ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE

January 1, 1997 - December 31, 1997

PROJECT TITLE: Protection of rice from invertebrate pests.

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OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION:

Objective 1: Evaluate the most effective control of rice water weevil with three insecticides that are proceeding toward registration (compared with Furadan 5G whose registration is scheduled for cancellation) while maintaining environmental quality compatible with the needs of society.

1.1) Rice water weevil chemical control - Ring plots.

1.1.1) Evaluation of the efficacy of Furadan, Icon, Dimilin, and Warrior for controlling the rice water weevil.

1.1.2) Evaluation of the influence of application method and timing on the efficacy of various compounds for rice water weevil control.

1.1.3) Compare efficacy of various formulations of new, experimental products for controlling rice water weevil.

1.2) Rice water chemical control - Basin plots.

1.2.1) Evaluation of the efficacy of Dimilin, Icon, Furadan, and Warrior for controlling a natural infestation of rice water weevil.

1.3) Rice water weevil chemical control - Grower field plots/ EUPs.

1.3.1) Evaluation of the efficacy of Dimilin 2L compared with Furadan 5G for controlling a natural infestation of rice water weevil in grower fields.

1.3.2) Evaluation of the efficacy of Icon 80WG compared with Furadan 5G for controlling a natural infestation of rice water weevil in grower fields.

1.3.3) Evaluation of the efficacy of Warrior 1EC compared with Furadan 5G for controlling a natural infestation of rice water weevil in grower fields.

1.4) Rice water weevil chemical control with Dimilin - Greenhouse studies.

1.4.1) Evaluate the influence of Dimilin 25W on rice water weevil to determine the number of days of activity following exposure

Objective 2: To evaluate a revised economic-injury level of rice water weevil on the most common commercial variety, and to appraise rice water weevil sampling methods.

2.1) Study the influence of rice water weevil on the growth, development, physiology and yield M-202.

2.2) Examine the relationship between rice water weevil scar incidence, larval density, plant growth and grain yield under grower conditions.

2.3) Examine the influence of winter flooding on rice water weevil populations.

2.4) Investigate timing of rice water weevil oviposition in water-seeded, continuously flooded rice fields.

Objective 3: Monitor the movement of RWW populations that result in economic injury to rice plants.

3.1) Monitor seasonal trends (timing and magnitude) in the flight activity of the rice water weevil at the Rice Experiment Station near Biggs.

SUMMARY OF 1996 RESEARCH BY OBJECTIVE:

Objective 1:

1.1) Chemical Control of Rice Water Weevil - Ring Plots

1.1.1, 1.1.2 & 1.1.3) The efficacy of 24 treatments was evaluated in a replicated field study. These treatments encompassed 7 chemical insecticide active ingredients. Three of the materials are in the registration process as replacements for Furadan 5G. Each treatment was replicated four times. Numerous formulations and application timings of the 7 active ingredients were used. Several of these treatments were a continuation of the testing we did in 1996 to further refine the timing and formulation of applicable products. The following treatments were evaluated:

Treatment	Rate (lbs.AI/A)	Timing	Treatment Date
1. Furadan 5G	0.5	PPI	28 April
2. Mustang 1.5EW	0.03	3-5 leaf	19 May
3. Mustang 1.5EW	0.05	3-5 leaf	19 May
4. Mustang 1.5EW+oil	0.03+1qt	3-5 leaf	19 May
5. Dimilin 2L	0.125	1st emerg.	15 May
6. Dimilin 2L	0.125	50% emerg.	19 May
7. Icon 70FS	0.0325	5-7d postflood	19 May
8. Dimilin 2L	0.125	10 d aft 50%	26 May
9. Dimilin 2L	0.1251	5 d aft. 50%	30 May
10. Icon 70FS	0.0325	PPI	28 April
11. Icon 70FS	0.025	PPI	28 April
12. Dimilin 2L	0.125	5 d aft 50% emg.	21 May
13. EXP90949A 1.5G	0.1	PPI	28 April
14. EXP90949A 1.5G	0.2	PPI	28 April
15. EXP61096 100EC	0.1	PPI	28 April
16. EXP61096 100EC	0.2	PPI	28 April
17. EXP61096 100EC	0.1	5-7 d post	19 May
18. EXP61096 100EC	0.2	5-7 d post	19 May
19. Karate 1EC	0.03	3 leaf	15 May
20. Warrior 1CS	0.03	3 leaf	15 May
21. Warrior 2CS	0.03	3 leaf	15 May
22. Beauveria bassiana	$1x10^7$ conidia/cm^2	5-7 d post	20 May
23. Bacillus popillae	~10 lbs./A	pre-emerge	1 May
24. Untreated	---	--	---

