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ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
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PROJECT TITLE: Rice water weevil within-field larval distribution and damage potential.

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

Field experiments were conducted in commercial rice fields in Colusa County. The objectives in the experiments were:

Objective 1: To validate observations regarding within-field rice water weevil (RWW) larvae distribution. Specifically, to confirm the prevalence of RWW larval populations around field borders.

Objective 2: To assess the effect of RWW larvae on rough rice yield under field conditions.

Materials and methods were similar for all experiments. Data analyses were conducted to address each of the objectives mentioned above. Materials, methods and analyses will be generally described and results presented by objective.

Materials and Methods

Experiments were conducted in commercial rice fields located in Colusa and Maxwell, in the Sacramento valley of California. Planting system, variety, and planting, flood, insecticide application, RWW sampling, and grain harvest dates are presented in Table 1.

At each location, plots 2.5 x 4.5 m were established 4.5, 30 and 60 m from one of the field's edge within a basin. Treatments assigned to plots were insecticide application (treated or untreated). Treated and untreated plots were separated by a 2.5 m buffer. Treated plots were sprayed with λ-cyhalothrin (Warrior II, Syngenta) at 33.6 g a.i./ha before flooding and at the 2 leaf stage of rice. To avoid movement of insecticides with irrigation water, individual treated plots were isolated using barriers made of roofing metal flashing 20 cm high held in place with wood stakes. The metal flashing was pushed into the soil after applying the flood and was removed before harvest. Each experiment was conducted as a randomized complete block and treatments replicated four times. In each field plots were managed in the same manner as the rest of the field.

RWW larvae were assessed using a core sampler (10 cm diameter and 10 cm deep). Plots were divided in three sections and one core sample taken from each on two sampling dates (≅ 6-7 weeks after seeding and 14 d later) as indicated in Table 1. Each core contained the roots of at least one rice plant. Cores were placed in 40 mesh screen buckets and soil washed from roots using a jet of water. Roots were discarded and screen buckets containing soil placed in water tubs. Screen buckets were then gently shaken and RWW larvae counted as they floated to the surface.

Rice yields were determined by harvesting 1 m^2 per plot and converting grain weights to kg/ha at 14% moisture.

Data analysis. Number of RWW larvae per core per sampling date and rice yields were analyzed using a two way analysis of variance (ANOVA) with fixed factors insecticide treatment and distance from the edge of the field and random factor block. To stabilize variances, dependent variables were transformed using ln(x+1) before applying ANOVA. Comparisons among levels of significant factors were made using Fisher's least significant difference test. Simple linear regression was used to determine the relationship between RWW larval population density and rice yield for each experiment. Average number of RWW larvae per core per plot during first and second sampling dates and their sum were regressed against yield per plot. The level of α used in all analyses was 0.05.

Results

Objective 1: To validate observations regarding within-field RWW larvae distribution. Specifically, to confirm the prevalence of RWW larval populations around field borders.

In Colusa, for number of RWW larvae, ANOVA showed a non-significant treatment by distance interaction in first core samples but a significant ($P = 0.005$) one in second core samples. In first core samples, no significant differences in number of RWW larvae were found among plots at different distances from the field's edge (Fig. 1 Colusa A); however, there were numerically fewer RWW larvae at 60 than at 4.5 or 30 m from the field's edge. In second core samples from untreated plots (Fig. 1 Colusa B), significantly more RWW larvae were found closer to the field's edge than at 30 or 60 m, while in treated plots very few RWW larvae were recovered and no significant differences among distances were detected. When comparing the number of RWW larvae in second core samples from treated and untreated plots at different distances from the field's edge, significantly more RWW larvae were found in untreated than treated plots at 4.5 m from the field's edge (Fig. 2A). At 30 or 60 m no significant differences in number of RWW larvae between treated and untreated plots were found.

