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IMPROVEMENT IN SAMPLING AND MANAGEMENT OF LATE-SEASON INSECT PESTS IN SAN JOAQUIN VALLEY COTTON

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Abstract

Sticky cotton, arising from honeydew from the silverleaf whitefly, *Bemisia argentifolii*, and cotton aphids, *Aphis gossypii*, became an issue in SJV cotton. The potential for both species to infest late-season cotton and to contaminate lint places an added burden on IPM programs for SJV cotton. The SLWF has continued to adapt to SJV conditions and cropping patterns and starting in 2001 SLWF populations expanded greatly both in severity and particularly in range. Populations in significant numbers have occurred farther northward and westward into the SJV, placing the pest into the primary cotton production area. Work continued in 2003 with studies on insecticide efficacy on late-season aphid populations, threshold levels for cotton aphids and sticky cotton, and the interaction of harvest aid materials and aphid/whitefly populations.

Introduction

A new challenge arose in terms of arthropod pest management in San Joaquin Valley cotton in 2001. Sticky cotton, arising from honeydew from the silverleaf whitefly, *Bemisia argentifolii*, and cotton aphids, *Aphis gossypii*, became an issue in SJV cotton. The environmental conditions were conducive to honeydew deposition on exposed lint in 2001 including no fall rain showers and a long, warm fall. Under these conditions, late-season cotton aphid populations developed in many areas and silverleaf whitefly populations expanded farther northward than in previous years. The threat from both of these insect pests creates a unique situation in California SJV cotton compared with the other southwestern states. Arizona has dealt with whitefly infestations and the threat of sticky cotton for the last 15 years (Ellsworth and Martinez-Carrillo 2001) and west Texas periodically has late-season cotton aphid infestations which can contaminate the crop (Slosser et al. 2002). However, in much of the SJV, both of these pests occur simultaneously and furthermore the management strategies differ between the two pests. This situation has certainly placed added importance on efficient IPM of arthropods in cotton, particularly aphids and whiteflies. The pre-harvest intervals of many insecticides and senescent cotton plants, which may inhibit translaminar movement of many insecticides, make control at this time particularly challenging.

The silverleaf whitefly (SLWF) and cotton aphid are not new insects to the SJV, but only in recent years have late-season populations of both of these pests become widespread. The silverleaf whitefly was first found in the SJV in 1992 (Gruenhagen et al 1993). Seasonal abundance and population dynamics were studied in 1993 and 1994 (Godfrey et al. 1994, Godfrey et al. 1995). Populations increased to a peak in the late summer and fall after overwintering on citrus, weeds, fall/winter cole crops, and urban ornamentals. Importantly, significant populations of SLWF only occurred on the southern and eastern sides of the SJV. These are the areas that had the most degree-days for development and also afforded the most protection from the cool winter conditions. However, the SLWF has continued to adapt to SJV conditions and cropping patterns and starting in 2001 SLWF populations expanded greatly both in severity and particularly in range. Populations in significant numbers occurred farther northward and westward into the SJV. This has pushed the whitefly into the primary cotton production area.

The cotton aphid occurred sporadically in cotton throughout the 1970's and 1980's but damaging populations were rare. Early-season populations in the late 1980's and early 1990's were researched by Rosenheim et al. (1997). Populations developed into a significant mid-season pest of SJV cotton and reduced lint yields in the mid-1990's with 1995 and 1997 being the most severe years. Late-season populations occurred occasionally during this period although impacts on lint quality were rare. However, in 2001, late-season populations occurred in many areas and contributed to the sticky cotton phenomena.

Research concentrating on management of late-season infestations of SLWF and cotton aphids and mitigation of sticky cotton was started in 2002 (Godfrey et al. 2003). Work continued in 2003 and specifically studies included insecticide efficacy on late-season aphid populations, threshold levels for cotton aphids and sticky cotton, and the interaction of harvest aid materials and aphid/whitefly populations.

Materials and Methods

Insecticide Efficacy Studies

Two efficacy studies were done at the Shafter Research and Extension Center to examine insecticide efficacy on cotton aphids occurring during the late-season period. The majority of the previous work on cotton aphid control in the SJV had been with mid-season aphids. Both tests were applied with ground equipment at 20 GPA which admittedly, during the late-season, likely maximizes the efficacy of the treatments. The first test was applied on 10 Aug. at the onset of boll opening (~10% open bolls). The second test was applied on 25 Sept. when about 90% of the bolls were open and this was about 7-10 days before defoliation. This is a critical period in the SJV for protecting lint quality. A randomized complete block design and strip test with alternating treated and untreated plots were used for the first and second tests, respectively. Aphid populations were quantified for 14-17 days after treatment (DAT). Ten fifth main stem node leaves (counting from the terminal) were collected from each plot on each sample date and aphid numbers were determined in the laboratory.

