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MANAGEMENT OF LATE-SEASON INSECT PESTS FOR PROTECTION OF COTTON QUALITY IN THE SAN JOAQUIN VALLEY

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Abstract

In 2001, sticky cotton, arising from honeydew from cotton aphids and silverleaf whiteflies, became an issue in SJV cotton. Environmental conditions were conducive to honeydew deposition on exposed lint and late-season cotton aphid and silverleaf whitefly populations developed in many areas. Insecticides and acaricides account for about 10% of the budget required to grow cotton in the San Joaquin Valley during a typical year. Arthropod pests were significant factors in SJV cotton production during the mid-1990's; cotton yield losses from spider mites, cotton aphids, lygus bugs, and lepidopterous larvae in the SJV were as high as 15% during the peak years. However, the emergence of sticky cotton concerns for the SJV placed an added importance on optimal management of insect pests, primarily aphids and whiteflies. Appropriate research was planned to address management of silverleaf whitefly and cotton aphids in order to protect lint quality. Efficacy of registered insecticides (including some newly registered products) on cotton aphids during the late-season period was examined. The most cost-efficient means to utilize these insecticides in management programs were examined. The interaction between harvest aid materials and aphid and whitefly populations was a priority for research efforts.

Introduction

Refinement in IPM strategies is an important and ongoing process in cotton in the San Joaquin Valley (SJV). Spider mites, cotton aphids, lygus bugs, silverleaf whitefly and lepidopterous larvae in the SJV can negatively impact cotton yields with yield losses from these arthropods peaking in 1995 and 1997. In 2001, a new challenge developed when a unique set of conditions resulted in sticky cotton in the SJV. In early 2002, mills worldwide had complaints about the quality of the 2001 crop. The sticky cotton resulted from the excretions of populations of silverleaf whitefly, *Bemisia argentifolii*, and cotton aphids, *Aphis gossypii*. These are not new insects to the SJV, but 2001 was the first year when significant populations of both of these pests occurred during a time when lint was exposed in August and September.

The silverleaf whitefly was first found in the SJV in 1992 (Gruenhagen et al 1993). Seasonal abundance and dynamics were studied in 1993 and 1994 (Godfrey et al. 1994, Godfrey et al. 1995). Populations overwintered on citrus, weeds, fall/winter cole crops, and urban ornamentals. In the spring, SLWF levels were low and increased to a peak in the late summer and fall. Crops such as cucurbits, cole crops, and cotton were threatened by SLWF outbreaks and the infestations were most severe on the southern and eastern sides of the SJV (the so-called Citrus Belt). In 2001 and 2002, whitefly populations expanded greatly both in severity and spatially. Populations were seen farther north into the SJV. Areas of the SJV that previously had no experience with this pest were affected in 2001 and this contributed greatly to the sticky cotton situation in 2001.

The cotton aphid developed into a significant pest of SJV cotton during the 1990's (Godfrey 1998). Cotton aphids were particularly troublesome during the 1995 and 1997 production years; these populations peaked during the mid-season (July) and caused substantial reductions in yields and increased production costs. Late-season populations that could impact lint quality were rare. However, in 2001, late-season populations occurred in many areas and contributed to the sticky cotton phenomena.

Besides the insect population factors, other unusual factors contributed to the loss of cotton quality in 2001. The lack of the small amount of fall precipitation which commonly occurs, the extended growing season, the interruption in aerial applications in mid-September, and other factors all played a role in the occurrence of sticky cotton.

To address management of silverleaf whitefly and cotton aphids in terms of sticky cotton, appropriate research was conducted. Studies included insecticide efficacy on late-season aphid populations, cost effective strategies to utilize newly-registered neonicotinoid insecticides for protecting lint quality, and the interaction of harvest aid materials and aphid/whitefly populations.

