A Native Weed as a Trap Crop for Whiteflies in Cotton

Peter C. Ellsworth, Jon P. Chernicky, David N. Byrne, Roberta Gibson, and Donna Meade

Abstract

A field study was conducted during 1991 to evaluate the effectiveness of Physalis wrightii *Gray, as a trap crop for* Bemisia tabaci *(Gennadius) when grown with the commercial crop* Gossypium barbedense L. *Aldicarb at two rates was used in* P. wrightii *for control of* B. tabaci. *Three sampling methods: pan counts, leaf turns, and leaf counts measured* B. tabaci *numbers in both crops. Aldicarb treatment in the trap crop did significantly affect* B. tabaci *populations in comparison with untreated* P. wrightii *($P=0.000$, $df=2, 240$). Differences in numbers of adults observed on the two hosts were not significant. Analysis of aldicarb metabolite residues by high pressure liquid chromatography exhibited a pronounced dose effect ($P=0.001$, $df=2, 22$) in the trap crop leaf tissues. The chemically treated trap crop did significantly protect the cotton crop from larger and more rapidly developing sweetpotato whitefly populations when compared to the untreated check.*

Introduction

The sweetpotato whitefly, *Bemisia tabaci* (Gennadius) is a pest of cotton, *Gossypium barbedense*, which can depress yields and contaminate the harvestable lint (Gerling et al., 1980). Contaminated lint or "sticky" cotton, is of reduced quality since mechanical difficulties occur during ginning (Hector and Hodkinson, 1989). Sweetpotato whitefly is also a complex management problem as it rapidly develops insecticidal resistance. Within the past decade, several common classes of insecticides, pyrethroids and organophosphates, have been reported ineffective (Prabhaker et al, 1985). In addition, the practice of year-round cropping in many cotton areas insures that hosts are always available. In Arizona, populations of sweetpotato whiteflies often move from spring vegetables (especially melons) to cotton; from cotton to fall vegetables; and from fall vegetables to overwintering weed hosts. Because of the need to manage sweetpotato whitefly on cotton in Arizona, an alternative control strategy using a chemically treated trap crop was investigated.

The technique of trap cropping has been used occasionally in the past with mixed success — and very few instances of commercial usage. Strip harvesting of alfalfa borders around cotton has been used for prevention of *Lygus* invasion. Recently, Moore & Watson (1990) used cotton as a trap crop for boll weevil. At present, most applications of the technique require intensive cultivation of the trap crop including field preparation, seeding, weed cultivation, and fertilizer and pesticide applications. Ultimately, the trap crop usually must be chemically treated or destroyed to suppress pest populations.

The annual, native weed, Wright's groundcherry, *Physalis wrightii*, grows readily from indigenous seed, and is a preferred host of sweetpotato whitefly (D.N.B., pers. comm.). Often it is the first host colonized by sweetpotato whiteflies, thus it acts as a sentinel plant by indicating possible population increases. In this study, selection of a ubiquitous, native weed as a trap crop may eliminate many cultivation and management problems. In addition, use of a preferred host of the targeted pest would induce voluntary movement into the trap crop. Finally, control of sweetpotato whitefly would be accomplished by treatment of the trap crop with the systemic insecticide aldicarb.

Materials and Methods

Four rows of Pima (S-6) cotton were established in 12 plots in a randomized complete block design at the University of Arizona Maricopa Agricultural Center in Maricopa, AZ. Trifluralin and prometryn were applied preplant to control all weed growth in cotton plots. Plots were surrounded by cultivated bare ground buffer areas which prevented harborages of extraneous sweetpotato whitefly. Trifluralin alone was applied to plot borders which allowed establishment of the trap crop. The trap crops of Wright's groundcherry surrounding each plot, approximately four rows wide, were treated with one of two aldicarb formulation rates: 1X — 16 oz/1000 ft or 2X — 32 oz/1000 ft. Applications were by shank injection into the soil on one side of the plant bed. A total of three applications were made on 7/31/91, 8/15, and 9/15. Check plots did not receive any insecticides. No other in-season insecticide was used except for one pinhead square treatment for pink bollworm (in early season) before sweetpotato whitefly invasion. Whitefly arrival occurred late in the year, thus populations were supplemented with feral whiteflies. Feral populations from both cotton and melon fields were collected by D-Vac. These collections and infested plant material were placed in the centers of buffer areas equidistant from all adjacent plots. Releases occurred on three dates; 8/8/91, 8/14, and 8/16.