Late-Season Aphid Threshold

Studies were conducted to investigate the relationship between the number of cotton aphids and lint stickiness. This study was a follow-up to the work done in 2002. After the development of a low cotton aphid population near the time of initial boll opening, plots were treated at weekly intervals with either Assail 70WP (1.1 oz. /A) or Warrior (3.84 fl. oz./A) to control and to flare aphid populations, respectively. Application dates (and corresponding percentage open bolls) were Sept. 4 (50% open bolls), Sept. 11 (75% open bolls), Sept. 18 (90% open bolls), Sept. 25 (95% open bolls), and 1 Oct. (at defoliation). Untreated plots and one additional treatment in which Assail was applied on 4 and 18 Sept. were also included. Aphid populations were quantified from samples of the 5^{th} main stem node leaves at weekly intervals. Cotton lint was hand-harvested, ginned, and stickiness determined at the International Textile Center.

Harvest Aids and Cotton Aphid Populations

Following the 2001 production season and the occurrence of sticky cotton in the SJV, techniques to manage aphid and whitefly populations at the time of defoliation needed to be refined. Harvest aid materials which quickly desiccate the foliage could alleviate insect pest populations. Minimizing regrowth, which could support pest populations, could be another important quality of a harvest aid material. Adding an insecticide to the defoliation application was another possibility; Liu et al. (2002) examined this strategy on silverleaf whiteflies in Texas. Use of an organophosphate harvest aid could be advantageous for whitefly control where pyrethroid + organophosphate tank mixes are commonly used (the insecticide organophosphate could be omitted in this case). The effects of these strategies on aphid population densities and sticky cotton were evaluated at the Shafter REC. Four harvest aids were examined 1.) Ginstar, 2.) Ginstar + Prep, 3.) Def + Prep, and 4.) Defol + Gramaxone, as well as untreated plots. Curacron (with and without) was superimposed across the harvest aid treatments to provide a level of aphid control. Treatments were applied on 16 Sept. with ground equipment at 16 GPA. Cotton aphid populations were quantified pretreatment and at 3, 7, 10, 14, and 17 DAT. Hand-picked lint samples were collected on the day of application and on 10 Oct., ginned, and lint stickiness analyzed by thermodetector by the International Textile Center.

Results

Insecticide Efficacy Studies

Pretreatment populations averaged 25.8 aphids per leaf for the August test. At 1 DAT, the best control, numerically, was provided by Furadan with Assail (0.05 lbs. AI/A) and endosulfan also providing at least 75% control (Fig. 1). Furadan and Assail (both rates) achieved 90% effectiveness at 3 DAT and Lorsban and endosulfan were in the 85% control range. Provado, F1785 (0.071 lbs. AI/A), Assail (both rates), and Furadan all provided at least 75% control at 8 DAT.

Both cotton aphids and silverleaf whiteflies infested plots in the Sept. test. Pretreatment levels were 12.9 aphids/leaf and 9.7 SLWF nymphs/leaf. Populations at 7 DAT had increased slightly compared with pretreatment levels especially for SLWF levels which doubled. Assail (96%) and F1785 (~89%) provided very good aphid control (Fig. 2). The best SLWF control was seen in the Diamond, Danitol + Orthene, and V-10112 treatments but this was in the 40-50% range. Populations continued to increase at the 14 DAT sampling. The untreated plots averaged 18.1 aphids/leaf and 24.9 SLWF nymphs/leaf. Assail and F1785 clearly provided the best aphid control (98%). Although significant aphid control was seen with Centric and Curacron, they were still substantially less effective than Assail and F1785. SLWF nymphal populations were reduced by all treatments except Centric; however, V-10112, Oberon, Diamond, and Danitol + Orthene were clearly more effective than the other treatments. At this point in the season, the plants are no longer actively growing and the leaves are not very receptive to insecticide uptake, so control is difficult.