Testing was conducted with 'M-202' in 8 ft^2 aluminum rings at the Rice Experiment Station. The plots were flooded on 30 April (pm) and seeded on 1 May, 1997. The application timings were as follows:

28 April, pre-flood applications
1 May, pre-emergent applications
15 May, first emergence, 3-leaf stage applications
19 May, 50% emergence, 3 to 5-leaf stage applications
20 May, 5 to 7 days post emergence applications
21 May, 5 days after 50% emergence applications
26 May, 10 days after 50% emergence applications

21 May, 5 days after 50% emergence applications
26 May, 10 days after 50% emergence applications
30 May, 15 days after 50% emergence applications

Granular treatments were applied with a "salt-shaker" granular applicator and liquid treatments were applied with a CO_2 pressurized sprayer at 18 GPA. Early-season rice plant establishment was hindered by a severe crayfish infestation. Rice stand was evaluated and adjusted to 96 plants per 8 ft^2 aluminum ring from 15 May. The natural rice water weevil infestation was supplemented with 5 adults placed into each ring on 19 and 26 May. The following sample dates and methods were used for this study:

Sample Dates:

<u>Seedling Vigor/ Emergence</u>: 15, 26 May
<u>Adult Leaf Scar Counts</u>: 30 May
<u>Larval Counts</u>: 18-19 June, 1 July
<u>Plant Growth Characteristics</u>: 18-19 June, 1 July
<u>Rice Yield</u>: 11 September

Sample Methods:

<u>Seeding Vigor/ Emergence</u>:
1 = very poor stand (<20 plants)
3 = good stand (~100 plants)
5 = very good stand (>150 plants)
<u>Adult Leaf Scar Counts</u>: percentage of plants with adult feeding scars on either of the two newest leaves (50 plants per ring)
<u>Larval Counts</u>: 44 in^3 soil core containing at least one rice plant processed by washing/ flotation method (5 cores per ring per date)
<u>Plant Growth Characteristics</u>: plant height, root length, number of leaves, number of tillers, and leaf/root dry weights were recorded from plants which had been sampled for larvae.
<u>Rice Yield</u>: entire plots were hand-cut and grain recovered with a "Vogel" mini-thresher.

Results:

Rice Emergence/Crustacean Invasion

Based on a visual rating, stand establishment was hindered by crustacean invasion (predominately crayfish). In past studies, it is not uncommon for crustacean pests such as crayfish and tadpole shrimp to infest a few rings and inhibit stand establishment. Symptoms for crustacean invasion include cloudy water and floating seedlings. This year, their populations were especially damaging in our test basins. The effects from these inhabitants definitely had an effect on rice plants by delaying emergence and establishment in the test rings and small basins in 1997. We were able to standardize the seedling density at 96 plants per ring by transplanting seedlings from rings within the same treatment.

Adult Leaf Scar Counts

Adult leaf-scar damage normally is insignificant in terms of rice plant growth and development. Although, feeding scars are evaluated as a means to determine the effects of the treatments on adult density. In 1997, the feeding scar data were collected after all of the treatments were applied. Several treatments showed a marked effect on adult feeding. These were Warrior 1CS and 2CS at 0.03 (3 leaf), Karate 1EC at 0.03 (3 leaf), Mustang 1.5EW + oil at 0.03 (3-5 leaf), Mustang 1.5EW at 0.05 (3-5 leaf). All five treatments had scores that were below 10% scarring (Table 1). Adult mortality from the post-flood treatments is expected since the insecticide is sprayed on to the exposed RWW adults. In fact, adult mortality is the mode of action for Karate, Warrior and Mustang.

