ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
January 1, 2023 – December 31, 2023

PROJECT TITLE: Refining true armyworm monitoring using pheromone traps

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OBJECTIVES AND EXPERIMENTS CONDUCTED, BY LOCATION, TO ACCOMPLISH OBJECTIVES:

OBJECIVE: Use armyworm moth catches from pheromone traps to predict the most appropriate time to monitor for armyworm larvae in the field.

Methods

Seven commercial rice fields were monitored during the 2023 season with pheromone traps and weekly larval searches. Fields monitored belonged to the pheromone trapping network that the PIs have been running for several years, where 15 sites are monitored. These fields have a history of armyworm infestations or are in an area where armyworms have been a problem in the past.

In each field, three bucket traps lured with true armyworm pheromones (Trece) were established soon after seeding (table 1). Each trap was hanged from a 4 ft wooden stake and placed in a levee. As a result, traps were 6-7 ft above the soil level and ended up 2-3 ft above the canopy when rice reached its maximum height. Stakes with traps were located 40-50 ft from the field edge, nearby irrigation boxes. Distance between traps ranged from 190 to 1800 feet (table 1). Lures were replaced every two weeks and moths counted every week. VaporTape strips (1x0.5 inches) containing 10% dichlorvos were placed inside the bucket and replaced every 4 weeks.

The week when the first moth count was made (week of 5/30) was considered week 1. Larvae monitoring started on the week of 6/21, or week 5, when the first armyworm larvae could be found, and ended on 9/14, or week 17. In each field, larval searches were conducted by three or four scouts. Each scout would perform three or four searches in random areas near the headlands of the field in the vicinity of a trap, so that basins on either side of the trap were inspected. For each week, a total of 12 searches were performed per trap and a minimum of 36 searches per field. For each search, the area within a 2 ft diameter ring was inspected. The number of larvae found, level of defoliation or panicle injury was recorded. Defoliation was recorded from week 5 to week 12 and panicle injury was recorded from week 11 to week 17. Defoliation was ranked according to the scale presented in table 2. Panicles injured by armyworm were counted within each ring.

Number of moths for each trap was standardized to number of moths/day by dividing the number of moths counted at each check date by the number of days since the last check (typically 7 days, but not always).

Analysis of covariance was used to relate number of moths in traps per day to number of larvae/ft^2, using number of larvae as covariate and location as factor. The number of larvae used were the number found the same week of moth inspection, or 1, 2, or 3 weeks later. The analysis was conducted relating each trap (one observation) to the average number of larvae from searches around that trap (average of 12 observations) for each week or relating the average number of moths in traps per location (average of 3 observations) to the average number of larvae for all the field (average of 36 observations) for each week.

Results

Previous work in true armyworm moth monitoring has shown that there are typically two peaks of moth activity, one in late June and another mid-August. When averaging trap counts in the 15 sites of the trapping network, 2023 reached moth flight peaks later than in previous years (fig. 1). This may be because 2023 was a late planted year and experienced spring rains and cooler temperatures during the first part of May.

During 2023, average moth numbers were greater than any of the years when the trapping network has been conducted (fig. 1). However, larval populations were low and there were very few problems with armyworms in commercial fields. In all locations the first moth peak was observed between weeks 8 and 9 and the second peak between weeks 14 and 15 (fig. 2).

The average number of larvae found during larval searches was very low (fig. 3). The Richvale location had the highest numbers. The first larval peak occurred between weeks 8 and 9, while the second was at 15 weeks.

For 2023, when relating the number of moths for each trap to the average number of moths around that trap, the best fit (adjusted r-squared) is obtained when using the number of larvae two weeks later (table 3); though results are similar for 1 week later. The analysis indicates that for each location, the slope of the line relating number of moths to number of larvae is different, but all locations have same the same intercept. When using the average moth numbers and larvae per location, the best fit is obtained when using the number of larvae either one or two week later. Similarly, the intercept is the same for all locations, but slopes are different (table 3). These relationships are presented in graph form in fig. 4.