Late-Season Aphid Threshold

Aphid populations continued to increase in untreated plots from an average of 1.1 per leaf on 4 Sept. to 36.8 per leaf in mid-Oct. Aphid-day accumulation over the 6 weeks of this test showed values from 96.7 (Assail applied on 4 and 18 Sept.) to 925.8 (Warrior on 4 Sept.) (Fig. 3). Values in the untreated plots totaled 514.8 aphid-days. Therefore, the treatments worked well for altering the aphid populations as desired. Thermodetector ratings of lint exposed to these aphid levels ranged from 24 to 49.8 sticky spots (Fig. 4). Using the criteria of Perkins and Brushwood (1995), these would all be classified as sticky lint. The treatment with two applications of Assail had the fewest sticky spots. A second harvest of selected treatments was done on 4 Nov. following 0.26" rainfall on 1 Nov. Sticky spots were reduced by 49% by this precipitation.

These results differ from the preliminary study done in 2002 when about 250 aphid-days was the threshold value that resulted in 10 sticky spots (using that as the criteria for stickiness). With a 6 week lint exposure period, aphid numbers of ~6 per leaf would be the threshold. However, in 2003, aphid-day numbers as low as ~100 still resulted in sticky spot values considerably higher (more than double) the 2002 values. One difference between the years was that the plots also had a light SLWF infestation in 2003. SLWF nymphs per leaf averaged 1.1 at the start of the study (4 Sept.) and increased to a range of 19.5 to 39.9 nymphs per leaf on 15 Oct. However, Naranjo et al. (1998) showed no relationship between SLWF populations and cotton lint stickiness with nymphal populations up to 100-fold that seen in our study.

Harvest Aids and Cotton Aphid Populations

Cotton aphid populations averaged 2.6 at 3 DAT and 14.6 at 17 DAT in the untreated plots (without harvest aids or insecticide). At 17 DAT, the addition of Curacron to the harvest aid decreased aphid numbers in the Ginstar, Ginstar + Prep, and Defol + Gramaxone treatments by an average 35.8% whereas the inverse occurred in the Def + Prep and untreated plots. Overall, populations averaged 14.8 and 12.9 aphids per leaf without and with Curacron, respectively. Similarly, the harvest aid treatment did not substantially affect aphid populations ranging from 11.1 to 14.0 aphids per leaf at 17 DAT across the four harvest aid treatments (populations averaged 16.3 aphids per leaf in the plots with no harvest aid applied). Aphid day values ranged from 81.9 to 119.8 across the ten treatments over this test. SLWF populations did not exceed 5 nymphs per leaf in any treatment. A second location for this study was done in Tulare county where the silverleaf whitefly was the most important pest.

The number of sticky spots from pretreatment harvest samples averaged 9.8; across the ten treatments, numbers ranged from 12.1 to 29.9 sticky spots. The addition of Curacron to the Ginstar and Ginstar + Prep treatments reduced sticky spots as it also reduced aphid populations (overall there was ~20% reduction in sticky spots from the Curacron addition). Across the harvest aid treatments, sticky spot numbers were lowest in the Def + Prep treatment at 11.1 and highest in the untreated at 16.3 sticky spots.

Acknowledgments

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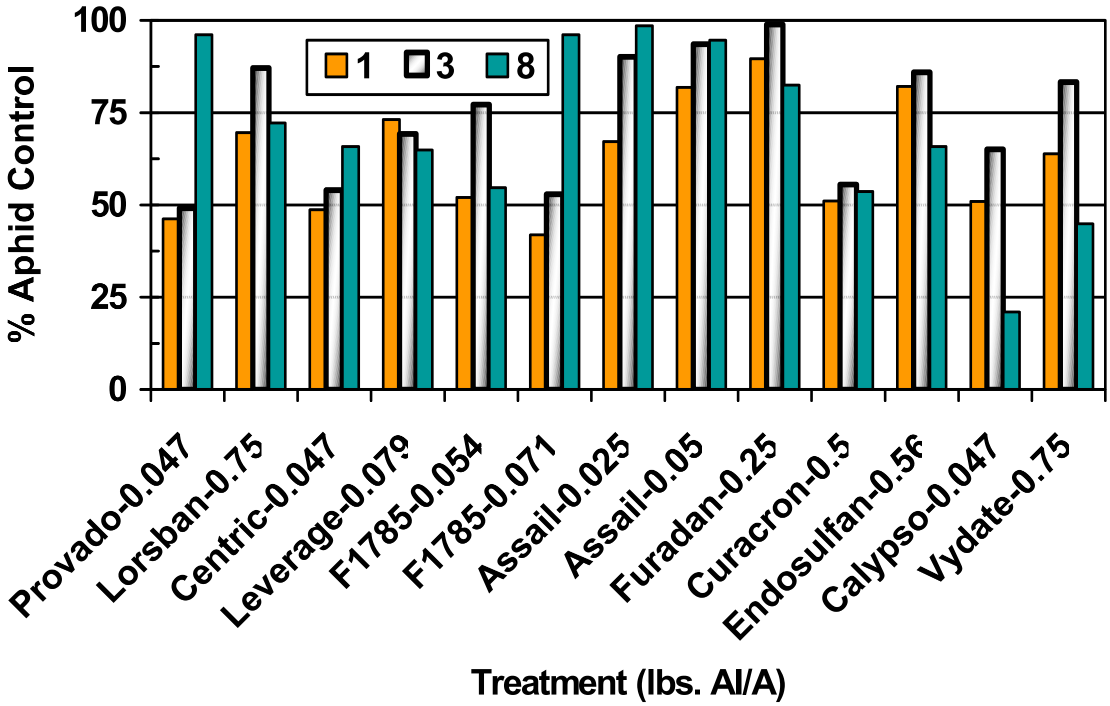

