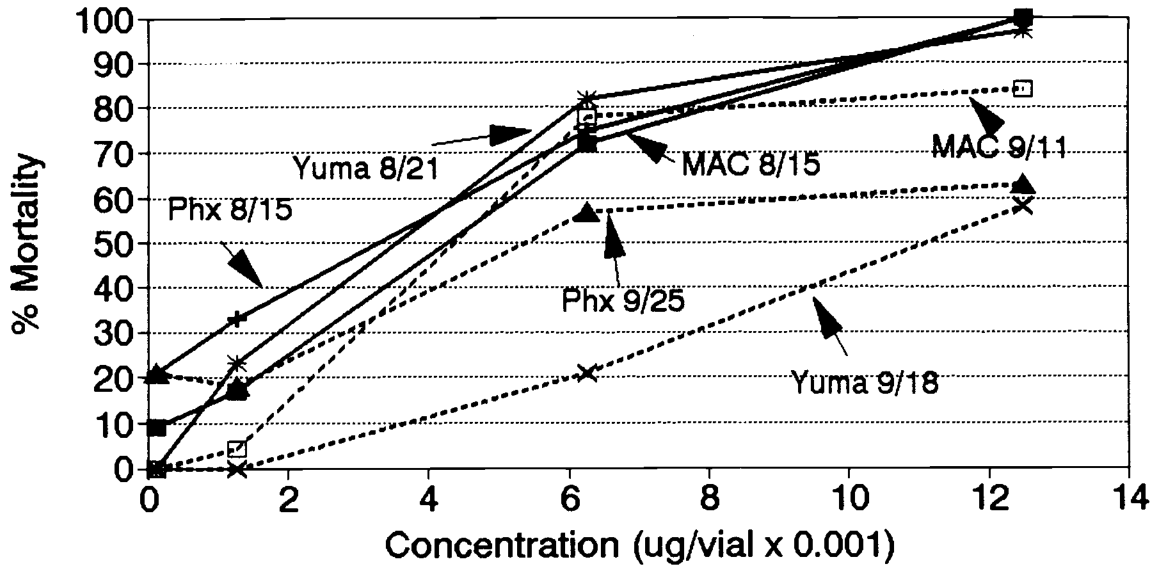

Fig.7. Temporal and location effects on susceptibility of the sweetpotato whitefly exposed to a mixture of Baythroid and DEF.

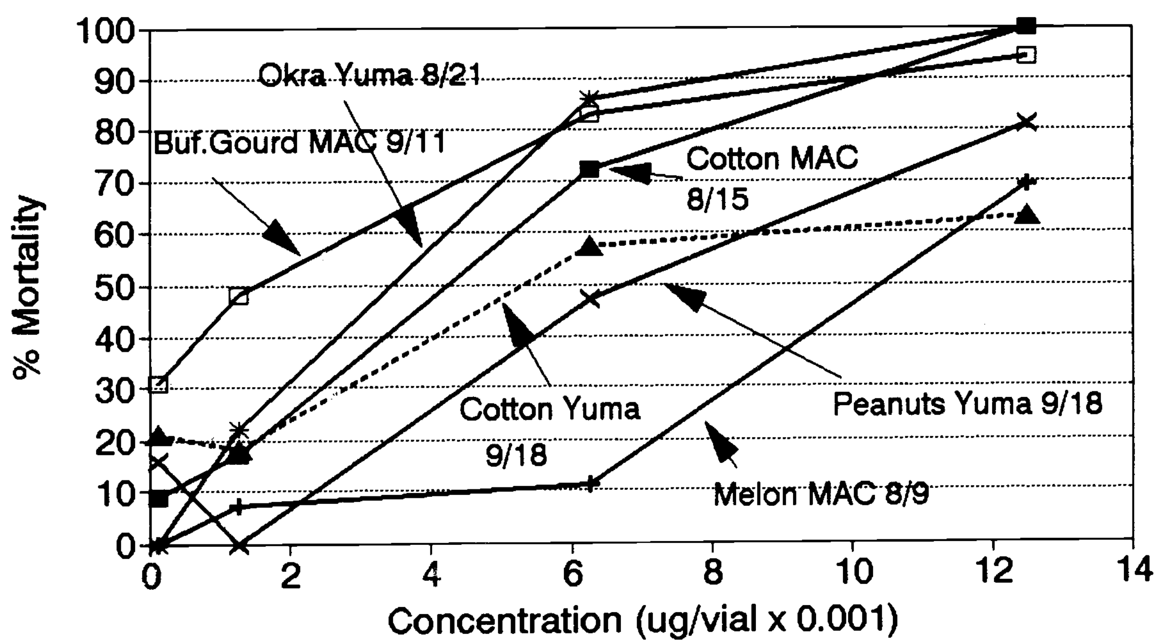

Fig.8. Effect of host-plant and location on the susceptibility of the sweet potato whitefly exposed to a mixture of Baythroid and DEF.

