COTTON APHID RESPONSE TO PESTICIDES IN SAN JOAQUIN VALLEY COTTON

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Abstract

Cotton aphid, *Aphis gossypii*, densities reached damaging levels from mid-July through August 1995 in the 15 San Joaquin Valley, CA fields sampled. Most growers responded by applying mixtures of pesticides for aphid control two to four times during the season. In many fields, pesticides were effica-cious for only 10 days. Petri dish pesticide bioassays were conducted to evaluate whether part or all of the poor efficacy was due to pesticide resistance. Cotton aphid resistance to Capture was most common followed by Lorsban and Thiodan. Several results of the study suggest that poor field efficacy was not due to insecticide resistance alone. Many aphid populations exhibited susceptibility to the pesticides, yet control did not last more than 2 weeks. Many of the aphid populations had lower levels of resistance in the pesticide bioassay a few weeks after they were selected with the same pesticide in the field. The general trend was for aphid populations to show decreased levels of resistance as the field season progressed, independent of pesticide selection. These results suggest that factors such as aphid physiology and/or aphid movement between fields are as important as pesticide resistance in influencing the efficacy of pesticide treatments.

Introduction

The cotton aphid, *Aphis gossypii* Glover, was considered up until the late 1980s a sporadic pest of cotton in the San Joaquin Valley of California. Recently, however, it's numbers have increased greatly, especially during mid-season, after squaring, when yields can be affected by heavy populations. Heavy populations of aphid at the end of the season have resulted in sticky cotton during some years. During 1988 and 1989 aphids were collected from throughout the San Joaquin Valley to determine if pesticide resistance was part of the problem of increased aphid densities (Grafton-Cardwell 1991). Resistance to organophosphate insecticides was common in eastern Tulare County and less common in other regions. Resistance to Thiodan was found in a few locations and aphids showed no resistance to Capture. In locations where resistance was a problem, resistance tended to decline at the end of the season, and tended to be greater in winged aphids than apterous aphids. Thus, there were physiological and seasonal effects on aphid resistance that were somewhat independent of in-field pesticide selection pressure. The mid-south region at that time, was experiencing a greater intensity of resistance to a greater number insecticide classes in their populations of cotton aphids (O'Brien et al. 1989, Kerns and Gaylor 1992). Since those early pesticide bioassays, researchers have continued to develop rapid petri dish bioassay techniques (McKenzie and Cartwright 1994) to monitor for resistance in an effort to manage cotton aphid populations. Cotton aphid densities have, however, continued to increase, and this has resulted in an escalation of pesticide use by San Joaquin Valley growers both in numbers of applications as well as an increase in the number of mixtures of pesticides being applied (Vargas et al. 1995). During the 1995 field season, bioassays of insecticide resistance in cotton aphids in commercial cotton fields in the San Joaquin Valley were conducted in conjunction with pest and beneficial arthropod sampling. This research was conducted in order to determine to what extent efficacy problems were due to insecticide resistance.

Materials and Methods

Aphid densities were evaluated using a 100 leaf sample and the presence-absence method resulting in a mean percentage of leaves infested for each field. Fifteen commercial cotton fields in the Madera, Fresno, Kings, Tulare, and Kern counties were sampled each week from May 23 until September 4, 1995. Growers applied pesticides based on the advice of their pest control advisors.

Petri dishes (55 mm) were prepared by coating the inner surface of the top and bottom of the dish with 0.7 ml of formulated insecticide in ethanol or ethanol alone and then air dried. Insecticides and discriminating concentra-tions tested included, Lorsban 4E (510 ppm chlorpyrifos), Thiodan 3 EC (270 ppm endosulfan), and Capture 2EC (5 ppm bifenthrin). Dishes were stored in a freezer and used within 4 weeks of preparation.

When sufficient cotton aphids were available for testing, they were collected from the cotton fields. Aphid infested leaves (50-100) were placed in paper bags and kept cool until bioassays could be performed 4-24 hours after collection. Twenty apterous adults were placed in each dish and the mortality was assessed after 3 hours. Two to three replications were completed for each insecticide, depending upon availability of aphids. Yellow and dark green aphids were noted and bioassayed separately. Abbott's (1925) formula was used to correct for control mortality.