Data collection consisted of sampling both plant hosts and counting the numbers of sweetpotato whiteflies present. Three sampling methods were used: pan counts, leaf turns, and leaf counts. For pan counts, plant terminals were shaken into an oiled 7" diam pan and the number of captured adults were recorded. Leaf turns consisted of in-field counts of the numbers of adults observed on leaf undersides. The third sampling technique, leaf counts, consisted of microscopic examination of leaf undersides to determine the number of nymphs and eggs found within a defined leaf area of one square inch.

On each sampling date, leaves of Wright's groundcherry were also collected for aldicarb residue analysis. Leaves were ground using a Virtischear Tissue Homogenizer (Gardiner, NY), and extracted using a hexane:ether (50:50) and ether:acetone (50:50, 5:95) series in a 13 inch column containing 3 cm of florisil (Fisher Scientific, Fair Lawn, NJ) and 3 cm of Darco-60 charcoal (MCB, Norwood, OH). Solutions were dried using BUCHI Rotary Evaporator (Flawil, Switzerland) and resuspended in 1 ml of methanol. Analysis by high pressure liquid chromatography (Waters, Milford, MA) determined the concentrations of metabolized aldicarb.

Results and Discussion

Wright's groundcherry has a highly dynamic plant architecture. In early season plants produce large leaves with few flowers. In mid-season leaves are intermediate in size and flowering increases. At late season, leaves become very small possibly due to the heavy and developing flower and fruit loads. These changes in leaf morphology have an impact on *B. tabaci* sampling techniques which are not adjusted for leaf areas. Furthermore, there seemed to be a direct effect of the aldicarb treatments on leaf areas. Leaves in the 2X treatments were larger than in the 1X which in turn, were larger than in the check. The effect was subtle, but consistent enough to bias various sampling methods.

Pan Counts: Comparisons between hosts is difficult with the pan counts technique because of the differences in amounts of plant biomass beaten into the oiled pan. However, numbers of adults were similar between the two hosts in spite of the relatively large biomass of cotton leaves (Figure 1). There were significant treatment effects for cotton (P=0.042; df=2, 288) and for Wright's groundcherry (P=0.000; df=2, 240) indicating the significant impact of the aldicarb applications on sweetpotato whitefly adult density within plots (Figure 1). The 1X and 2X rates often responded similarly. Over the season (Figure 1) the cotton adjacent to untreated Wright's groundcherry had approximately twice as many sweetpotato whitefly adults per pan sample than the two aldicarb treatments.

Leaf Turns: Data from the leaf turns samples are also unadjusted for the relative sizes of the host plant leaves (i.e., Wright's groundcherry leaves are considerably smaller than cotton leaves). This is reflected in the rather small sample means seen in Figure 2B. Approximately ten times more adults were counted on cotton leaves when compared to Wright's groundcherry leaves. There were significant treatment effects for cotton (P=0.000; df=2, 648) and Wright's groundcherry (P=0.047, df=2, 540). The untreated check had an average of three times more adult whiteflies on the leaves than the two aldicarb treatments (Figure 2). Both the 1X and 2X rates performed similarly (Figure 2). In general, however, leaf turn samples were extremely variable.

