ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
January 1, 2022 – December 31, 2022

PROJECT TITLE: Refining 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 growing 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. These fields have a history of armyworm infestations or are in an area where armyworm has been a problem in the past.

In each field, three bucket traps lured with true armyworm pheromones (Trece) were established soon after seeding. 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 field 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 1600 feet. 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.

Larvae monitoring started on the week of 6/13, when the first armyworm larvae are typically found. 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 the 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 36 searches per field. For each search, the area within a 2 ft diameter circle was inspected. The number of larvae found and the level of defoliation and panicle injury was recorded. Defoliation was ranked according to the scale presented in table 2.

The week when the first moth count was made (week of 5/16) was considered week 1. Number of moths for each trap was standardized to number of moths/day by dividing the number of moths counted at each check by the number of days since the last check (typically 7 days, but not always). Number of larvae is expressed in number per square foot.

Analysis of covariance was used to relate number of moths in traps per day to number of larvae/ft2, using number of larvae as covariate and location as factor. The number of larvae used were the number found the same week, 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 (12 observations) for each week or relating the average number of moths in traps per location (3 observations) to the average number of larvae for all the field (36 observations) for each week.

Results

Previous work in armyworm moth monitoring has shown that there are typically two peaks of moth activity, one in late June and another in mid August. In 2022, the first peak was similar to what has been observed in previous years. In all locations except Farris, this first peak occurred on week 6, corresponding to late June (fig. 1). At Farris, the peak was reached on week 5. At the peak, average moth counts were 38.8 moths/trap/day. Variability increased as the number of moths increased. The second peak was low compared to previous years, and very low compared to the first peak. For all locations, except White, the second peak was reached on week 13, corresponding to the second week of August. At White, the second peak occurred on week 14. On average, the second peak was 2.8 moths/trap/day.

Number of larvae/ft2 was highly variable among locations. At W, White, Sankey, and Ramirez number of larvae/ft2 was less than 1 during the whole season, while at Richvale, Afton, and Farris it ranged from 1.2 to 2.8 at the peak. Only one peak was observed, which occurred between weeks 6 and 8. Towards the end of the season a small increase on larvae density was observed at Afton and Farris. At the Richvale location, an insecticide application was made at the end of week 7.

Because of the absence of larvae at White, this location was removed from the analysis. When relating the number of moths for each trap to the average number of moths around that trap, the best fit is obtained when using the number of larvae one week later (table 3). The analysis indicates that each location has a different slope but all locations have same the same intercept. When using the average moth numbers and larvae for the field, the best fit obtained when using the number of larvae one week later as well. Similarly, the intercept is the same for all locations but slopes are different (table 3). These relationships are presented in graph form in fig. 3.

These results indicate that the relationship between moth captures and larvae is field specific. While in some fields the number of moths captured in the traps is similar (for example, W and Richvale), the number of larvae found in the field is very different. The reason for this variation from field to field is not known, but may be related to presence of natural enemies, herbicide applications early in the season, landscape composition, etc.

Averaging moth and larvae values per field per week increased the fit of the ANCOVA model from 30 to 65%. This is because there was quite a bit of variability in the number of moths found in each trap per field. By averaging per field, we are reducing the variability. However, the predictions that each model give are different. For example, for Richvale, using the model that uses the values for each trap, finding 30 moths per trap predicts 3.5 larvae/square foot a week later. The model that uses the average of the three traps predicts close to 3 larvae/square foot a week later. Nevertheless, these values are close. Collecting more data in upcoming years is needed to improve the model.

The stage of development of monitored fields was similar throughout the season. Because of this, defoliation observations will be pooled for all locations. Larval densities peaked between weeks 6 and 8, therefore, the analysis will focus on these weeks. Defoliation started to become noticeable after week 6 and reached more than 25% on a few samples (at the Richvale location) (fig. 4). Overall, densities up to 7.5 larvae per square foot caused defoliation that remained below 25%, the economic threshold. Only in a few samples 25% defoliation or higher was observed, in these cases, the number of larvae ranged between 7.5 to 12/square foot. Panicle injury was not observed in any of the locations monitored.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS

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

Moth numbers caught in pheromone traps related well to the number of larvae found in the field on week later. The relationship between moths and larvae seem to be field-specific, with some fields having high number of moths but very low number of larvae and others fields with similar number of moths having much higher larval populations.