In Maxwell, for number of RWW larvae, ANOVA showed a significant treatment by distance interaction ($P = 0.008$) in first core samples, but not in second core samples. In fist core samples from untreated plots, significantly more RWW larvae were recovered at 4.5 m than at 30 or 60 m from the field's edge (Fig. 1 Maxwell A). In first core samples from treated plots, no significant differences were observed in number of RWW larvae collected at any distance from the field's edge. When comparing the number of RWW larvae in first core samples from treated and untreated plots at different distances from the field's edge, significantly more RWW were found in untreated than treated plots at 4.5 m from the field's edge. At 30 m no significant differences in number of RWW larvae between treated and untreated plots were found, and at 60 m no RWW larvae were recovered (Fig. 2B). In second core samples, significantly more RWW larvae were recovered from plots at 4.5 m from the field's edge, regardless of treatment (Fig. 1 Maxwell B).

In summary, in both locations RWW larval population were higher in plots near the edge of the field than in plots 30 or 60 m from the edge of the field. Insecticide applications reduced the number of RWW larvae in treated plots effectively and this effect was significant in plots closer to the edge of the field, where populations where higher. In plots 30 or 60 m from the edge, differences between treated and untreated plots were not significant because RWW populations were very low or zero. Average number of RWW larvae per core in untreated plots located 4.5 m from the field's edge ranged from 0.33 to 1.75.

Objective 2: To assess the effect of RWW larvae on rough rice yield under field conditions.

Insecticide treatment significantly reduced RWW larval populations in Colusa and Maxwell. In Colusa, significantly ($P < 0.001$) fewer RWW larvae were found in treated plots in both first and second core samples (Table 2). In first core samples from Maxwell, significantly more RWW were found in untreated than treated plots at 4.5 m from the field's edge (Fig. 2B) only. In second core samples, no significant differences were found in the number of RWW larvae between treated and untreated plots; however, numerically, there were more RWW larvae in untreated than in treated plots (Table 2).

These results suggest that the insecticide applications effectively reduced RWW larval populations in treated plots. In Maxwell first core samples, this was only observed in plots 4.5 m from the field's edge because in plots further from the edge RWW larval populations were very low in both treated and untreated plots.

ANOVA of yields resulted in a non-significant treatment by distance interaction and a non-significant treatment effect in both locations. In Colusa, average yield was 9661 ± 154 kg/ha. In Maxwell, ANOVA detected a significant distance effect ($P = 0.001$). Yields from plots 4.5 m from the field's edge were significantly higher than yields from plots 30 or 60 m from the field's edge (Table 3).

Results of linear regression analyses between yield and average number of RWW larvae per core sample for each experiment are presented in Table 4. The average RWW larval population per core per plot ranged from 0 to 3 for first and second core samples in Colusa and from 0 to 0.7 and 0 to 2 in first and second core samples, respectively, in Maxwell. At the Maxwell location, significant linear relationships were found. Slope estimates for these relationships were 4482 ± 1316, 1139 ± 519 and 1162 ± 405 kg/ha, respectively. In Colusa, slopes estimates were not significantly different from zero.

Yields were not negatively affected by RWW larval populations in the experiments. Insecticide treatments significantly reduced RWW populations; however, this did not translate into a yield increase in treated plots. Linear regressions between yield and RWW population were not significant (Table 4), except in Maxwell, where yield increased as RWW population increased. In this experiment, yield of plots 4.5 m from the field's edge was significantly higher than yield of plots 30 or 60 m from the field's edge. Higher yields closer to the field's edge are likely due to aqueous ammonia application overlap in this area, and not to the presence of RWWs. Even though the density-yield relationship is significant, it is not proof of causality.

PUBLICATION OR REPORTS

Espino, L. 2010. Rice water weevil within field larval distribution in California rice. *In* Proceedings, 33rd Rice Technical Working Group, 22-25 February, Biloxi, MS. Louisiana State University Agricultural Center – Louisiana Agricultural Experiment Station, Crowley (in press).

Espino, L. 2010. Rice water weevil within field distribution in California rice. Abstract. Pacific Branch of the Entomological Society of America meeting, Boise, ID.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS

The main goal of this project is to improve management guidelines for the rice water weevil (RWW). During 2010, research was conducted to study the RWW within-field larval distribution and effect on grain yield. Experiments were conducted in plots established in two commercial rice fields with different management systems.