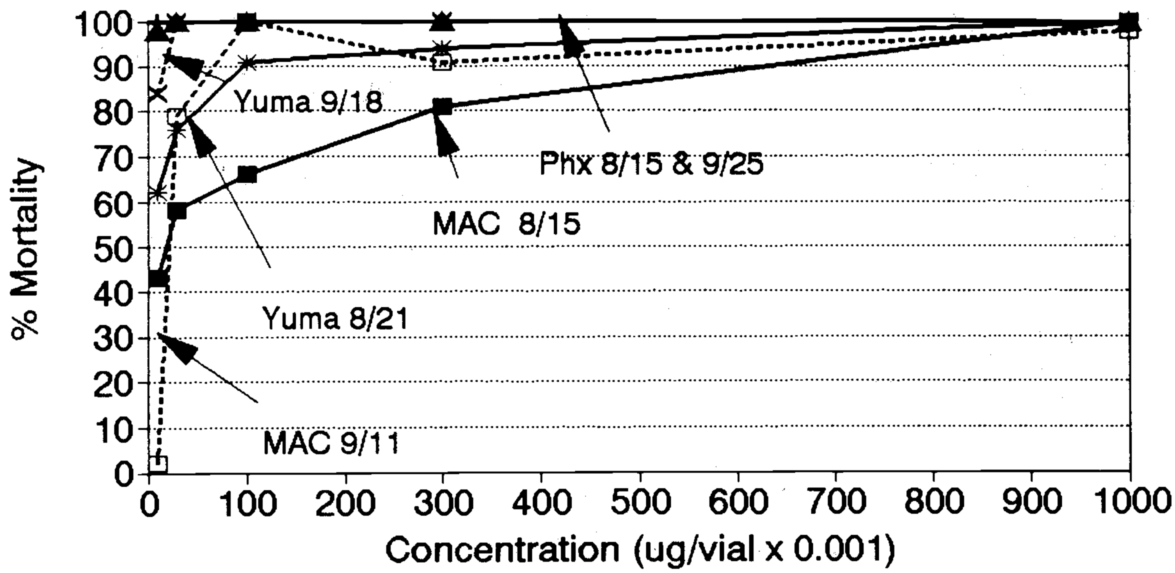

Fig.9. Temporal and location effects on susceptibility of the sweetpotato whitefly exposed to Capture.

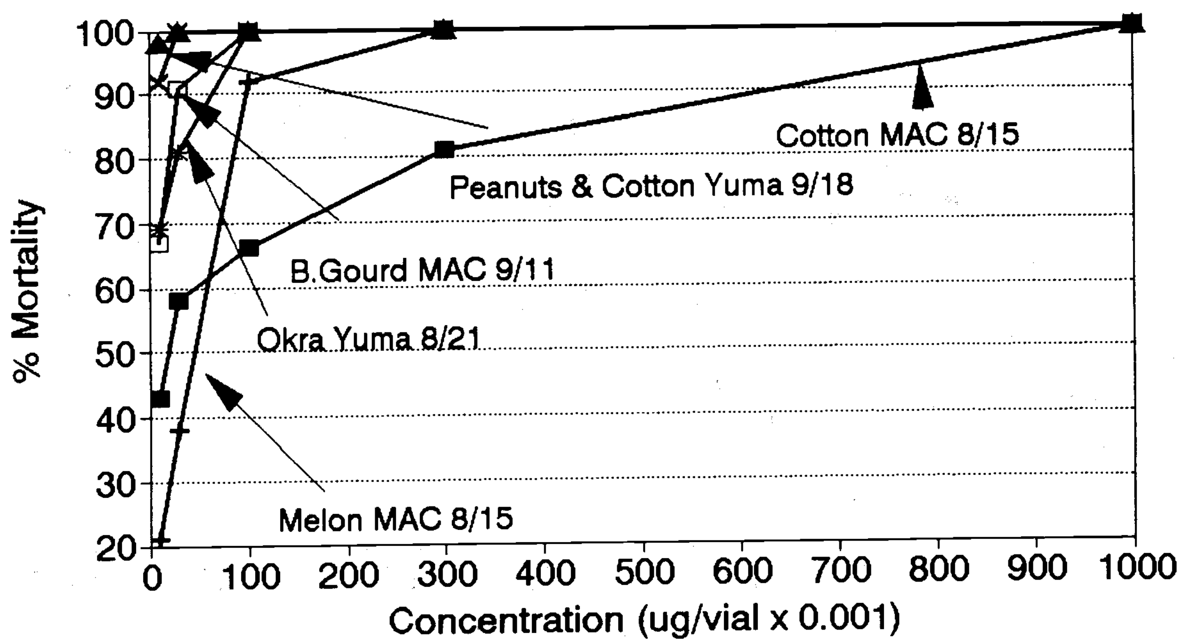

Fig.10. Effect of host-plant and location on the susceptibility of the sweet potato whitefly exposed to Capture.