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Results and Discussion

Of the fifteen fields sampled, 12 had sufficient aphids on one or more dates to conduct insecticide resistance bioassays. Table 1 shows the mean response of all aphid populations tested during each week of the season. Cotton aphid resistance to insecticides, as defined by less than 80% mortality at the discriminating concentrations tested, was greatest for Capture, followed by Lorsban, and least for Thiodan. When bioassays of aphids from different fields were averaged, resistance tended to be highest at the beginning of the season, and lower at the end of the season especially for Capture. In 1989, Grafton-Cardwell (1991) did not find significant resistance to Capture in cotton aphid. Our data suggest that resistance to Capture is relatively widespread in the San Joaquin Valley. Most cotton growers no longer use Capture for aphid control in this area. Cotton aphid resistance to Lorsban and Thiodan was variable during 1995.

Cotton aphid densities were high from July 15 through August 31 during 1995 in most of the cotton fields sampled. The number of applications of insecticides for aphid control ranged from one to five with an average of three and many of these applications were mixtures of insecticides from different chemical classes. Insecticides applied alone or as mixtures in the different cotton fields included Lorsban, Curacron, Monitor, Dimethoate, Dibrom, Lannate, Capture, Baythroid, Thiodan, Provado, and Ovasyn. All applications resulted in only 1-3 weeks of suppression of aphid populations.

There were nine locations in which we conducted bioassays on aphids more than once during the season. If insecticide resistance was the cause of poor efficacy, we would expect to see increased resistance (expressed as reduced mortality in the bioassays) after insecticides were applied. This was rarely the case. Figure 1 shows a Fresno County site, that received four insecticide applications for aphids. Notice that the aphid population in late July was susceptible to Lorsban and Thiodan and moderately resistant to Capture. After the Provado+Dibrom application was made, mortality decreased (resistance increased) for all three chemical classes. The next two insecticide applications were a mixture of Lorsban, Dibrom and Baythroid, and a mixture of Curacron and Dibrom. We would expect that these organophosphates and pyrethroids would select for greater resistance to Lorsban and Capture, however, bioassays conducted in late August indicated that the aphids were susceptible to all three insecticides. Aphid resistance fluctuated widely during the season, and these data suggest that the changes may be due more to susceptible or resistant aphids migrating into the cotton field rather than selection for resistance within the field.

Further evidence that aphid movement from neighboring fields is important, is that aphids in an organic field exhibited resistance (only 50-70% mortality) to Capture and Thiodan. No insecticides other than sulfur were applied to this plot.

Our data suggest that resistances to the organophosphates and chlorinated hydrocarbons are not areawide problems. Thus, insecticide resistance monitoring can be used to wisely choose an insecticide that the aphids will succumb to. However, large densities of winged aphids moving about the San Joaquin Valley can quickly reinvade cotton fields, resulting in the need for repeated, pesticide applications. Cotton growers need to find ways to increase alternative methods of aphid control during the early part of the season to reduce the overall number of aphids infesting their fields. Early season broad spectrum pesticide applications that remove natural enemies should be avoided. During the early season, aphid damage does not affect cotton yield (Wilhoit et al. 1992). Heavy use of fertilizers that may stimulate aphid outbreaks should also be avoided. Broad spectrum pesticides should be saved for the end of the season, when aphids tend to be more susceptible to them.

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Table 1. Mean percentage mortality of cotton aphids collected from 12 cotton fields on various dates in 1995 and exposed to discriminating concentrations of insecticides.

	Mean % mortality of cotton aphid on various dates							
	6/25	7/9	7/16	7/23	7/30	8/6	8/13	8/20
Capture (5 ppm)	13.3	23.8	56.9	30.7	45.0	70.8	39.9	51.9
Lorsban (510 ppm)	9.5	51.2	95.8	84.6	51.8	94.8	58.5	93.1
Thiodan (270 ppm)	-	71.4	97.3	84.3	73.3	80.6	75.4	80.6
No. aphid populations tested	1	3	3	1	4	2	2	5

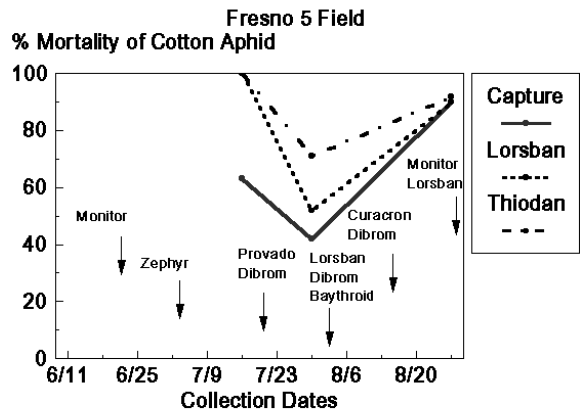

Fig. 1. Percentage mortality of cotton aphid collected from a Fresno cotton field when exposed to discriminating concentrations of 5 ppm Capture, 510 ppm Lorsban, and 270 ppm Thiodan.