Within-field RWW larval distribution. Based on the number of RWW larvae at different distances from the field's edge, RWW infestations were more severe near field borders. RWW populations were higher in untreated plots 4.5 m from the field's edge than in plots 30 or 60 m from the field's edge. Average number of RWW larvae per core sample in untreated plots located 4.5 m from the field's edge ranged from 0.33 to 1.75. At 30 or 60 m, populations were generally very low or zero. Experiments conducted during 2009 agree with 2010 results. These experiments confirm that edge and levee treatments in California rice are adequate when RWW insecticide applications are needed.

RWW effect on grain yield. Yield was not affected by treatment in any of the experiments, even though insecticide treatment significantly reduced RWW larval populations. In one experiment, yields were higher in plots 4.5 m from the field's edge. Most likely, this increase in yield was caused by aqueous ammonia application overlap in the area where these plots were established. RWW-density yield relationships were not significant in Colusa, but they were significant in Maxwell, where yield increased as RWW larval population increased. Higher yields in plots where RWW larval populations were higher are explained by the effect of extra N fertilizer in the aqueous ammonia overlap, which coincides with the area where RWW populations are higher. Average RWW larval density per plot ranged from 0 to 3 in Colusa and from 0 to 2 in Maxwell. In experiments conducted during 2009, no significant density-yield relationships were found, and average RWW density per plot was as high as eight larvae per core. The RWW did not have an effect on rice grain yield under the conditions of these experiments.

Table 1. Agronomic information and important dates for RWW experiments, 2010

Info/Operation	Experiment	
	Colusa	Maxwell
Planting system	No till, stale seedbed, water-seeded	Water seeded
Variety	M-206	M-206
Planting date	17 June	4 May
Flooding date	16 June	4 May
Insecticide application	15 June, 1 July	30 April, 20 May
Fertilizer used	Urea flown at seeding	Aqua ammonia injected at seeding
First RWW larval sampling	29 July (6 waf[1])	22 June (7 waf)
Second RWW larval sampling	12 August (8 waf)	7 July (9 waf)
Harvest	2 November	21 October

[1] waf: weeks after flood

Table 2. Mean number of RWW per core sample ± SEM in treated and untreated plots, 2010

Experiment	First cores		Second cores	
	Treated	Untreated	Treated	Untreated
Colusa	0a	0.97 ± 0.24b	0.06 ± 0.04a	0.81 ± 0.23b
Maxwell	0.03 ± 0.03	0.11 ± 0.03	0.14 ± 0.07	0.39 ± 0.14

Means followed by different letters within the same row are significantly different.

Table 3. Grain yields (kg/ha) by treatment and distance from the field's edge, 2010

Effect	Experiment	
	Colusa	Maxwell
Treatment		
Treated	9771 ± 171	9790 ± 362
Untreated	9550 ± 260	9965 ± 399
Distance		
4.5 m	9854 ± 228	11198 ± 458a
30 m	9421 ± 313	9403 ± 195b
60 m	9661 ± 154	9031 ± 239b

Means followed by different letters within the same column are significantly different.

Table 4. Results of linear regression analyses between yield and average number of RWW larvae per plot, 2010

Experiment	First core samples			Second core samples			First + second core samples		
	r^2	t^a	P	r^2	t	P	r^2	t	P
Colusa	0.001	-0.134	0.895	0.003	-0.246	0.808	0.002	-0.224	0.825
Maxwell	0.345	3.405	0.003	0.180	2.194	0.039	0.273	2.871	0.009

[a]Test for H_o: slope estimate = 0

Fig. 1. Mean number of RWW larvae ± SEM by treatment and distance from the field's edge in first (A) and second (B) core samples in Colusa and Maxwell, 2010. Bars with different letters indicate means that are significantly different.