Larval Counts

RWW larval counts were made twice during the season. Most individuals were second and third instars and third instar and pupae at the first count and second counts, respectively. The population decreased in the untreated and less effective treatments from the first to second sample dates probably due to larval feeding to the extent that some larvae starved to death (Table 2). Densities ranged from 0.0 to 1.99 larvae per plant in 18, 19 June samples. The Mustang 1.5EW, 0.05 (3-5 leaf) and Karate 1EC, 0.03 (3 leaf) treatments were the most effective on this date (Table 2, 3). Although the above treatments had the fewest larvae, the majority (67%) of the remaining treatments also provided good to excellent control with larval densities less than 1 larva per plant. On 1 July, the RWW immature density ranged from 0.0 to 2.99 per plant. On the average 15 treatments were below 1 larva per plant. The Mustang 1.5EW, 0.05 (3-5 leaf), Dimilin 2L, 0.125 (10 d aft. 50% emerg.), Icon 70 FS, 0.0325 (PPI), Karate 1EC, 0.03 (3 leaf) and Warrior 1CS and 2CS, 0.03 (3 leaf) treatments provided the best control (numerically).

Plant Growth Characteristics

Plant growth is a good measure of the immediate impact of RWW feeding. The 1997 field season quantification of plant growth characteristics is still ongoing in the laboratory from stored samples.

Rice Yield

Rice yield was evaluated on 11 September. Grain yields were increased in comparison with the 1996 results. The yields in the untreated rings were 528.8 g/plot in 1996, and 983.2 g/plot in 1997. This was a 46 % increase in yield over 1996. In the Furadan 5G (0.5 lb. AI/A pre-plant incorporated) treatment, the yields were 725.8 and 1015.5 g/plot in 1996 and 1997, respectively (Table 3). In 1997, yields ranged from 972.6 to 1308.1 g/plot. Yield was lowest in the Bacillus popilliae (milky spore) plots and highest in the Icon 70 FS, 0.0325 (PPI) treatments.

1.2) Rice Water Weevil Chemical Control - Basin Plots

1.2.1) Evaluation of the efficacy offer controlling a natural infestation of rice water weevil. The efficacy of Dimilin, Icon, Furadan, and Warrior for controlling a natural infestation of RWW was evaluated in small basins. The rationale for this study is that prospective treatments can be studied under more realistic conditions compared to our ring studies. Especially with some of the short residual products being developed, the timing of the infestation is important and the rings may not adequately address this. The ring studies are always useful for screening numerous treatments, so each evaluation method has its strength. The following

treatments were used in the small basin studies:

Treatment	Rate (lbs. AI/A)	Timing	Appl. Date
1. Furadan 5G	0.50	PPI	28 April
2. Mustang 1.5EW	0.03	3-5 leaf	19 May
3. Dimilin 2L	0.125	1st emer. through water	15 May
4. Dimilin 2L	0.125	50% emer. through water	19 May
5. Dimilin 2L	0.125	5 days after 50% emer. thr. water	22 May
6. Icon 70FS	0.0325	PPI	28 April
7. Icon 70FS	0.0325	5-7 days post	19 May
8. Warrior 1CS	0.03	3-leaf stage	15 May
9. Karate 1EC	0.03	3-leaf stage	15 May
10. Untreated	-----	-------	----

Testing was conducted within a 0.25 acre check in 10 feet x 20 feet basins of 'M-202' at the Rice Experiment Station. The plots were flooded 30 April (p.m.) and seeded 1 May, 1997. The liquid treatments were applied with a CO_2 sprayer at 18 GPA and the granular treatments were applied by hand with a "salt shaker applicator". A natural rice water weevil infestation was used in this test.

The following sample dates and methods were used for this study:

Sample Dates:

Adult Leaf Scar Count: 30 May
Larval Counts: 18-19 June, 1 July
Plant Growth Characteristics: 18-19 June, 1 July
Rice Yield: 12 September

Sample Methods:

The sample methods used were identical to those described under 1.1 except that rice yield was estimated by harvesting four 10.8 ft^2 areas and recovering grain with a mini-thresher.

Results:

Seedling establishment in this test was poor such that only one of the four replications could be rescued. A severe crayfish infestation was the culprit. It was not possible to control the crayfish without effecting the RWW control, thus no remedial actions could be taken. Although the data could not be analyzed because there was only one replication; however, there was no obvious differences among the treatments. Adult leaf scar counts peaked at only 4%, larval densities peaked at 0.05 RWW/plant and yields ranged from 3700 to 7400 lbs./A.

1.3) Rice Water Weevil Chemical Control - Grower Field Plots/ EUPs.

