

Thresholds, Monitoring and Sampling

Development of a Pheromone-Based Monitoring System for *Calocoris norvegicus* (Gmelin)  
(Hemiptera: Miridae)

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Field bioassay trials designed to identify the sex pheromones of *Calocoris norvegicus* were continued in 1997. The purpose of this work was to develop pheromone traps as a monitoring tool to detect *Calocoris* migrations into pistachio orchards prior to shell hardening in early spring. Most of the 1997 field trials were carried out in a large vineyard near Avenue 10 and Highway 41 in southern Madera County, California. This vineyard was suitable as a *Calocoris* bioassay test area because of the vetch cover crop that existed throughout the vineyard, providing large populations of *Calocoris* from late March through April. Standard wing traps (Pherocon 1C, Trécé, Inc., Salinas, CA) were suspended from the center wire in the vineyard row at the top of the vetch cover crop. All treatments with candidate pheromone isomers, blends, and lure load rates were replicated at least five times in a randomized complete block design. In each test, traps were rotated one position in the trap placement array at each count interval. Bugs responding to the traps were counted and removed at one to three day intervals throughout all the tests in Madera County.

The first bioassay for *Calocoris* was emplaced at the Madera County location on March 31 and continued through April 7, 1997. This test used relatively high rates of pheromone on rubber septa, similar to loads used in the 1996 *Calocoris* trials, and compared a five-component ("complete") pheromone blend to blends containing one to four of the respective components. In addition to the traps with synthetic pheromone lures, five traps each with three virgin *Calocoris* females were included in this test. Although high numbers of bugs were trapped in this bioassay (Table 1), it was difficult to separate any of the respective pheromone blends and treatments because of high numbers of female bugs that were also trapped. In addition, an unacceptably high number of bugs, both male and female, was trapped in the five check or blank traps in this trial (ca. 3 m : 1 f) as a result of the general movement and activity of the bugs both in the vetch and in the vine canopies. The one positive aspect of this first 1997 test was the high number of male bugs collected along with an improved male:female ratio (ca. 5:1) in the traps with virgin female bugs, confirming again the presence of a female-produced sex attractant. It was determined that the pheromones applied to red rubber septa began to lose attractiveness after only three to four days of exposure in the field. Also, the bugs were observed to be very active from early morning to midday in contrast to observations of adult *Phytocoris* spp. which are active primarily at night. Because of the high numbers of females collected in the trial, we continued testing only those pheromone blends that collected ratios of males to females in a ratio higher than that observed in the blank traps (approximately 3:1).

A second *Calocoris* pheromone bioassay was placed at Madera on April 7-14 using

varying ratios of a three-component blend. A total of 20 pheromone blends was included in this trial. As in the first trial, high numbers of both males and females were collected in the pheromone traps. Unlike the first test, however, some pheromone blends in this second trial collected only males in most of the five trap replications. Consequently, pheromone blends that collected either relatively high numbers of males in traps or ratios of more than three males to one female over the duration of the test were selected for continued testing.

Laboratory data from *Calocoris* electroantennograms, along with results of the first two field bioassays for *Calocoris*, indicated that two primary components produced by *Calocoris* females were involved in the *Calocoris* sex pheromone. Consequently, the third series of *Calocoris* pheromone bioassays in 1997 was designed to evaluate various ratios of two-component blends of pheromones but using two of three candidate isomers. This trial, conducted in the Madera vineyard location April 15-21, resulted in again high collections of both males and females in all of the candidate pheromone treatments (over 1,800 bugs total in seven days). Because this test was also very difficult to evaluate because of the high numbers of females collected, a fourth set of baits, again using two-component blends of three different candidate isomers, was emplaced in late April at the Madera location. This fourth series of bioassays was again somewhat confusing and contradictory but the one result that stood out was that, in several of the two-component blends in this trial, more female bugs were collected than male bugs. This was the first time this had been observed consistently in any of the *Calocoris* bioassays previously conducted and was not the type of result expected, since the *Calocoris* pheromones are primarily produced by females and should attract males.

Because the previous two bioassays using two-component blends had been inconclusive it was decided to go back and reevaluate various three-component blends of *Calocoris* isomers, again using relatively high doses of the total blend in each rubber septa. The results of this trial showed that the three-component blends were more attractive than any of the two-component blends previously evaluated in the field. The series of *Calocoris* pheromone bioassays in Madera was terminated on April 28 due to rapidly declining adult bug populations in the test field, even though the vetch was still in relatively good condition from vineyard irrigations.