Given the low larval levels observed in 2023, results from this year should be interpreted carefully. Results seem to coincide with results from 2022 and field observations made by the PIs during the past few years, that is, that the relationship between moth captures and larvae is field specific. Unfortunately, we cannot use the number of moths caught in pheromone traps to predict larval numbers. However, the moth numbers can be used to time when scouting should be intensified. Since in each field the number of moths is related to the number of larvae one or two weeks later, growers and PCAs can expect that larval numbers will peak one or two weeks after the moth peak is found. Additionally, results of moth trapping this year show that the peak number of moths is not always found around the same date; peak moth numbers can vary each year.

Because the number of observations when defoliation was higher than 25% was very low, the observations for 2022 and 2023 were pooled (fig. 5). Data indicates that densities above 5 larvae per square foot can result in defoliation that is 25% of the canopy or higher. Past research has shown that 25% defoliation is a good action threshold for insecticide applications, therefore managers can use 5 larvae per square foot as larval economic threshold. More observations are needed to confirm this value; however, in informal consultations with growers and PCAs this density seems to be a good approximation to the economic threshold.

Panicle injury was very low during 2023. Most of the samples (80%) did not have panicle injury. The most injury that was found was 3 injured panicles per square foot; if we consider panicle density to be 60 panicles/square foot, this level of injury is only 5%. Past research has determined that the threshold for panicle injury is 10%. When regressing the number of larvae/square foot with the number of injured panicles per square foot, a poor (r^2=0.034) though significant (P<0.001) relationship is found (number of larvae/square foot=0.11+0.37*number of injured panicles/square foot). More observations are needed to improve this prediction.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS

In 2023, moth populations were high; however, larval populations were very low. Considering 2022 and 2023, data indicates that weekly moth numbers caught in pheromone traps can predict number of larvae found in the field one or two weeks later. This information can be used to enhance monitoring. When moth numbers peak in traps, one could expect peak larval number one or two weeks later.

Analysis of defoliation and larval density seem to indicate that the 25% defoliation threshold is reached when larval densities are 5 larvae/square foot. The number of injured panicles in 2023 was very low, therefore conclusions about panicle injury cannot be made. More data is needed to improve the relationship between larval densities and defoliation and panicle injury.

PUBLICATIONS AND REPORTS

1. **Espino, L. 2022.** 2022 pest review. Rice Leaf Newsletter. November.
2. **Espino, L. 2022.** Bugs to watch out for in 2022. Rice Farming 56 (5): 21.
3. **Espino, L. 2022.** The true armyworm continues to be an issue for rice growers. CAPCA Adviser 25 (5): 56-58.
4. **Espino, L. 2022.** Advances in management of armyworms in rice. Progressive Crop Consultant 7 (6): 20-23.
5. **Bateman, N. R., G. Lorenz, B. C. Thrash, J. Gore, M. O. Way, B. E. Wilson, and L. Espino. 2022.** 2018 rice insect losses in the United States. Midsouth Entomologist 15: 10-18.
6. **Bateman, N. R., G. Lorenz, B. C. Thrash, J. Gore, M. O. Way, B. E. Wilson, L. Espino, and M. T. Vanweelden. 2022.** 2019 rice insect losses in the United States. Midsouth Entomologist 15: 19-28.
7. **Bateman, N. R., G. Lorenz, B. C. Thrash, J. Gore, M. O. Way, B. E. Wilson, L. Espino, and M. T. Vanweelden. 2022.** 2020 rice insect losses in the United States. Midsouth Entomologist 15: 29-38.
8. **Espino, L., T. Clark, M. Giron, and C. Baez. 2022.** Insecticides for armyworm control, Rice Field Day Booklet, Rice Experiment Station, Biggs, CA.
9. **Espino, L. 2022.** Pest management update, Rice Field Day Booklet, Rice Experiment Station, Biggs, CA.
10. **Espino, L. 2023.** Insecticides for armyworm control. Rice Leaf Newsletter. January.
11. **Espino, L. 2023.** Pyrethroids in California rice. Rice Farming 57 (5): 20.
12. **Espino, L., T. Clark, and C. Baez. 2023.** Armyworm monitoring update, Rice Field Day Booklet, Rice Experiment Station, Biggs, CA.
13. **Espino, L. 2023.** Rice disease and arthropod update, Rice Field Day Booklet, Rice Experiment Station, Biggs, CA.