Figure 1. Cotton aphid control at specified days after treatment from foliar insecticides applied in Aug. 2003.

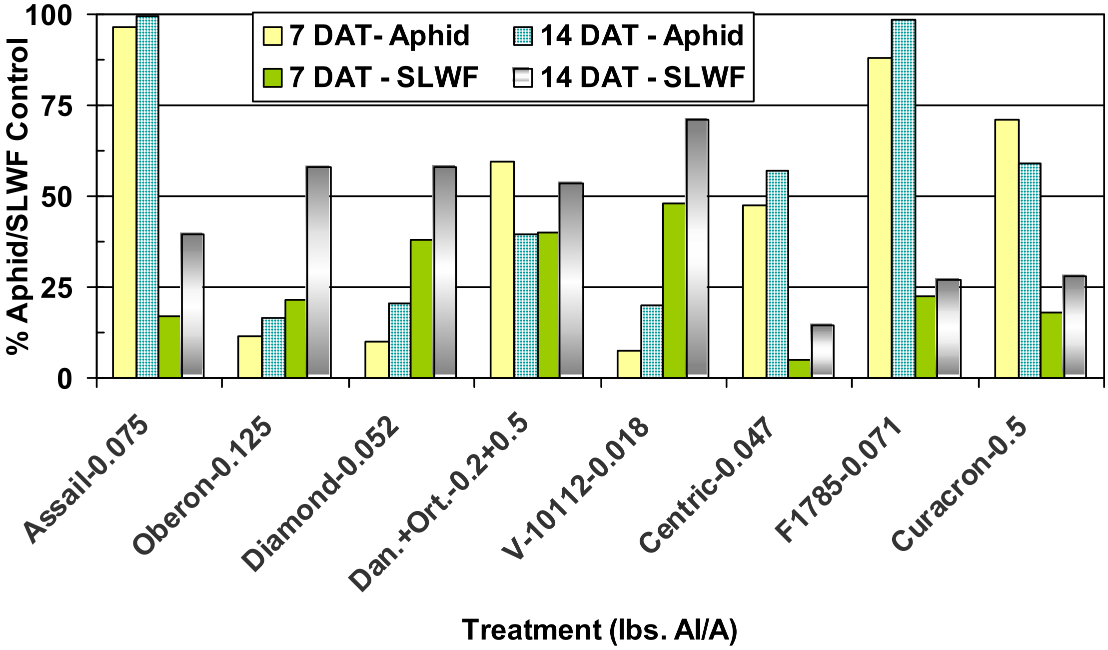

Figure 2. Cotton aphid and silverleaf whitefly control at two intervals after treatment from foliar insecticides applied in Sept. 2003.

