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FACTORS INFLUENCING HONEYDEW DEPOSITION BY COTTON APHID AND SILVERLEAF WHITEFLY AND INCIDENCE OF STICKY COTTON IN CALIFORNIA COTTON

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Abstract

Sticky cotton, arising from honeydew excrement from sucking insects, was reported from the 2001 cotton crop in the San Joaquin Valley. Refined management schemes during the 2002 to 2004 production seasons have enabled lint contamination to be greatly minimized. Control of the silverleaf whitefly, *Bemisia argentifolii*, and the cotton aphid, *Aphis gossypii*, has been enhanced by optimal use of crop protection tools. However, the potential for both species to infest late-season cotton and to contaminate lint has placed an added burden on IPM programs for SJV cotton. Studies were conducted in 2002 and 2003 and were designed to better understand sampling and control of late-season insect pests. Studies conducted in 2004 provided additional information about the threshold for late-season insect pests and the incidence of sticky cotton.

Introduction

The 2001 California cotton crop was identified as having an abnormally high level of stickiness arising from insects and this created problems and concerns by processors. An intensive education and awareness program was conducted during the 2002 growing season and the situation has been largely mitigated. The 2002 to 2004 crops were of high quality and honeydew-producing insects have been optimally managed. Increased use of insecticides has been one means used to effectively manage populations of cotton aphids, *Aphis gossypii*, and silverleaf whitefly, *Bemisia argentifolii*, the honeydew producing insects in California cotton. Insecticide applications have increased from 2.7 to 2.9 to 3.5 applications per cotton acre in 2001, 2002, and 2003, respectively (CA Dept. of Pesticide Regulation, 2004). Populations of other arthropod pests have been fairly low (and consistent from year-to-year) over this period so the majority of these differences were directed at aphids and whiteflies. Products such as endosulfan, thiamethoxam, pyriproxyfen, and buprofezin increased significantly from 2001 to 2002 and acetamiprid use increased dramatically from 2002 to 2003. In the short-term, this strategy has been very effective, but the long-term sustainability of this strategy is in question. Repeated applications of neonicotinoid products during a growing season increase the selection pressure and the chances for insecticide resistance development. Similarly, increased production costs and regulatory scrutiny are other potential drawbacks of this strategy.

Management of honeydew-producing insects in California cotton is definitely challenging. Sticky cotton is also an issue in other southwestern cotton producing states but several factors suggest that the situation may be most challenging in California. Both cotton aphids and silverleaf whiteflies can infest cotton fields in the San Joaquin Valley. In contrast, Arizona typically has to manage only whiteflies and in Texas only cotton aphids generally reach pest levels. The management schemes for aphids and whiteflies in California often are not compatible. For example, if a synergized pyrethroid treatment is used to manage whiteflies, aphid populations are often flared by this treatment. Similarly, some of the more effective treatments for cotton aphids have little impact on populations of whiteflies. In addition, the most critical period for protection of exposed lint is usually the 3- to 4-week period immediately before harvest. At this time, the “hardened” leaf surfaces and senescing plants hinder uptake of insecticide active ingredients and furthermore pre-harvest intervals limit the control options. As in other irrigated production systems, irrigation cut-off is used to stop cotton growth and “finish” the crop in the late summer. Deficit water status, and also nitrogen which is also often depleted at seasons-end, are conditions that have been shown enhance the feeding and honeydew production by sucking insects (Blua and Toscano 1994, Flint et al. 1996). Finally, the warm, dry falls in the San Joaquin Valley are ideal for the cotton crop, but also favor reproduction and development of late-season populations of aphids and whiteflies.

One of the keys to effectively managing late-season honeydew-producing insects is knowledge of the relationship between population levels and the amount of lint stickiness. This threshold value is critical for scheduling appropriate management actions, including insecticide applications. Rosenheim et al. (1995) suggested a threshold of 10-15 aphids per leaf following boll opening in California and Slosser et al. (2002) found the threshold ranged from 11 to 50 aphids per leaf in west Texas cotton. Naranjo et al. (1998) found significant relationships between silverleaf whitefly populations and lint yield but relationships with honeydew deposition were lacking. Godfrey et al. (2003, 2004) reported on studies conducted in 2002 and 2003 examining the relationship between late-season sucking insects and honeydew deposition on exposed cotton lint. In summary, in 2002 results showed that the threshold for preventation of sticky cotton was 5 to 10 aphids per 5th main stem node leaf. In 2003, aphid levels of 5 per leaf resulted in sticky cotton; however, this population of aphids was confounded with a low population of silverleaf whiteflies which also contributed to the stickiness. These mixed populations of sucking insects are becoming the norm for the SJV as opposed to ingle species infestations. Therefore, one goal of the 2004 research was to investigate the influence of mixed whitefly and aphid infestations on honeydew contamination of cotton lint.