Table 1. Location of fields monitored for moth numbers and larval densities during 2023.

Field ID	County	Date traps set up-removed	Distance between traps (ft)
Richvale	Butte	5/12-9/19	710
Afton	Butte	5/15-9/19	340
Farris	Butte	5/18-9/19	700-1600
W	Glenn	5/9-9/19	1300
SS	Glenn	5/9-9/19	580
PP	Glenn	5/9-9/18	470-1800
Ramirez	Yuba	5/24-9/18	600

Table 2. Defoliation level categories used to evaluate defoliation by true armyworm in 3-ft^2 rings.

Defoliation level	Description
0	No defoliation observed
1	Bite marks observed in a few plants inside search area, up to 10% of foliage inside search area consumed
2	Most plants inside search area with bite marks, up to 25% of foliage inside search area
3	25% or more of foliage inside search area consumed

Table 3. Results of analysis of covariance between number of moths per trap and number of larvae at seven locations, 2022 and 2023.

Statistic	Using each trap				Using average of field			
	Same week	1 week later	2 weeks later	3 weeks later	Same week	1 week later	2 weeks later	3 weeks later
	2022							
Adjusted r-squared	0.112	0.302	0.258	0.100	0.123	0.645	0.497	0.154
P for intercept	0.034	0.165	0.806	0.500	0.655	0.649	0.992	0.831
P for slope	0.033	<0.001	<0.001	0.307	0.349	<0.001	0.001	0.400
	2023							
Adjusted r-squared	0.049	0.286	0.289	0.161	-0.031	0.383	0.383	0.117
P for intercept	0.158	0.923	0.850	0.886	0.803	0.941	0.910	0.988
P for slope	0.994	<0.001	<0.001	<0.001	0.997	<0.001	<0.001	0.211