Materials and Methods

Insecticide Efficacy Studies

Two efficacy studies were done 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 has been with mid-season aphids. The first test was done at the Shafter Research and Extension Center and applied with ground equipment on 7 Aug. at 20 GPA. This was at the onset of boll opening (~10% open bolls). The pretreatment population in this test was 28.2 aphids per leaf; aphid populations were sampled at 3, 7, and 14 days after treatment (DAT). Ten fifth main stem node leaves (counting from the terminal) were collected from each plot on each sample data. Aphid numbers were quantified in the laboratory. The second aphid control study was conducted at the West Side Research and Extension Center. Treatments were applied on 4 Sept. One Assail® treatment was applied at 5 GPA to simulate aerial application whereas all the other treatments were at 20 GPA. The pretreatment aphid population was 7.4 aphids per leaf and plants had about 40-50% open bolls (note some of these treatments were not legal according to the label). Populations were quantified at 2 and 9 DAT. The materials evaluated in these studies are listed in Table 1.

Strategies for Utilizing Insecticides to Protect Lint Quality

One of the strategies for managing late-season aphids discussed in the SJV in 2002 was to control the populations during the mid-season period just prior to boll opening. It was thought that the crop would remain "clean" of aphids for the rest of the season, particularly during the critical end of the season when lint is most exposed. Therefore, data were collected from the Shafter efficacy test at 21 and 35 DAT to see if control earlier in the season corresponded with lower aphid numbers during peak boll opening.

Many of the late-season aphid, and to some extent silverleaf whitefly, treatments in 2002 relied on a neonicotinoid insecticide. These materials are taken up by the leaves and move systemically in the plant. One key question regarding these materials was if they would continue to work as well as the crop progressed through cut-out to harvest, i.e., would the leaves absorb the insecticide. A study was conducted at the Shafter REC where one neonicotinoid, Assail (1.15 oz./A), was applied to a late-season aphid infestation at weekly intervals from 27 Aug. to 24 Sept. (day of defoliation). Aphid control was assessed at 7 day intervals after application.

Harvest Aids and Cotton Aphid Populations

Questions arose after the 2001 production season regarding the best manner to manage aphid and whitefly populations at the time of defoliation. Populations of aphids and/or whiteflies could be flared by harvest aid products or conversely may be reduced by these products. Adding an insecticide to the defoliation application was another strategy that had merit in many cases. Liu et al. (2002) conducted similar work on silverleaf whiteflies in Texas. The influences of these strategies on aphid population densities, honeydew production and sticky cotton were evaluated at the Shafter REC. Treatments listed in Table 2 were applied on 25 Sept. with ground equipment at 20 GPA. Cotton aphid populations were quantified pretreatment and at 2, 5, 7, and 14 DAT. Honeydew production was assessed using water sensitive paper following the techniques of Bi et al. (2001). Plant response were rated by quantifying percentage defoliation, desiccation, and open bolls as well as rating regrowth on a 1-5 scale and counting nodes above cracked boll at 6, 14 and 23 DAT. Hand-picked lint samples were collected on 18 Oct., ginned, and lint stickiness analyzed by thermodetector by the International Textile Center.

Results

Insecticide Efficacy Studies

Lorsban, Centric, Furadan, Leverage and Assail gave the best aphid control at 7 DAT (Fig.1). The results with these products were in the 60-70% control range. Vydate, Dibrom, Trilogy, and *Paecilomyces fumosoroseus* were less effective. Overall, products were less efficacious than we have seen in previous years on mid-season aphids (Wright et al. 1997), but it appears the late-season aphids are more difficult to control. At the West Side REC test, efficacy was even less than that seen in the Shafter test. At 2 DAT, control was very slight with the highest percentage control being 52% (Assail 0.57 oz. rate). Eight of the ten treatments provided less than 30% aphid control on this date. Lorsban, Metasystox-R, and both rates of Assail applied at 20 GPA provided at least 75% aphid control at 9 DAT. The simulated aerial application of Assail (5 GPA) was less efficacious than the comparable treatment at 20 GPA (63 versus 100% control at 9 DAT).

Strategies for Utilizing Insecticides to Protect Lint Quality

Aphid numbers at 35 DAT in the Shafter test were independent of the control efficacy earlier in the season. For example, aphid numbers in the Furadan, Dibrom, and untreated plots were similar at 35 DAT. Furadan is considered a very effective aphid control material, whereas Dibrom is relatively ineffecive. Populations at 35 DAT following Assail and Centric treatment (both effective treatments) were twice that seen in the untreated. It appears that aphid populations near the time of defoliation are not closely related to during the mid-season period.