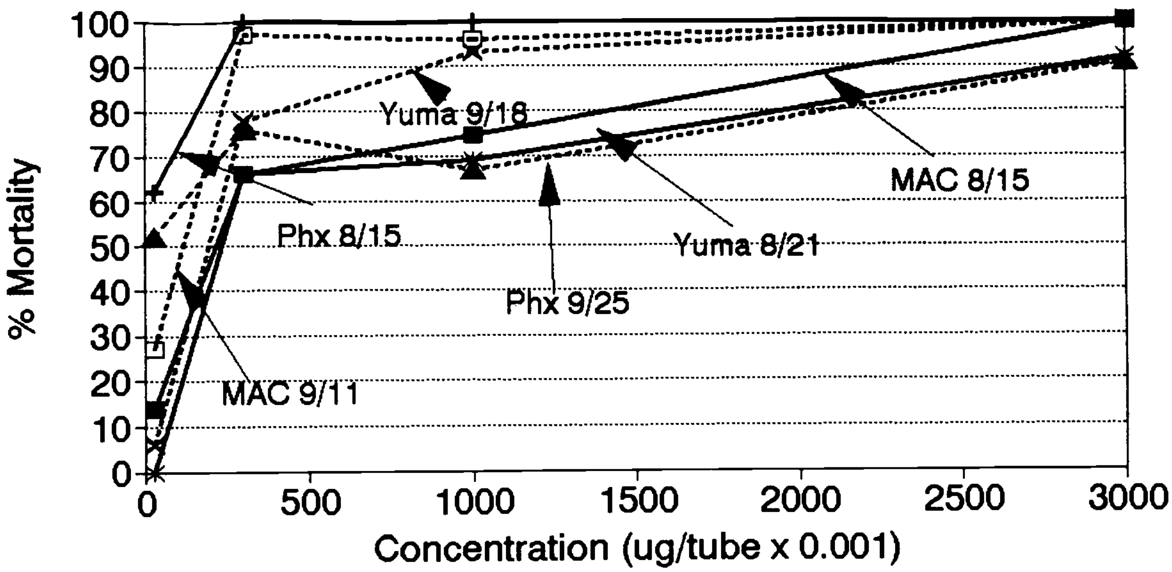

Fig.11. Temporal and location effects on susceptibility of the sweetpotato whitefly exposed to Capture in 'treated' test tubes.

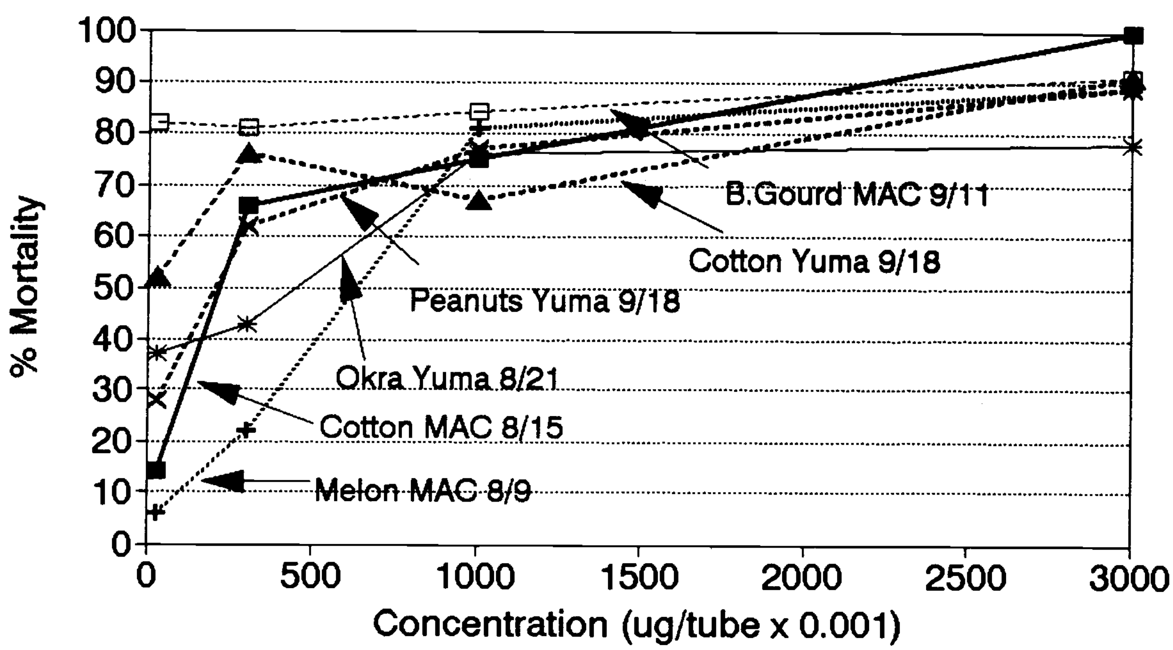

Fig.12. Effect of host-plant and location on the susceptibility of the sweet potato whitefly exposed to Capture in 'treated' test tubes.