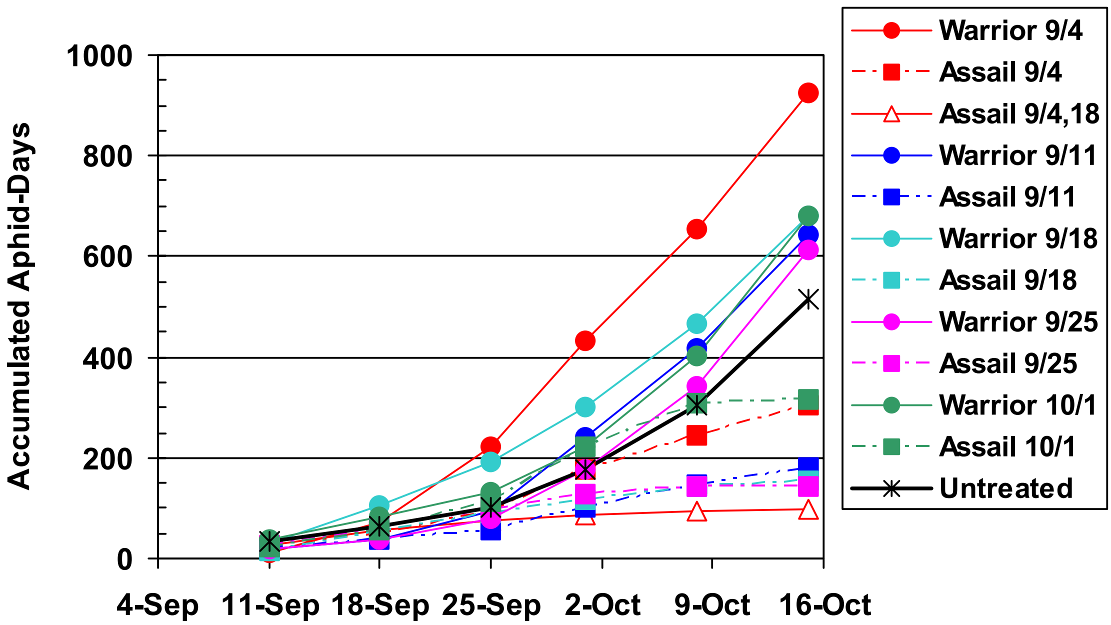

Figure 3. Accumulated aphid-days for cotton aphid and cotton lint stickiness study, 2003.

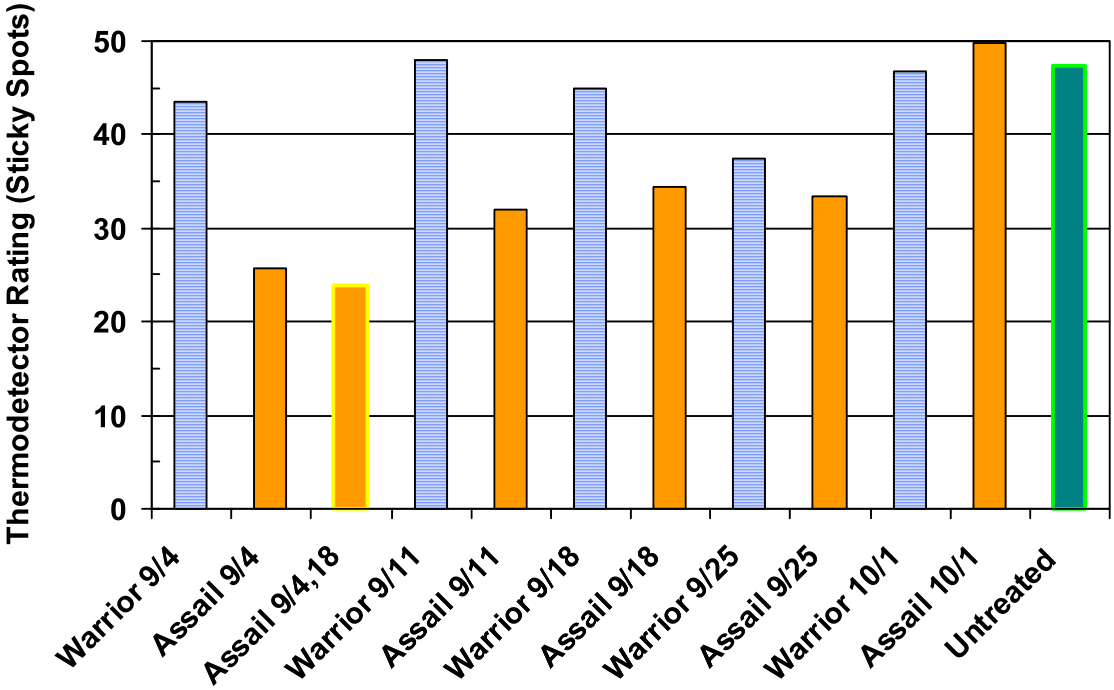

Figure 4. Influence of insecticide treatments and resulting aphid populations shown in Fig. 3 on cotton lint stickiness as measured by thermodetector ratings, 2003.