Analysis of defoliation and larval density seems to indicate that the 25% defoliation threshold is reached when larval densities reach 7.5/square foot.

Table 1. Location and important dates for stem rot and aggregate sheath spot (AGSS) variety trials, 2022.

Field ID	County	Date traps set up-removed	Distance between traps (ft)
W	Glenn	5/13 – 9/7	1300
Richvale	Butte	5/12 – 9/7	710
Afton	Butte	5/12 – 9/7	340
Farris	Butte	5/9 – 9/7	700-1600
White	Colusa	5/9 – 9/7	730
Sankey	Sutter	5/6 – 9/7	190
Ramirez	Yuba	5/23 – 9/7	600

Table 2. Defoliation level.

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.

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
Adjusted Rsquared	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

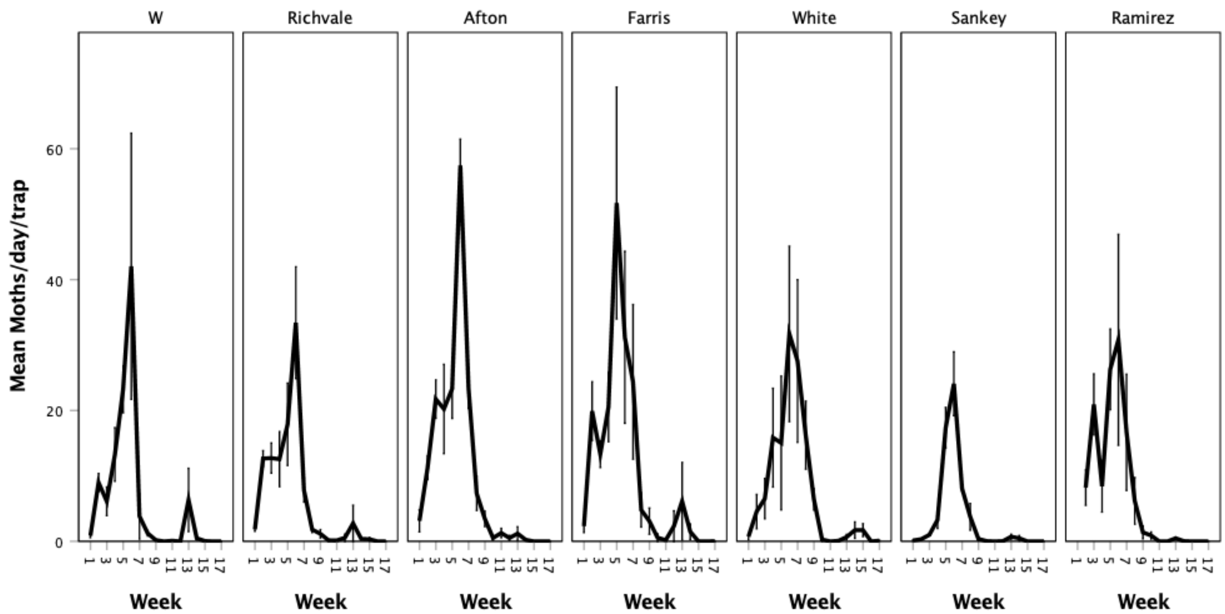


Figure 1. Average moths/trap/day captured in pheromone traps in seven locations of the Sacramento Valley of California, 2022.