Materials and Methods

Studies were conducted at the Univ. of California Shafter Research and Extension Center in Kern County in irrigated acala ('Maxxa') cotton planted in mid-April 2004. Insecticides were used to manipulate naturally-occurring populations of cotton aphids and silverleaf whiteflies in field plots (13 x 65 feet with 4 replicates). Treatments were started at the initiation of boll opening (11 Aug.) and continued at weekly intervals until (and including) the time of defoliation (15 Sept.). The treatments applied were Assail 70WP (1.1 oz./A) to control aphids and Warrior (3.8 fl.. oz./A) to flare aphid populations. Untreated (in terms of aphids) plots were also included. Silverleaf whitefly nymphs were controlled in all these plots with an application of Courier 40 SC (12 fl. oz./A) on 29 July and Knack (8 fl. oz./A) on 25 Aug. Another set of treatments was included so as to better evaluate the influence of whitefly infestation on stickiness; these plots were randomized with the treatments detailed above. Treatments were applied on 29 July and were designed to compare plots with whiteflies controlled versus natural populations of whiteflies; aphid treatments were superposed across the whitefly treatment. Courier 40 SC (12 fl. oz./A) on 29 July and Knack (8 fl. oz./A) on 25 Aug. were again used for whitefly control. The aphid treatments were the same as previously detailed, except that Lorsban 4E (24 fl. oz./A) was used for aphid control in plots with natural populations of whitefly nymphs (Assail would have also provided some reduction in whitefly levels). Insect populations were quantified every 5 to 7 days; leaf samples (20 fifth main stem node leaves per plot) were collected and aphids and whitefly nymphs counted in the laboratory. Aphid control treatments were re-applied if there was evidence of aphid build-up.

Cotton lint was hand-harvested from all plots on 14 Oct. and additional samples of lint were hand-harvested from selected treatments on 27 Oct. following precipitation (0.86 inch) on 26 Oct. Finally, lint was collected from the treatment extremes, i.e., aphids controlled and whiteflies present, whiteflies controlled and aphids present, both species controlled, and both species present at natural levels, also on 18 Aug. and 8 Sept. All lint samples were ginned and stickiness determined at the International Textile Center. Lint from selected treatments was subjected to HPLC analysis to determine the profile of sugars.

Results

Aphid and silverleaf whitefly populations began to develop in mid-July and peaked in mid-Aug. and late Aug., respectively. The insecticide treatments generally produced the desired results. Cumulative aphid-day values for the primary study (manipulation of aphid numbers with whiteflies universally controlled) showed that the highest aphid populations were in the plots treated with Warrior on 11 Aug. and averaged ~80 aphid-days (Fig. 1). Overall the plots treated with Assail on 25 Aug. had the lowest aphid-day accumulation at ~14 aphid-days. Assail treated plots generally had the lower aphid-day accumulations; the untreated plots had intermediate aphid populations at 44 aphid-days. Silverleaf whitefly populations ranged from 36 to 65 whitefly-day accumulation and there were no obvious trends among the treatments. Thermodetector ratings of lint exposed to these aphid and whitefly levels ranged from 14 to 34 sticky spots (Fig. 2). Using the criteria of Perkins and Brushwood (1995), ratings above 15 spots would be classified as moderately sticky and those greater than 25 spots as heavily sticky. The Assail treatments initiated on 25 Aug. and 31 Aug. had the fewest honeydew spots whereas the Warrior-treated plots (18 Aug., 25 Aug., and 31 Aug.) and the untreated plots had the greatest numbers of sticky spots (more than 30 in all cases).

Whitefly and aphid populations in plots designed to examine the impact of simultaneous infestation by both species on lint stickiness showed excellent aphid control with plots treated with aphicides, intermediate populations in untreated plots, and flaring of aphid populations in plots treated with Warrior (Fig. 3). Whitefly nymphal control was achieved by the whitefly-targeted treatments and populations in these plots were about 40% less than untreated plots (Fig. 4). Thermodetector ratings showed that the whitefly infestation increased the number of sticky spots by 34 to 70%, depending on the aphid level (Fig. 5).