Aphid control with Assail applied at weekly intervals showed that the 27 Aug. application controlled about 75% of the aphids, compared with the untreated, at 7 DAT and the percentage fell to ~50% at 14, 21, 28, and 35 DAT (Fig. 2). The applications on 3 Sept. and 10 Sept. consistently provided about 75% aphid control as did the 24 Sept. application. Results with this last application were confounded by the fact that the insecticide was combined with the defoliant (the defoliant was also applied to the untreated plots). Inexplicably, aphid control was nil from the 18 Sept. application. However, overall, it appears that Assail provided aphid control satisfactorily as the crop nears defoliation.

Harvest Aids and Cotton Aphid Populations

Cotton aphid populations were low in this study averaging 4.9 per fifth main stem node leaf in untreated plots. Rosenheim et al. (1995) suggested a threshold of 10-15 aphids per leaf following boll opening. Aphid levels responded significantly to the application of harvest aid materials. At 5 DAT, numbers ranged from 1.9 (Ginstar + Assail and Ginstar + Curacron treatments) to 5.2 aphids per leaf (untreated) (Table 3). At 7 DAT, populations were intermediate in the untreated and numerically lowest in the Ginstar + Assail and Defol 5 + Prep treatments and highest in the Ginstar + Prep treatment (Table 3). Aphid populations were similar in all the harvest aid treatments at 14 DAT and these were all lower than in the untreated. Honeydew production was variable in this study and no conclusions could obtained.

Plant response to the defoliants was fairly similar ranging from 55 to 76% defoliation, 65 to 93% dessication, 89 to 94% open bolls, 0.8 to 1.3 open above cracked boll, and a rating of 1.3 to 2.0 for regrowth at 14 DAT. These values differed substantially from that in untreated plots.

The number of sticky spots from the thermodetector analysis showed an average of 10.6 to 20.1 spots in the treated plots compared with 34.4 spots in the untreated plots (Fig. 3). There were no significant differences among the means of the treated plots. Some of these plots would be rated as "sticky" depending on the criteria used; values of 10 to 18 sticky spots are the limits of that commonly used to delineate stickiness. This amount of sticky was surprising for the relatively low number of aphids. Additional studies will be conducted on late season insect thresholds and treatments along with different methods for measuring and relating insect presence with stickiness.

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Table 1. Treatment list for Shafter and West Side REC late-season cotton aphid tests in 2002, California.

Product	Formulation per A	Shafter REC	West Side REC
Provado 1.6F	3.75 fl. oz.	x	x
Lorsban 4E	1.5 pts.	x	x
Centric 25WG	3 oz.	x	x
Leverage 2.7EC	3.75 fl. oz.	x	x
Paecilomyces fumosoroseus	0.125 lbs.	x	
Paecilomyces fumosoroseus	0.25 lbs.	x	
Assail 70WP	0.57 oz.	x	x
Assail 70WP	1.15 oz.	x	x[A]
Vydate C-LV	25.5 oz.	x	
Furadan 4F	8 oz.	x	x
Trilogy	1:100	x	
Dibrom 8EC	1 pt.	x	
Lannate LV	0.75 pts.		x
Thiodan 3EC	1 qt.		x
Metasystox-R	1 qt.		x
Untreated	---	x	x

[A] applied at 5 GPA and at 20 GPA.

Table 2. Treatment list for Shafter REC cotton aphid by harvest aid test in 2002, California.

Treatment	Formulation per A
Ginstar-EC	10 oz.
Ginstar-EC	5 oz.
Ginstar-EC + Prep	5 oz. + 1 qt.
Defol 5 + Prep	1 gal. + 1 qt.
Defol 5 + Gramoxone Extra	1 gal. + 13 oz.
Harvade-5F + Ginstar-EC	8 oz. + 6 oz.
Ginstar-EC + Curacron 8E	5 oz. + 0.5 pts.
Ginstar-EC + Prep + Curacron 8E	5 oz. + 1 qt. + 0.5 pts.
Ginstar-EC + Assail 70WP	5 oz. + 0.9 oz.
Untreated	----

Table 3. Influence of harvest aid materials on populations of late-season cotton aphids, CA, 2002.