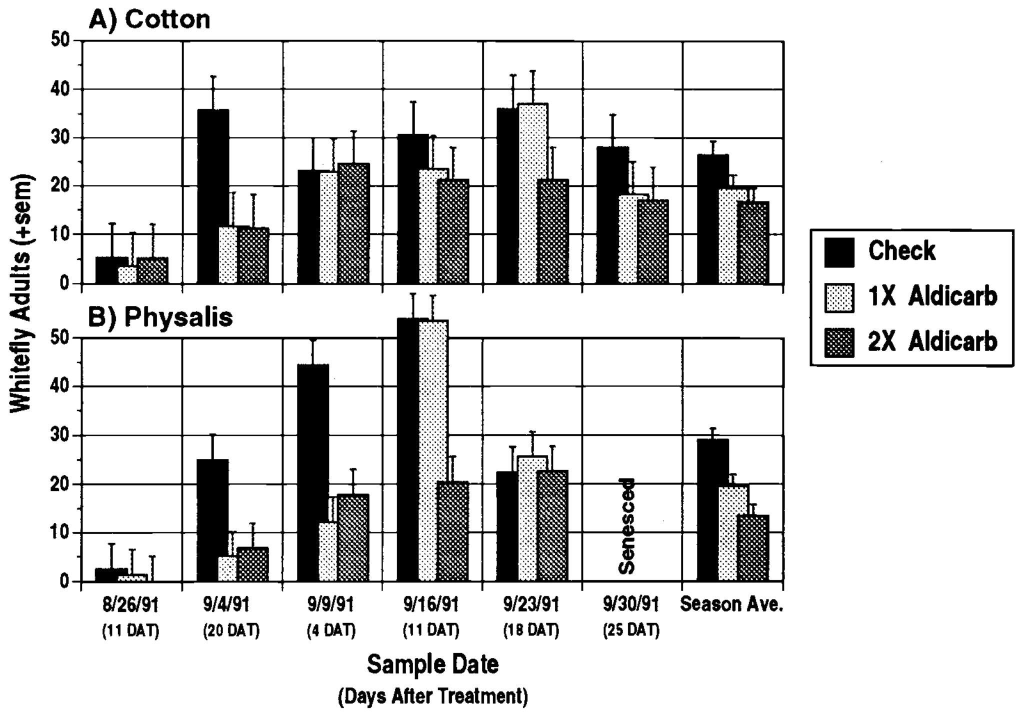

Figure 1. Pan Counts: Mean numbers of whitefly adults counted in an oiled pan sample of A) cotton and B) *Physalis* terminals in the field.

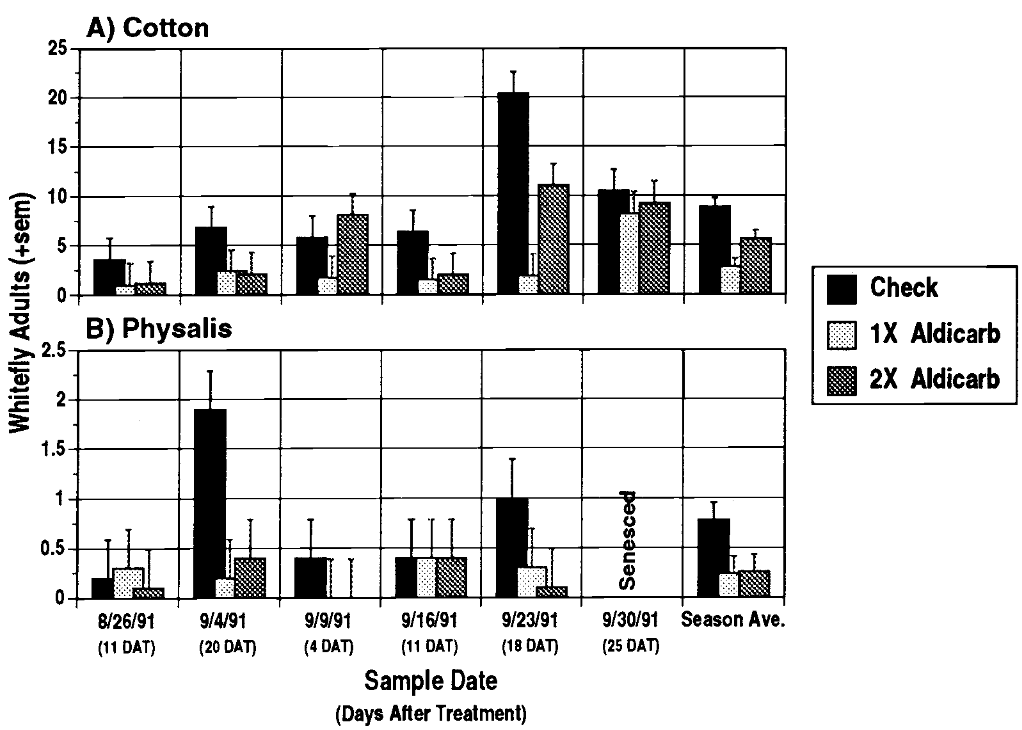

Figure 2. Leaf Turns: Mean numbers of whitefly adults observed on the undersides of A) cotton and B) *Physalis* leaves in the field.

Leaf Counts: Leaf counts, adjusted per unit leaf surface, were the only absolute measure of whitefly density — immatures only. There were no significant differences in egg numbers between plant hosts (P=0.951; df=1, 751); however, there was a trend towards more immatures on Wright's groundcherry than on cotton (P=0.082; df=1, 754) (Figures 3-4). For both life stages there were highly significant aldicarb effects (P=0.000; df=2, 751) (Figure 3-4). The untreated trap crop and adjacent cotton had two to three times more immatures than in either of the crops associated with aldicarb treatments (Figure 3-4).