Temporal honeydew accumulation is shown in Fig. 6 from treatments with and without whiteflies and aphids. The highest number of sticky spots was seen in plots with both aphids and whiteflies and the lowest number where both pests were controlled. Honeydew spots accumulated fairly linearly over time in three of the four treatments. Following the rainfall event, sticky spots were reduced significantly in all treatments. The reduction was 75-80% in the treatments with whiteflies controlled and only 50-55% where higher levels of whiteflies were present.

Acknowledgements

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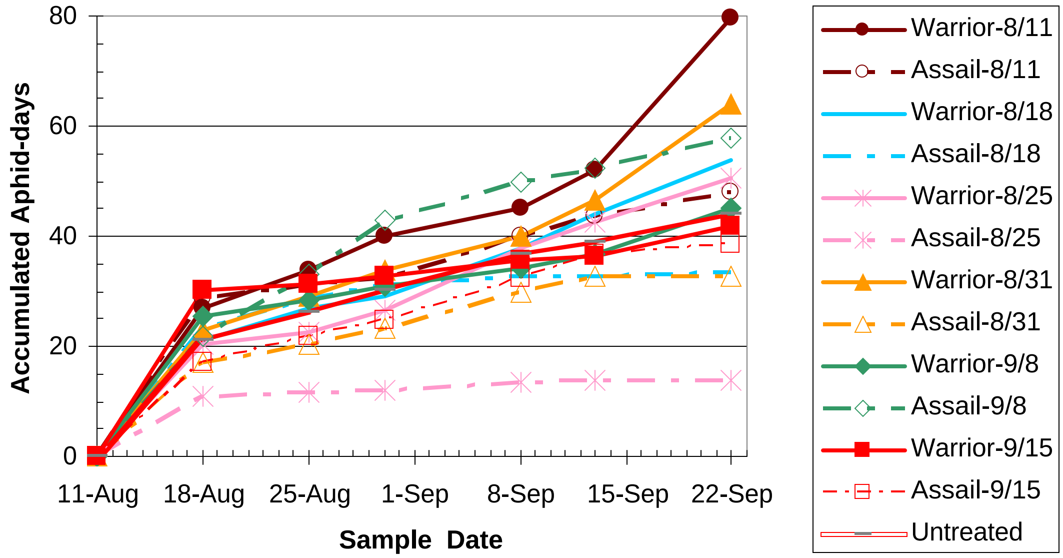

Figure 1. Influence of insecticide treatment and application timing on late-season cotton aphid populations, 2004.

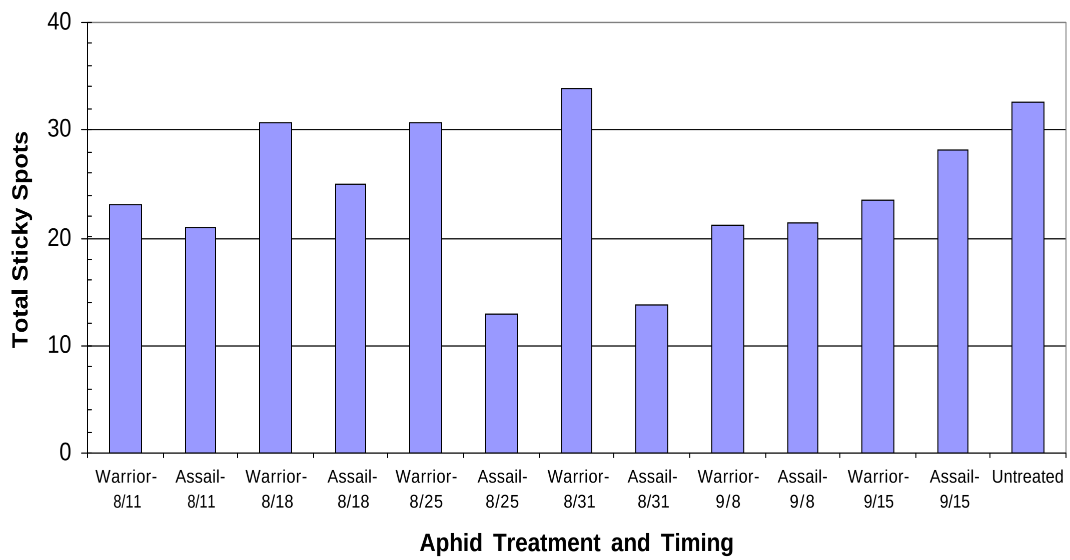

Figure 2. Influence of insecticide treatment and timing targeting cotton aphids on lint sticky spots, 2004; whiteflies were controlled in these plots.