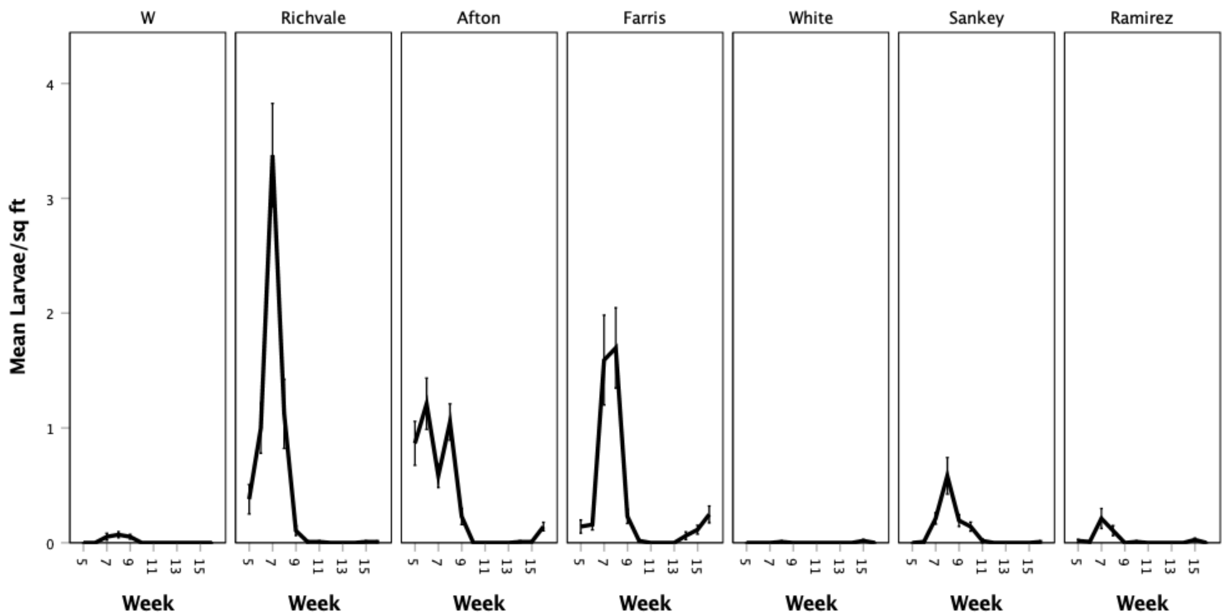
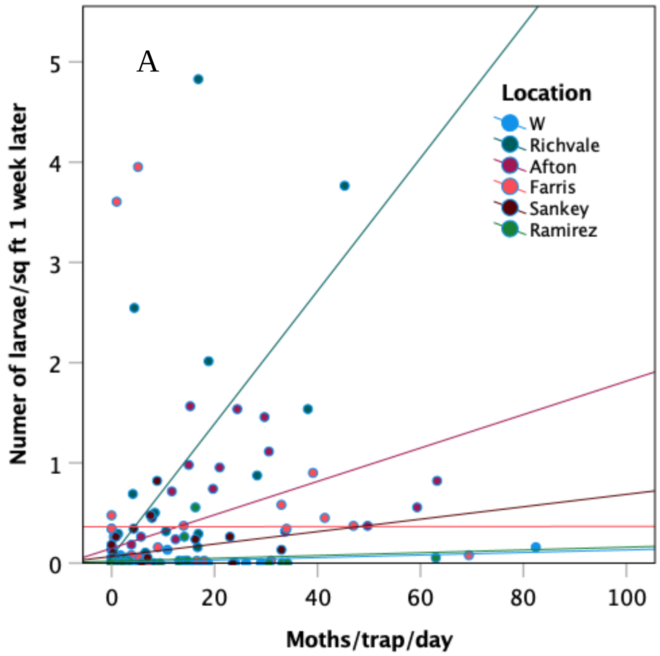


Figure 2. Average number of armyworm larvae/ft^2 in seven locations of the Sacramento Valley of California, 2022.