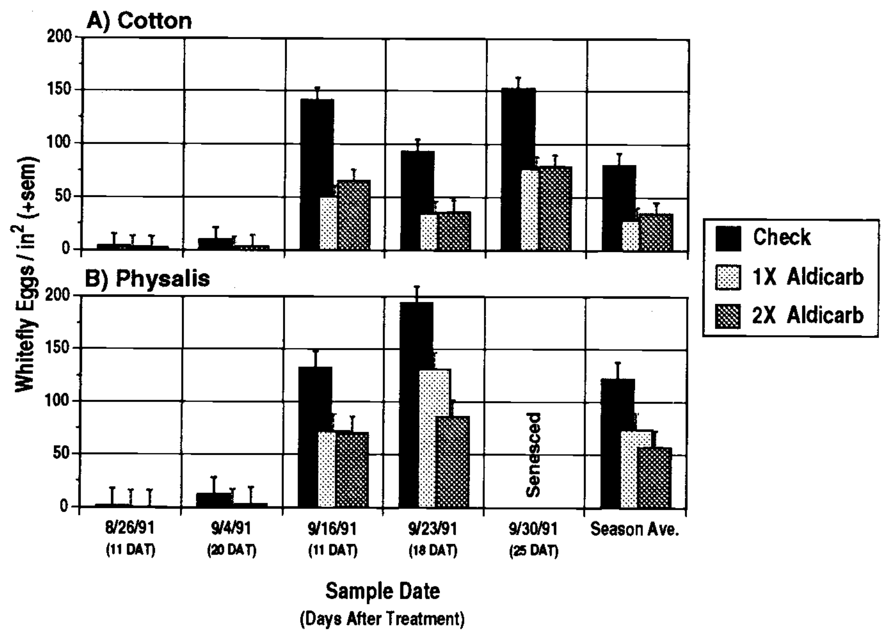

Figure 3. Leaf Counts: Mean numbers of whitefly eggs found on A) cotton and B) *Physalis* leaf undersides.

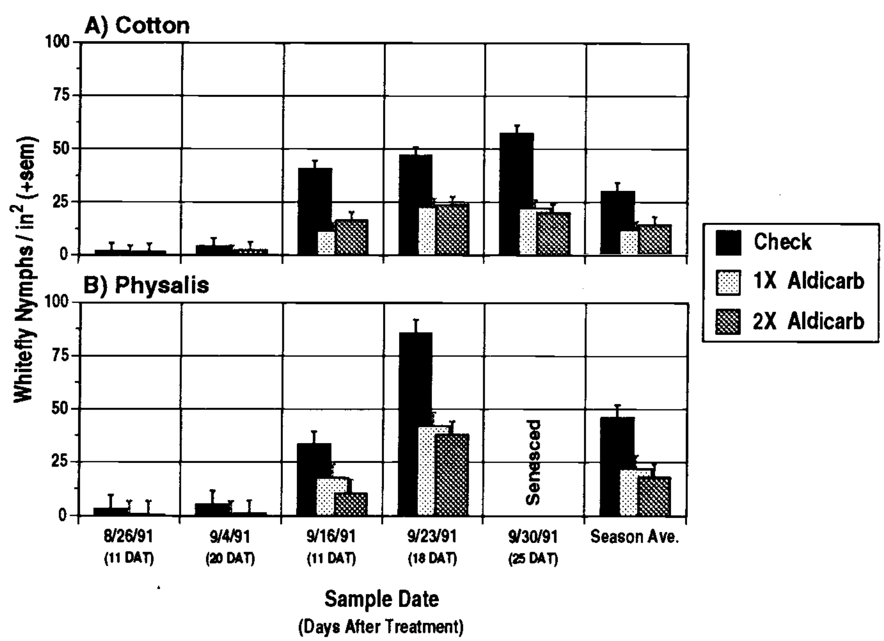

Figure 4. Leaf Counts: Mean numbers of whitefly nymphs found on A) cotton and B) *Physalis* leaf undersides.