	Days After Treatment			
Treatment	2	5	7	14
Ginstar-EC	3.3 a	2.1 cd	4.5 ab	1.7 a
Ginstar-EC	4.9 a	3.4 b	3.4 bc	1.6 a
Ginstar-EC + Prep	5.2 a	2.9 bc	5.4 a	2.3 a
Defol 5 + Prep	4.9 a	2.7 bc	0.9 de	0.9 a
Defol 5 + Gramoxone Extra	5.9 a	3.0 bc	1.4 de	0.9 a
Harvade-5F + Ginstar-EC	6.3 a	2.9 bc	3.2 bc	1.5 a
Ginstar-EC + Curacron 8E	5.1 a	1.9 cd	2.0 cd	1.0 a
Ginstar-EC + Prep + Curacron 8E	5.1 a	2.3 cd	3.4 bc	1.4 a
Ginstar-EC + Assail 70WP	3.3 a	1.9 d	0.0 e	0.6 a
Untreated	4.8 a	5.2 a	2.4 cd	7.4 b

Means within a column followed by the same letter are not significantly different, LSD, $P<0.05$.

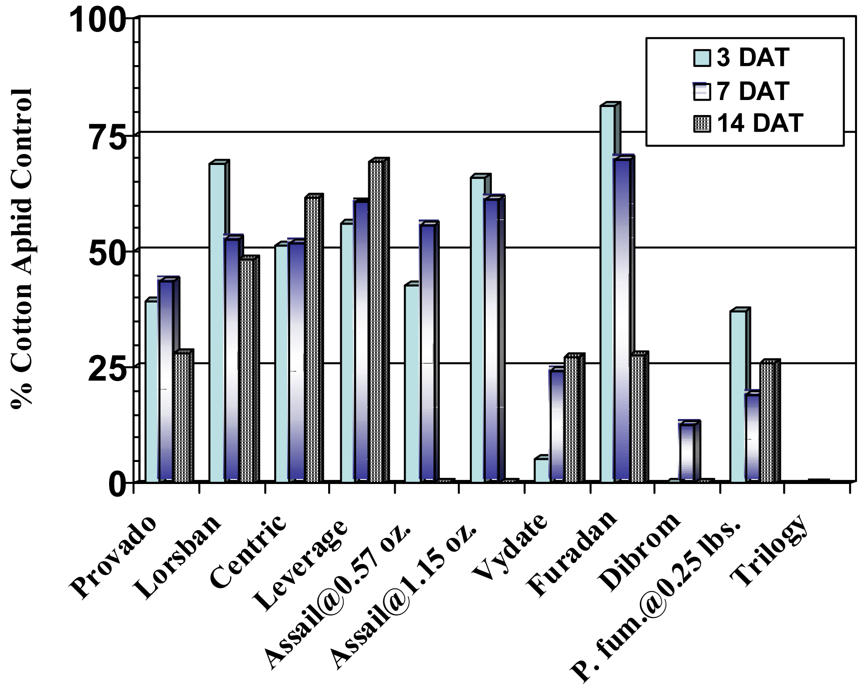

Figure 1. Cotton aphid control with various insecticides at 3, 7, and 14 days after treatment, Shafter REC, 2002.