The efficacy on RWW of Dimilin, Warrior (Karate) and Icon (fipronil) was studied in comparison with Furadan (and untreated plots) in grower fields in 1997. In cooperation with Uniroyal Chemical Co. (Dimilin), Zeneca (Warrior), and Rhone-Poulenc Ag. Products (Icon) personnel, seven field sites were set-up under a Research Authorization/crop destruct scenario. Two of the sites were in Butte Co., two in Sutter Co., one in Placer Co., and two in Colusa Co. The standard preplant Furadan 5G application was used for comparison. At each site, the respective treatments were applied to individually leveed 2-3 acres plots. The percentage scarred plants was sampled as previously described in all fields in May and June. All sampling was concentrated ~ 10 feet from the levee so as to have the highest RWW densities. Rice water weevil larval samples (using previously described procedures) were taken in June and July at a time when populations should be mostly large larvae and possibly some pupae. This timing was chosen so that late-deposited eggs would have hatched. In addition, larger larvae are easier to recover with our sample processing methods. Lastly, grain yields were estimated by hand harvesting four 10.8 ft^2 areas per plot and recovering the grain with a "Vogel" mini-thresher. In addition, at the Icon and Dimilin sites, machine harvests were also done. The field site locations and treatments were as follows:

County Site	Treatment	Seeding Date	Date Applied	Method
Sutter 1	Untreated	9 May	---	---
	Dimilin 2L(8oz/A)	9 May	21 May	fixed wing
	Dimilin 2L(12oz/A)	9 May	21 May	fixed wing
	Dimilin 2L(16oz/A)	9 May	21 May	fixed wing
	Furadan 5G	9 May	8 May	pre. incorp
Butte 2	Untreated	25 April	---	---
	Dimilin 2L(8oz/A)	25 April	13 May	helicopter
	Dimilin 2L(12oz/A)	25 April	13 May	helicopter
	Dimilin 2L(16oz/A)	25 April	13 May	helicopter
	Furadan 5G	25 April	24 April	pre. incorp
Sutter 1	Untreated	6 May	---	---
	Icon 80 WG	6 May	5 May	ground sprayer
	Furadan 5G	6 May	5 May	pre., incorp.
Butte 2	Untreated	10 May	----	----
	Icon 80 WG	10 May	9 May	ground sprayer
	Furadan 5G	10 May	9 May	pre., incorp.
Colusa 1	Untreated	26 April	---	---
	Warrior 1EC	26 April	20 May	fixed wing
	Furadan 5G	26 April	26 April	pre., incorp.

(treatments cont.)

County Site	Treatment	Seeding Date	Date Applied	Method
Colusa 2	Untreated	4 May	----	----
	Warrior 1EC	4 May	30 May	fixed wing
	Furadan 5G	4 May	4 May	pre., incorp.
Placer	Untreated	8 May	----	----
	Warrior 1EC	8 May	24 May	fixed wing
	Furadan 5G	8 May	8 May	pre., incorp.

1.3.1) The efficacy of Dimilin 2L at three rates (8, 12, 16 oz. AI/A) was studied in comparison to Furadan 5G (and to untreated plots). The Dimilin application rates and timings were similar among the two study sites. All Dimilin applications were made by air to 2-3 acre plots within the individual leveed checks. The untreated areas were similarly sized. In addition to the field plots, a ring infested with 20 RWW adults, was placed into each treatment and data also collected from this ring.

The percentage scarred plants in the tests (excluding rings) ranged from 12.5% to 54% (Table 4). These two results were recorded from the Furadan 5G treatments. The percentages averaged for the three Dimilin 2L formulations (8, 12, 16 oz.) were 23.2, 50.4 and 37.6 respectively (Table 5). Overall, the percentages in the Dimilin treatments were comparable to the Furadan treatment (Table 5). The 27% scarred plants in the untreated exceeded the threshold of 10-20%. The majority (94%- Table 4) of larval densities in the Dimilin 2L treatments were higher when compared to the Furadan treated areas. When examining the ring data, larval densities ranged from 0 to 3.45 per plant (Table 4), and averaged over the sites, the density was lowest (0.27/plant) in the Dimilin 16 oz treated areas (Table 5).

Hand-harvested grain yields for all Dimilin treatments were higher than the Furadan 5G. In addition, the 8 and 16 oz. Dimilin treatment yields were higher than the untreated plots (Table 5). The averaged results from the machine harvested areas showed that all Dimilin treatments were higher than the Furadan and untreated plots. The Dimilin treated areas yielded on average about 200lbs./A more than Furadan 5G and 1000 lbs./A more than the untreated areas.