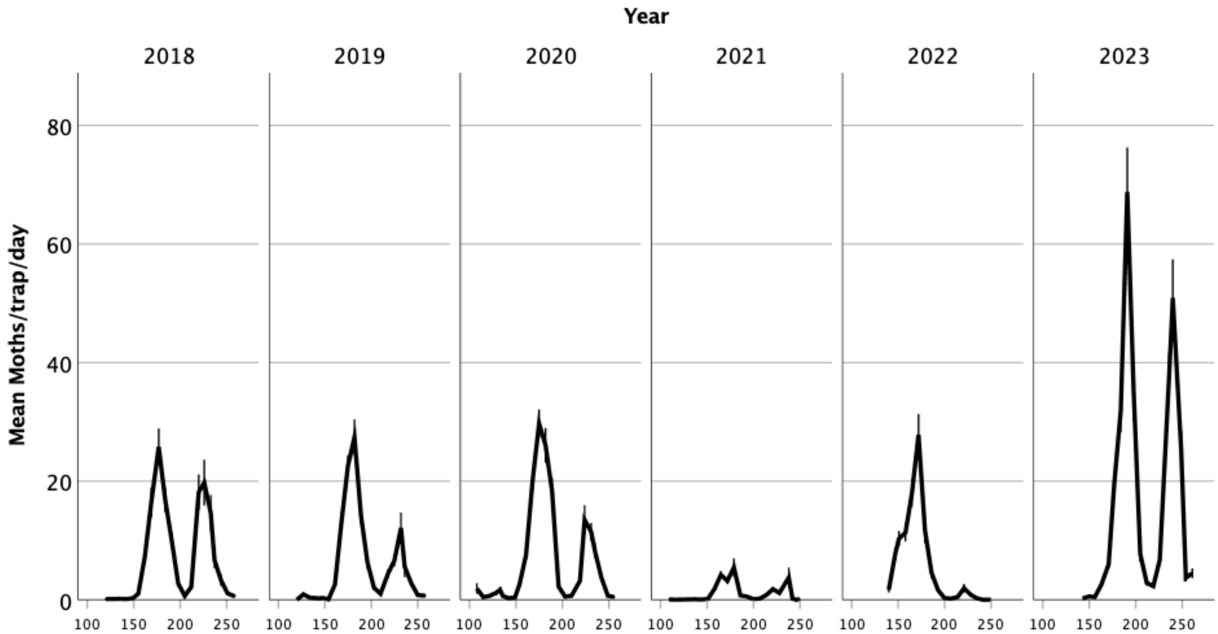

Fig. 1. Average number of true armyworm moths per trap per day in 15 sites across the Sacramento Valley, 2018-2023.

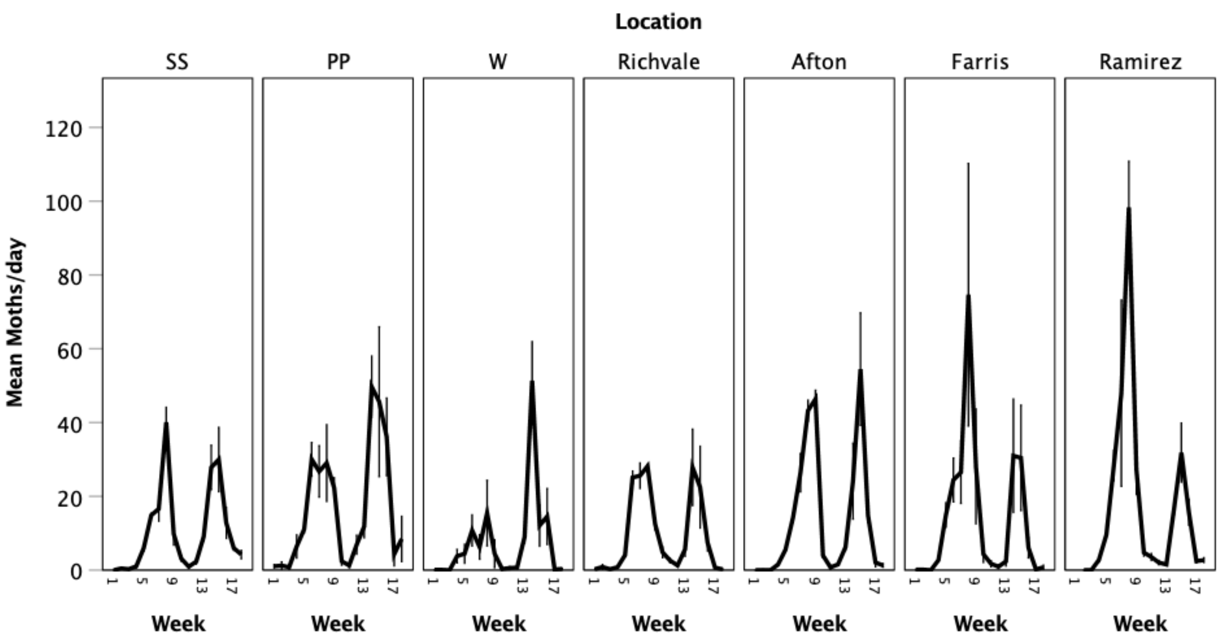

Figure 2. Average number of true armyworm moths per trap per day in seven locations of the Sacramento Valley of California, 2023.