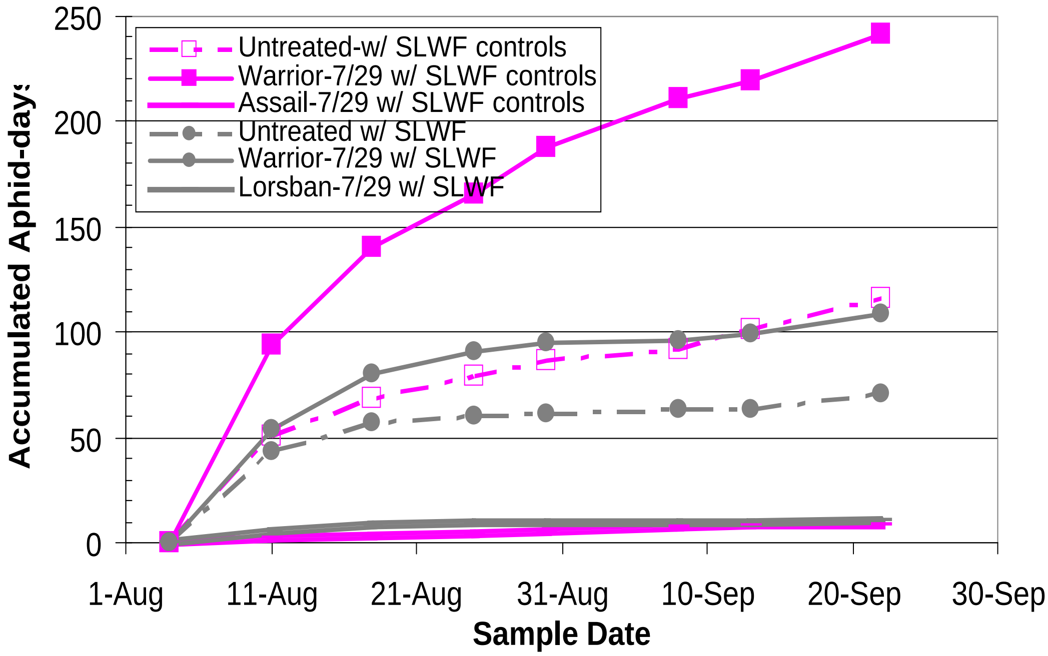

Figure 3. Aphid populations (accumulated aphid-days) as influenced by cotton aphid insecticide controls and also by insecticide treatments targeted for silverleaf whiteflies, 2004.

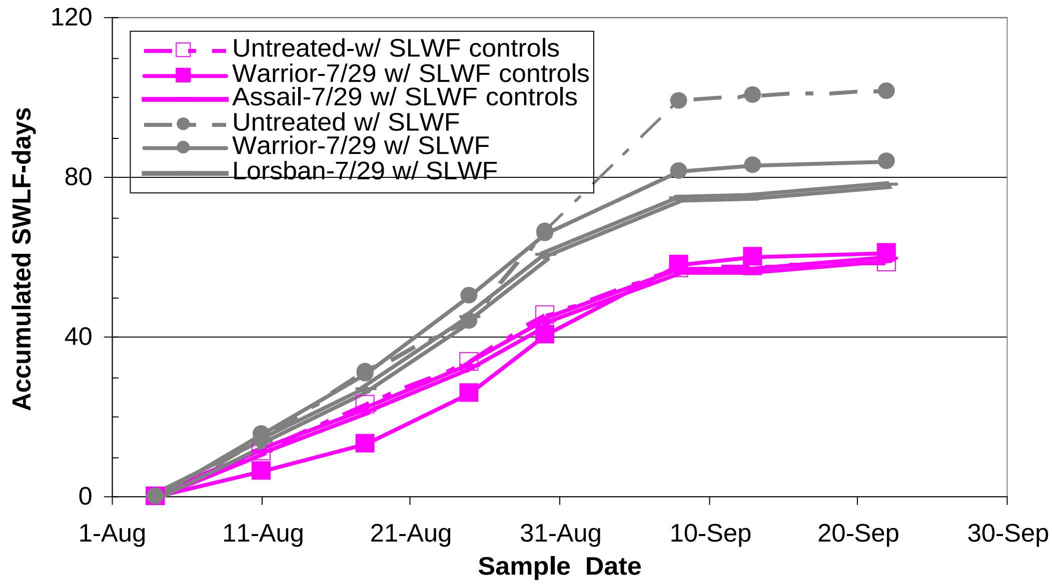

Figure 4. Whitefly populations (accumulated whitefly-days) as influenced by whitefly insecticide controls and also by insecticide treatments targeted for cotton aphids, 2004.