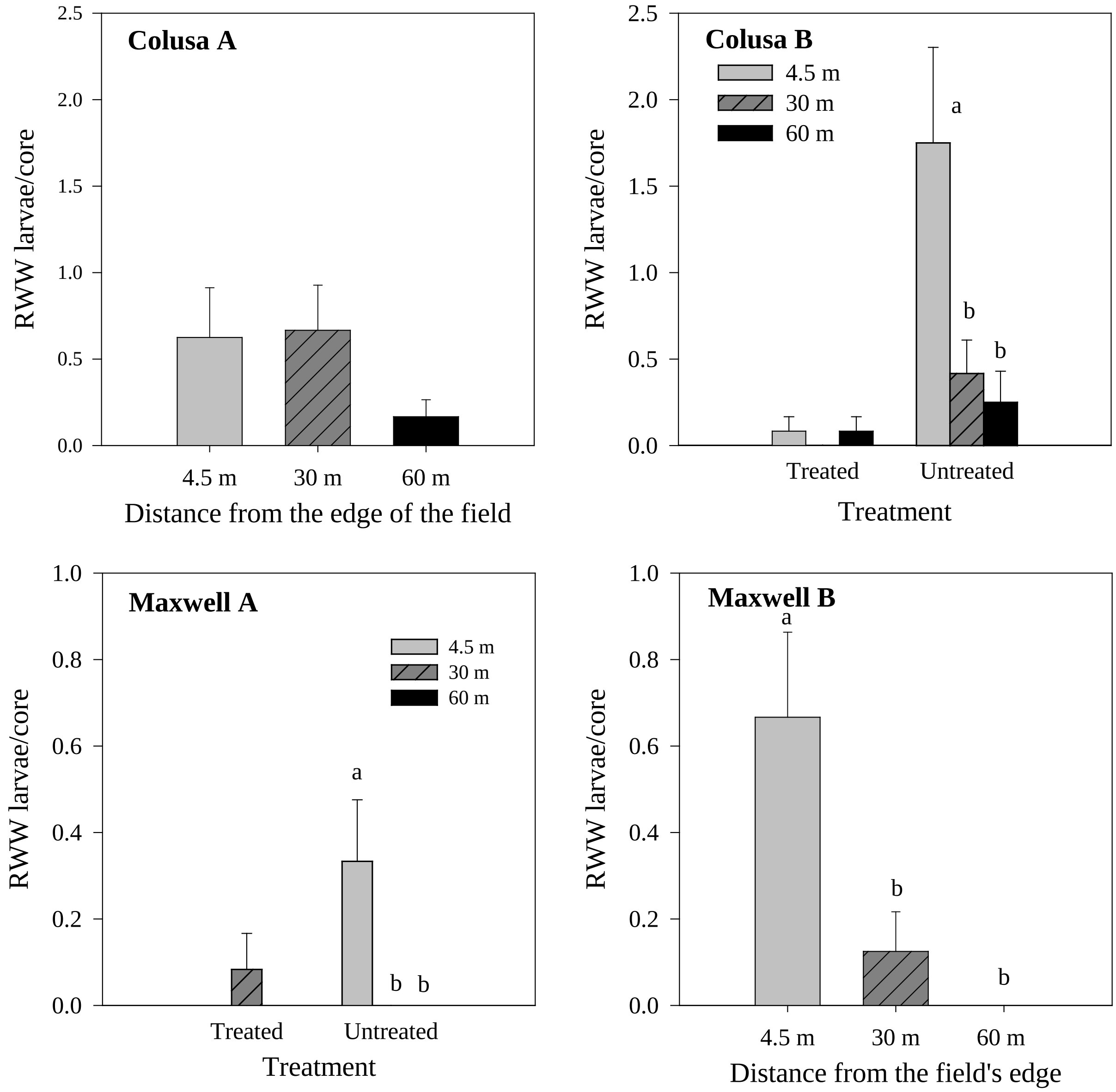

Fig. 2. Mean number of RWW larvae ± SEM by treatment and distance from field's edge in second core samples, Colusa (A), and first core samples, Maxwell (B), 2010. Bars with different letters within a group indicate means that are significantly different.