Because the loss of univoltine (one-generation) *Calocoris* populations had been anticipated in the central and southern San Joaquin Valley, a test area for *Calocoris* in the Sacramento Valley had been located through efforts of Cooperative Extension farm advisors in Sutter and Yuba counties where populations of adult *Calocoris* were still present in commercial vetch seed fields. Consequently, the last *Calocoris* pheromone bioassay test (no. six) was emplaced at Pleasant Grove, Sutter County, on May 2 using combinations of pheromone blends that had looked promising from all previous trials in 1997. This trial was designed to evaluate six candidate pheromone blends, but was different from previous trials in that the standard amount of pheromone per lure was compared to a load rate of 1/10 of the standard rate. Also, the trap design in this trial was changed from the wing trap designs previously used in all tests to smaller Jackson traps to reduce the sticky trapping surface. As in earlier trials, five replications per pheromone blend were emplaced in a randomized complete block. Traps were suspended from wooden stakes approximately three to six inches above the vetch plants.

Results of this *Calocoris* field bioassay showed that one of the three-component blends

was highly and significantly more attractive than any of the other blends in the trial (Table 2). The most attractive pheromone blend in this test (CN-97-114) was the same as treatment 104 but 1/10 the dose. This finding was our first indication that most if not all of the previous trials had been using dose rates of pheromone on rubber septa dispensers much too high for proper response and collection of male bugs at the pheromone sources. The change to the smaller Jackson traps also seemed to eliminate much of the random collection of female *Calocoris* on the sticky surfaces, which had been a perplexing and continuing problem with the larger, more open wing traps. Also for the first time in any *Calocoris* field bioassays, adult male bugs were observed walking and moving about on the surface of the Jackson traps, as well as on the plant foliage in close proximity to the trap and pheromone source. This suggests that even more male insects than those actually trapped were being attracted to the vicinity of the pheromone source. It also suggests that perhaps even further modifications in trap design for *Calocoris* (and *Neurocolpus*) should be evaluated in order to optimize or maximize collection of responding bugs.

**Table 1.** Field bioassay of *Calocoris norvegicus* pheromone blends, trial I, Madera County, California.

| Pheromone blend      | No. <i>Calocoris</i> collected <sup>1</sup> |         |
|----------------------|---|---------|
|                      | Males                                       | Females |
| CN-97-1              | 33  | 11      |
| CN-97-2              | 37  | 15      |
| CN-97-3              | 41  | 10      |
| CN-97-4              | 34  | 37      |
| CN-97-5              | 44  | 18      |
| CN-97-6              | 48  | 22      |
| CN-97-7              | 52  | 8       |
| CN-97-8              | 45  | 27      |
| CN-97-9              | 40  | 11      |
| CN-97-10             | 37  | 26      |
| CN-97-11 (blank)     | 29  | 9       |
| CN-97-12 (3 females) | 208   | 40      |

<sup>1</sup>Total bug collections from five counts and trap rotations, April 1-7, 1997.

**Table 2.** Field bioassay of *Calocoris norvegicus* pheromone blends, trial VI, Sutter County, California.

| Pheromone blend        | No. <i>Calocoris</i> collected <sup>1</sup> |         |
|------------------------|---|---------|
|                        | Males                                       | Females |
| CN-97-101 <sup>2</sup> | 1   | 1       |
| CN-97-102              | 1   | 0       |
| CN-97-103              | 1   | 0       |
| CN-97-104              | 9   | 0       |
| CN-97-105              | 0   | 0       |
| CN-97-106              | 0   | 0       |
| CN-97-111 <sup>3</sup> | 0   | 0       |
| CN-97-112              | 0   | 0       |
| CN-97-113              | 2   | 0       |
| CN-97-114              | 23  | 0       |
| CN-97-115              | 0   | 0       |
| CN-97-116              | 1   | 0       |
| CN-97-117 (blank)      | 3   | 2       |

<sup>1</sup>Two counts, one trap rotation, May 5-6, 1997.

<sup>2</sup>Standard pheromone load per septa, treatments 101-106.

<sup>3</sup>1/10 standard pheromone load per septa, treatments 111-116.