Larval control with Dimilion in 1997 was less than in 1996. From these studies and previous work, we know that timing of application is critical with Dimilin. Rice growth during the early-season in 1997 was extremely rapid because of nearly perfect environmental conditions and in some cases the timing was probably slightly too late. Dimilin did provide excellent protection of yield in 1997, which we have seen in previous years.

1.3.2) The efficacy of Icon 80 WG was studied in comparison to Furadan 5G (and to untreated plots). All applications were made preplant. All Icon applications were made by ground sprayer to 2-3 acre plots within individual leveed checks. The untreated areas were similarly sized.

The percentage scarred plants in the tests ranged from 10.25% to 40.25% (Table 6). These two results were recorded from an Icon 80 WG treated field and an untreated field, respectively. The percentage averaged for the Icon 80 WG treatments was 13.1% (Table 7). Overall, the average percentage in the Icon treatments was lower than in the Furadan treatments (Table 7). The 33.0% scarred plants in the untreated exceeded the threshold of 10-20%. Average larval densities ranged from 0.06 to 1.09 (Table 6) per plant, and averaged over the two sites, the density was lowest (0.06/plant) in the Icon treatment (Table 7). Rice water weevil larval densities in the Icon treatments were lower when compared to the Furadan 5G treatments and to the untreated plots. All chemical treated areas had lower RWW per plant when compared to the untreated plots. Therefore, the larval densities were reduced by the both of the insecticides.

The average, hand-harvested yield for Icon was lower than the Furadan 5G or the untreated plots (Table 7). The lower yield was attributed to rice plant disease or mortality which was more pronounced within the first 30 feet from the levee, which is where the hand-harvest samples were taken. The average yield from the machine-harvested Icon areas was lower than the Furadan 5G plots but higher than the untreated plots. Average yield was compromised at the Butte county site (Table 1) by aggregate sheath spot in the untreated and Icon field plots; therefore, yields from these two fields were drastically reduced. The (machine-harvested) Icon treated areas yielded on average about 1400 lbs./A less than Furadan 5G and 400 lbs./A more than the untreated areas.

Icon has consistently provided outstanding larval control but the yield results are only moderate. The reason for these yield results is unclear but may warrant further research.

1.3.3) The efficacy of Warrior 1EC was studied in comparison to Furadan 5G (and to untreated plots). The Warrior application rates were similar among the three study sites. The application timings were 4-8 leaf stage (5-10 inches tall). All Warrior applications were made by air to 1-4 acre plots within individual leveed checks. The untreated areas were similarly sized.

The percentage scarred plants in the tests ranged from 8% to 47.75% (Table 8). These two results were recorded from untreated plots. The percentage averaged for the Warrior 1EC treatments was 23.25% (Table 9). Overall, the average percentage in the Warrior treatments was higher than in the Furadan treatments and similar to the untreated (Table 8). The 24.83% scarred plants in the untreated exceeded the threshold of 10-20%. Larval densities per plant ranged from 0.07 to 1.84 (Table 8), and averaged over the sites, the density was lowest (0.43/plant) in the Furadan treatment (Table 9). Rice water weevil larval densities in the Warrior 1EC treatments were higher when compared to Furadan 5G treatments but slightly lower than untreated plots.

The yield results were erratic. In Colusa-1, the average yield for Warrior 1EC was higher than the Furadan 5G but lower than the untreated plot (Table 8). Yield results were confounded at this location because the original test sites were commercially harvested prior to our harvest evaluations. We generally collect our hand-harvest data from ~10 feet from the levee. This is the area with the highest RWW density, thus we maximize the effect of this pest. In order to salvage some representation of each treated field, we hand-harvested at ~25 feet in from the levee. Therefore, these Colusa-1 harvest data may not be representative of the damage incurred from the original RWW scar and larval counts. At the Colusa-2 site, the Warrior yield was again lower than the untreated plot and at this field site the grower opted not to use a Furadan field as a comparison. The Warrior yield at the Placer county site was slightly higher than the untreated but lower than the Furadan treatment. Overall, Warrior treatments (Table 9) yielded on average about 300 lbs./A less than Furadan 5G and 900 lbs./A less than the untreated areas.

Application timing is very important for this product. Based on ring studies, applications should be made at the 3 leaf stage. Based on recent RWW biology studies, oviposition for this pest starts at the 2 leaf stage. At the two Colusa sites, due to various difficulties, Warrior was not applied until at least the 5 leaf stage, after which many RWW may have oviposited. The difficulties included windy weather and long periods of drained conditions. In addition, at one site a severe infestation of armyworms occurred which could have affected yields. We recommend the need for further studies to evaluate Warrior 1EC (Karate) as a postflood material to manage damaging RWW populations in California water-seeded rice.