Aldicarb Metabolism: Residues of two aldicarb metabolites were recovered from Wright's groundcherry leaf tissue; aldicarb sulfone (Figure 5A), and aldicarb sulfoxide (Figure 5B). The former was found in much smaller concentrations, but both compounds exhibited a pronounced dose effect ($P=0.001$; $df=2, 22$). The check had trace amounts of aldicarb residues (< 1 µg / mg of leaf tissue) and was probably due to dissolution and transport of aldicarb down the irrigated furrows. Peak concentrations of aldicarb residue occurred at 11 d after treatment (Figure 5A-B). However, 12 d after treatment (9/17), the concentrations were lower (Figure 5A-B). This may be due to the aging condition of the plant, which diverted resources to the developing fruit. Generally there was twice as much residue in the 2X treated tissue than in the 1X treated tissue.

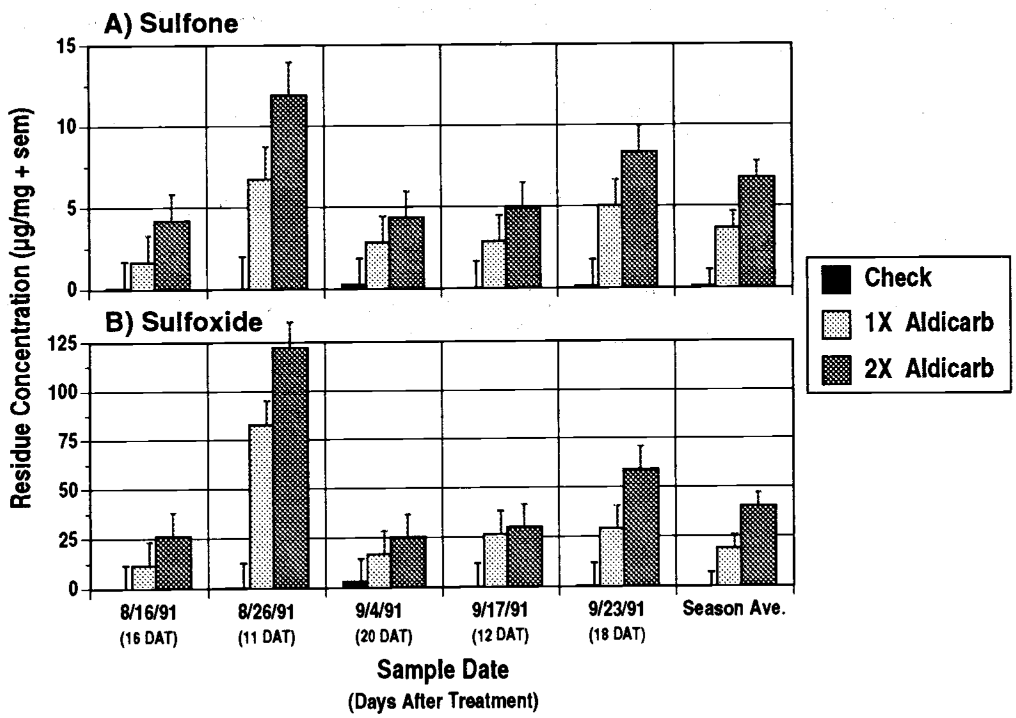

Figure 5. Aldicarb metabolites: A) Sulfone and B) Sulfoxide residues found in *P. wrightii* leaf tissue.

Summary

Wright's groundcherry is a prolific, low maintenance, native weed of the Arizona agricultural irrigated landscape. Aldicarb can be applied to the soil in the trap crop alone and persists for at least 20 d in Wright's groundcherry leaf tissue. Aldicarb was active against sweetpotato whitefly at both concentrations with varying degrees of efficacy throughout the duration of the infestation— often two to five times as many whiteflies were found in the untreated check plots. All three sampling methods detected reductions in whitefly population densities in the treated groundcherry and its adjacent cotton crop. These results are suggestive of a trap crop effect. As there is not a significant added cost in "growing" this weed, the system of using this plant as a preferred, barrier, trap crop may increase its acceptance.

This paper summarizes the first year of a two year feasibility plan for utilizing Wright's groundcherry as a trap crop for sweetpotato whitefly. Experiences in 1991 have led to several important changes for the 1992 design. The first of these changes, an increase in plot size width, will allow more intensive sampling, reduced border effects, and a more balanced crop biomass to trap crop biomass ratio. Experimental design will also be changed, from RCB to a latin square design, and a fourth treatment, cotton without a trap crop, will be included. This will allow assessment of the protective effects of growing Wright's groundcherry when compared with the untreated check. Finally, two rows of spring melons will be planted on either side of each plot to assure locally abundant whitefly populations.

Acknowledgments

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