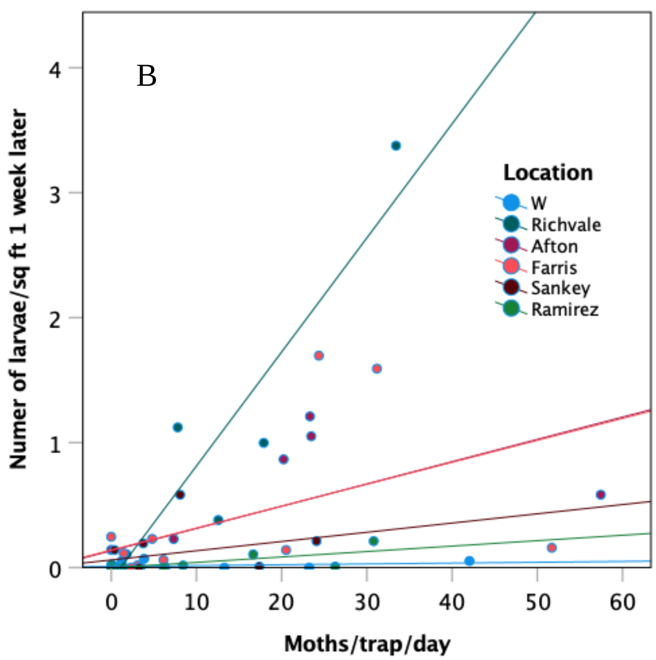


Figure 3. Relationship between number of armyworm moths captured in traps and number of larvae per square foot on week later. A. Using each trap versus the average of larvae around each trap and B. using the average for the three traps and the average number of larvae for the field.

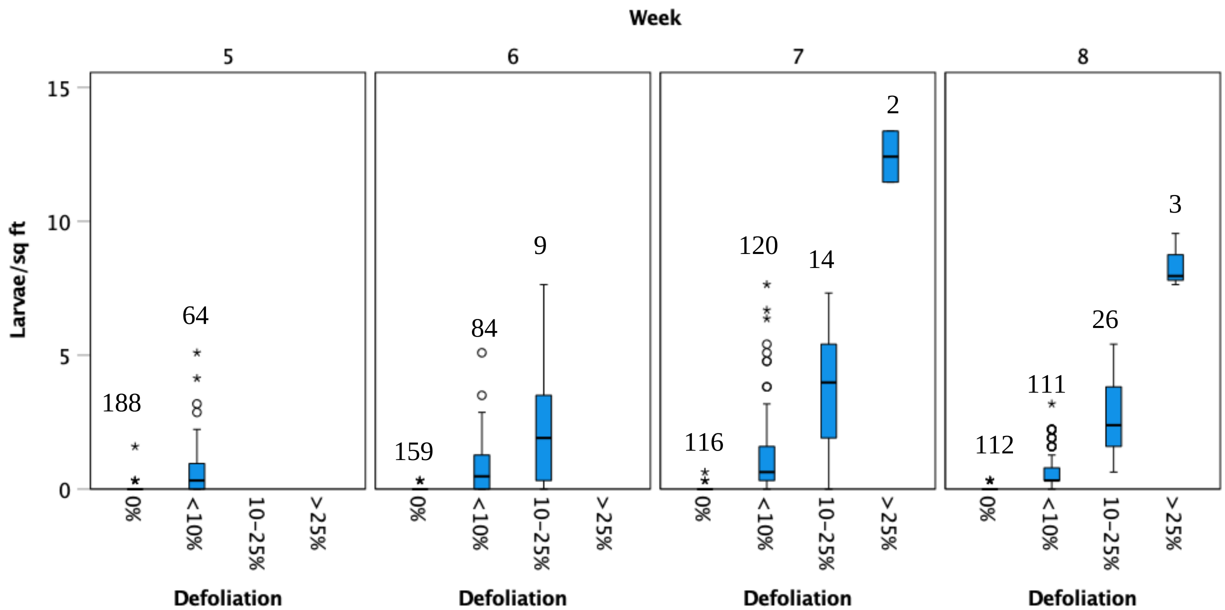


Figure 4. Boxplot of number of larvae per square foot found causing defoliation in seven locations of the Sacramento Valley of California, 2022. Numbers above boxes correspond to the number of observations of that level of defoliation.