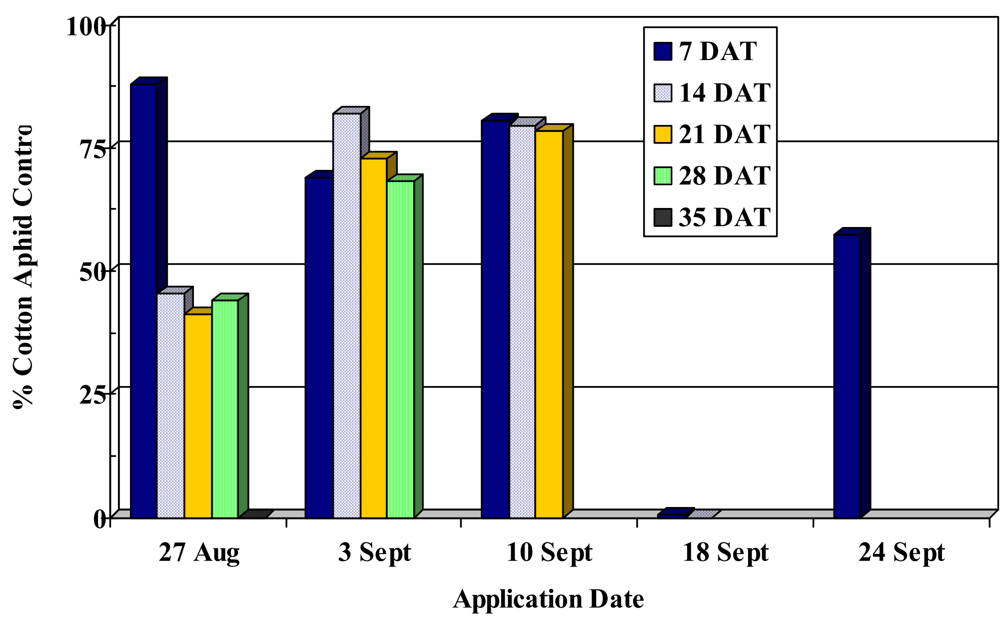

Figure 2. Percentage cotton aphid control with Assail® applied at weekly intervals during the late-season period, Shafter REC, 2002.

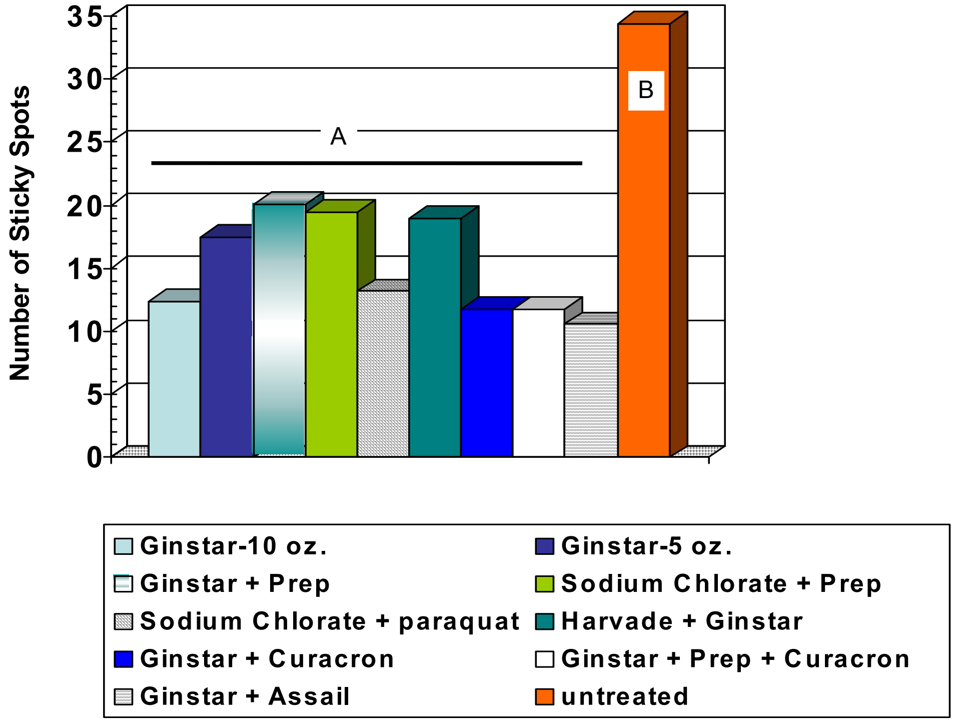

Figure 3. Cotton lint stickiness following treatment with several harvest aid materials and insecticides, Shafter REC, 2002.