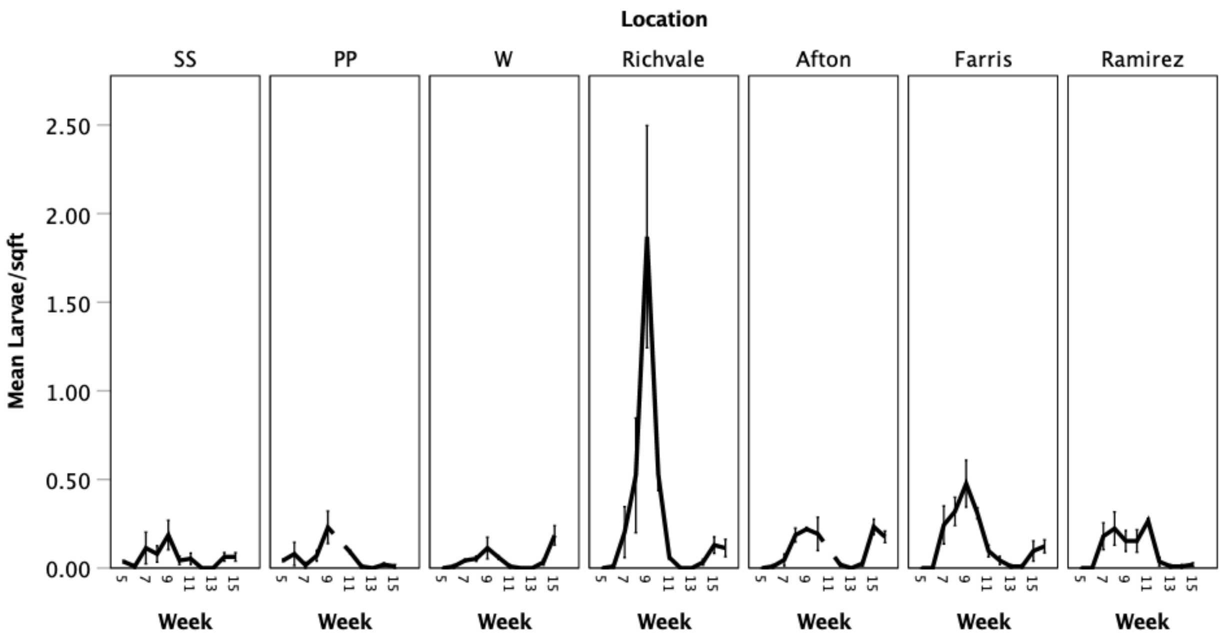

Figure 3. Average number of true armyworm larvae/ft^2 in seven locations of the Sacramento Valley of California, 2023.