1.4) Greenhouse studies with Dimilin.

A greenhouse study was continued to evaluate the activity of Dimilin. This was a continuation of the 1996 study detailed in last year's report. The study was designed to examine the number of days after exposure that Dimilin exerts an effect on RWW oviposition.

Rice plants were grown in a UC-Davis greenhouse in 32 oz. plastic cups within soil from the RES. Once the plants reached the 3 to 4-leaf stage, the appropriate Dimilin treatments were applied, the plants were caged, and field-collected RWW adults were introduced. The introduction and removal of the adults was manipulated so that the above objectives could be addressed. Plants/soil was processed and RWW larvae counted. Results are presently being analyzed.

Objective 2: To evaluate a revised economic-injury level of rice water weevil on the most common commercial variety, and to appraise rice water weevil sampling methods.

2.1) Study the influence of rice water weevil on the growth, development, physiology and yield 'M-202'.

Many times when sampling larval densities, populations are erratic from one date to the next. One explanation for this is that under high infestation the larvae consume the majority of the root tissue, to the extent that the remaining larvae starve. We studied this in 1997, continued from 1997. The goal was to set up plots in 8 ft^2 aluminum rings with either 96 or 150 plants (4 replications or each). Plots wee infested with a high density of RWW adults to achieve a high larval density. Core samples for RWW larvae were taken once per week from 9 June to 15 July. Results from 1996 showed a higher RWW larval density in the higher plant density compared with the lower plant density. In 1997, because of the high crayfish populations, we were unable to set up the high plant density (150 plants per 8 ft^2). Larval populations were sampled and no differences were found between the plant densities.

Studies continued in 1997 to examine the relationship between scar counts, larval density, and grain yield. These studies were in an abbreviated format compared with past years. The objective in 1997 was to develop additional data on year-to-year variation in yield losses from RWW injury. Three years of intensive ring studies showed a grain yield loss of 80-100 lbs./RWW larva. Three densities of RWW were evaluated in ring plots at the RES in 1997. These densities were achieved by infesting field-collected RWW adults in plots at 18 and 20 days after seeding. Densities used were 0 RWW adults per plant (uninfested), 0.4 RWW adults per plant (moderate infestation), and 0.6 RWW adults per plant (high infestation). Studies were conducted in a rice ('M-202') check planted on 1 May.

Analyses of results (Table 10) showed a ~102 lb./A yield loss per RWW larva (0.9% per larva). These values are ~one-fourth the values found in 1996 studies, but comparable to the 1993-95 studies. This may reflect the more favorable growing season in 1997 compared with 1996; the plant was better able to withstand the RWW feeding.

2.2) Examine the relationship between rice water weevil scar incidence, larval density, plant growth and grain yield under grower conditions.

Research was conducted in 1997 to evaluate yield losses from RWW under grower field conditions. These studies were done to supplement the 4 years of research in this area conducted in ring plots at the RES. The data collected from ring plots are useful; however, similar data from field plots are also needed. The elevated yield from ring plots and the controlled RWW infestation introduce some uncertainty in these data. Information of yield losses from RWW have several uses such as, 1.) to support Section 18 and 24c registrations, 2.) by agrichemical companies investigating possible product development, 3.) by EPA regarding the need for registrations, 4.) by growers concerned about possible yield losses from RWW, and 5.) for investigating thresholds needed for possible postflood applications.

Studies were conducted in 8 grower fields. In each field, the incidence of plants with RWW scars, RWW larval density (2 times), and grain yield were determined. These factors were examined at 5 areas, namely 5, 15, 25, 35, and 45 feet from the levee, in each field. Previous research by Grigarick had shown that the RWW larvae density generally decreases within the first 50 feet from the levee. Areas more than 50 feet from the levee generally have very low RWW populations.

In 1997, the % scarred plants and larval density generally declined as the distance from the levee increased (Table 11). Grain yields were lowest at the 5 ft. sampling zone and relatively constant at 15-45 ft (Table 11). The 5 ft. zone was the only area that had larval populations at levels exceeding the commonly accepted threshold (~1 larva per plant). The larval densities and effects on yield in 1997 were considerably less then in 1996. In addition in 1997, none of the 8 fields sampled had damaging RWW larval populations at distances greater than 50 ft. from the levee. This again differs from 1996 when 3 of the 9 fields sampled had damaging larval populations in the 45 ft. sample. The 1997 results bode well for the perimeter insecticide treatment strategy.