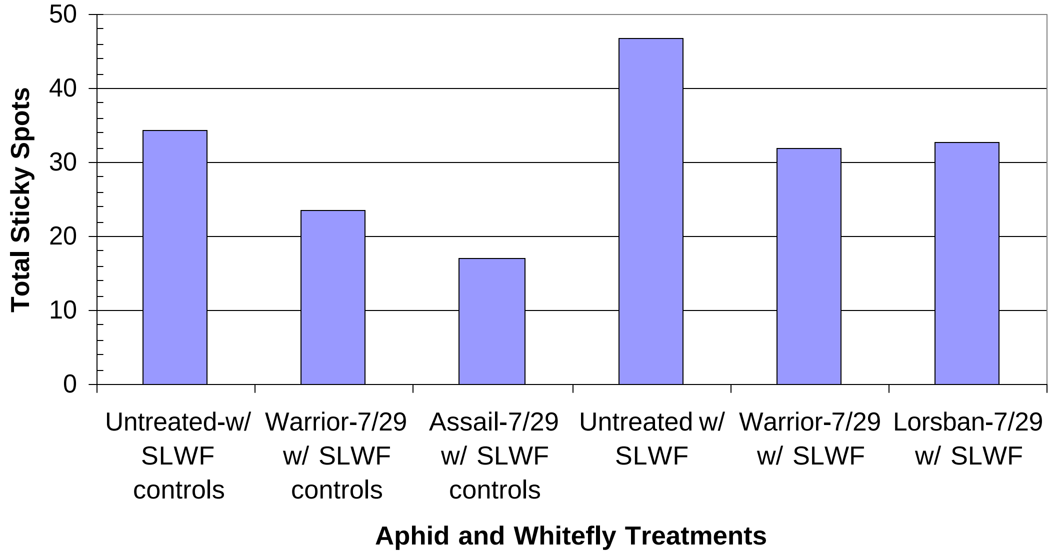

Figure 5. Influence of aphid and whitefly treatments, and resulting pest populations levels, on total sticky spots in cotton lint, 2004.

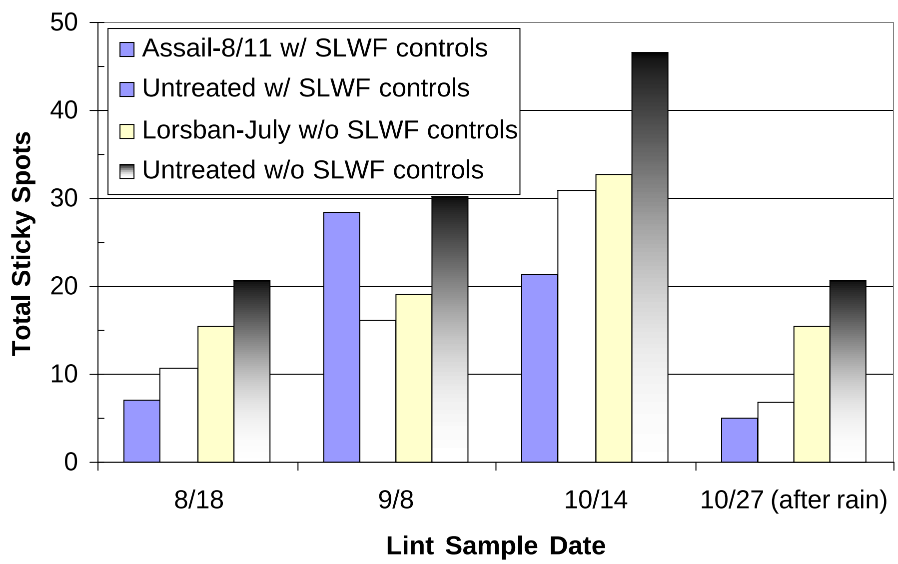

Figure 6. Temporal accumulation of honeydew, as measured with total sticky spots, on plots with and without natural levels of cotton aphids and silverleaf whiteflies, 2004.