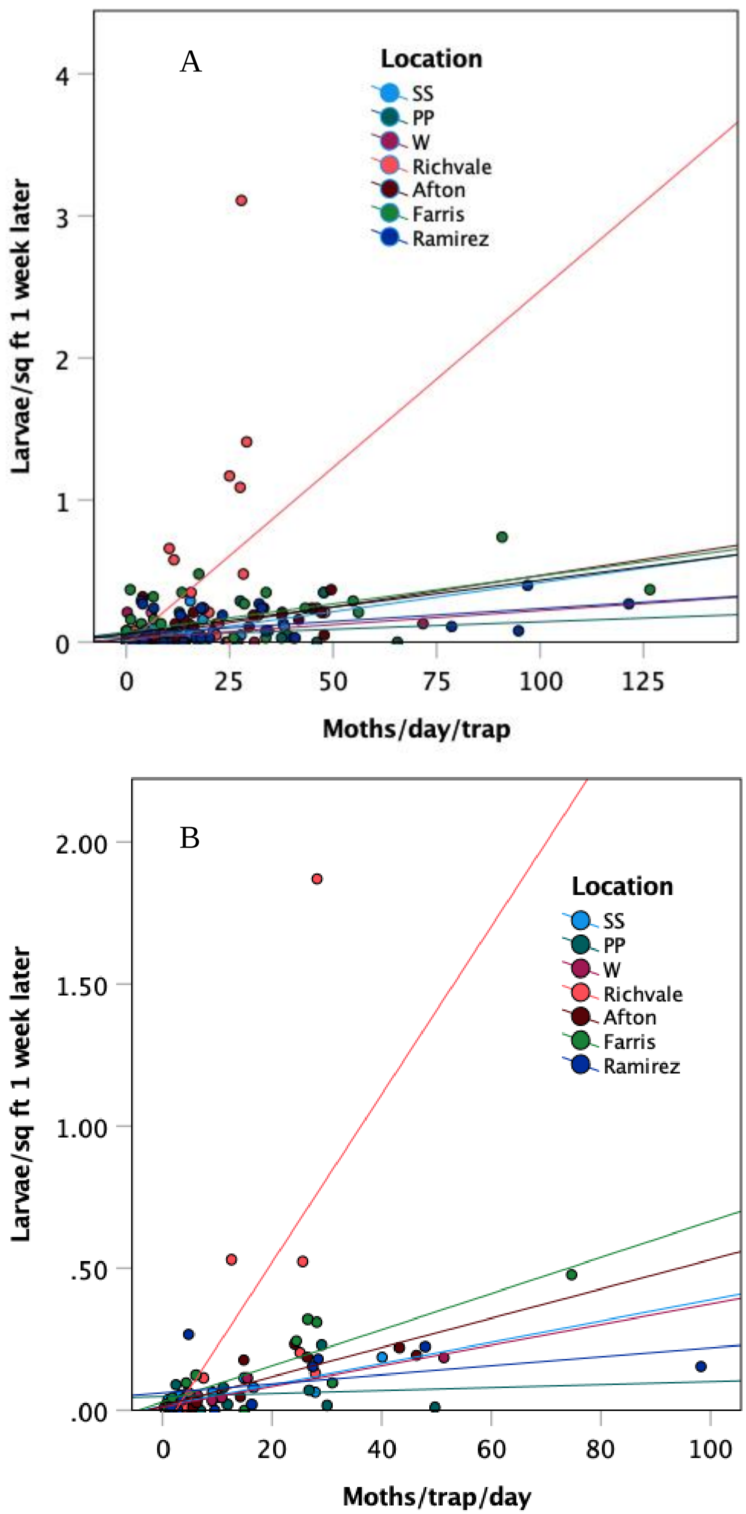

Figure 4. Relationship between number of armyworm moths captured in traps and number of larvae per square foot on week later using each trap versus the average of larvae around each trap (A) and using the average for the three traps and the average number of larvae for the field (B). 2023.

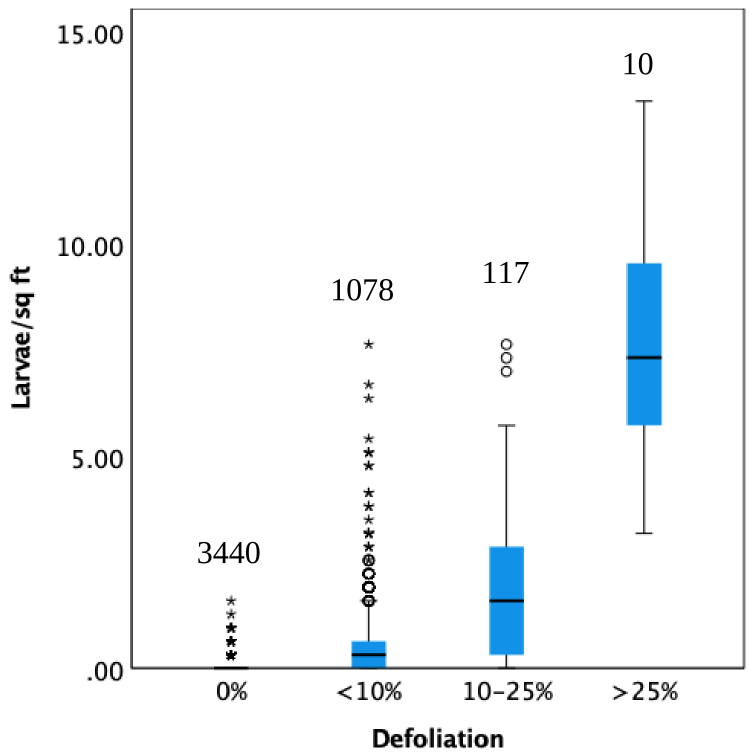

Figure 5. Boxplot of number of larvae per square foot found causing defoliation in seven locations of the Sacramento Valley of California, 2022 and 2023. Numbers above boxes correspond to the number of observations of that level of defoliation.