2.3) Examine the influence of winter flooding on rice water weevil populations.

Populations of arthropod pests of seeding rice were monitored in all eight straw management treatments (winter flooded vs. nonflooded by the four straw management methods) at the Colusa Co. straw management site coordinated by Steve Scardaci and Jim Hill. The goal was to see if straw management methods influenced rice pest arthropod populations. Seed midges, tadpole shrimp, and crayfish are pests of rice at or near the time of seedling emergence. The shrimp and crayfish biologies are closely aligned with the conditions in the particular fields; seed midges are mobile and can fly in from adjacent fields.

The influence of the straw management treatments on rice water weevil populations was examined in 1997. Both damage by the adults (the percentage of plants with weevil feeding scars) and larval populations were measured. The presence of a winter flood compared with nonflooded conditions consistently influenced rice water weevil population dynamics. The incidence of scarred plants in 1997 averaged 7.4% in the winter flooded plots compared with 8.6% in the nonflooded plots (Fig. 1). The straw tillage treatment had no significant effects on the incidence of rice water weevil damaged plants. Rice water weevil larval populations were reduced in the winter flooded plots in 1997. Larval densities averaged 0.35 and 0.9 larvae/plant in the winter flooded and nonflooded plots, respectively (Fig. 2). As with scar incidence, the straw tillage treatments did not significantly effect larval population density. The larval differences have been seen each of the four years of this year and differences in 1997 were actually stronger than previous years.

The significant effects of the straw management treatments on rice water weevil populations were unexpected. The differences could be important because they were of the magnitude such that economically important populations were reduced to noneconomical levels. The reason for these differences is uncertain at this time, but will be investigated in future studies.

Populations of early-season seed pests were monitored with petri dishes filled with a thin layer of soil and 15 presoaked rice seeds; these were placed in each basin for ~7 days. In the laboratory, seed damage was classified as that indicative of injury by crayfish, tadpole shrimp, and/or seed midge. The second sampling method used was a visual search for tadpole shrimp, clam shrimp, and crayfish. The search was made along two 25 foot sections of each basin about 5 feet from the levee. These data were also collected about 1 week after seeding in 1997.

There were no significant differences in damaged seed incidence among the eight treatments or within the main effects of winter condition or straw technique in 1997 (Fig. 3). Seed midge damage ranged from 7.5 to 20% and damage indicative of crayfish feeding ranged from 2.5 to 13%. The high amount of damage occurred because the seeds were placed in the field about 1 week after seeding, which allowed time for the arthropod populations to build-up.

The visual searches for early-season arthropod pests also showed no difference among the eight treatments. Overall, it appears the straw management treatments had little to no effects on populations of tadpole shrimp, crayfish, and seed midge.

2.4) Investigations of timing of rice water weevil oviposition in water-seeded, continuously flooded rice fields.

Two of the three proposed Furadan replacement compounds are used as postflood products. As such, these insecticides have no effect on RWW larvae; they provide control by effecting the adult RWW. Therefore, proper timing is imperative for these products to work adequately. Applications made too late are ineffective. Alternatively, these materials are quite short-lived in the water, which is a favorable attribute to registration agencies. This again points to the critical importance of application timing. In 1996, we conducted a small study to examine when RWW adults deposit eggs in rice plants. This study was expanded in 1997.

Rice seedlings were sampled from untreated basins at the RES and from a Butte Co. grower field. Collections were made as soon as the seedlings were visual (either through the water or at the surface) and continued until the 5-6 leaf stage. Collections were made twice per week. Seedlings were taken to the laboratory and held in water until the eggs hatch. Newly-hatched larvae were counted three times per week.

At the RES, RWW oviposition started at the 2 leaf stage and peaked at the 3 leaf stage at ~1.5 larvae per seedling (Fig. 4). At the grower site, results were similar but the densities were lower (~0.75 larvae per seedling) (Fig. 4). This oviposition timing is much earlier than previously thought and will influence when postflood treatments should be applied. This area needs to be examined further as oviposition timing will undoubtedly be influenced by timing of flight peaks, drained periods, depth of water, etc.

Objective 3:

3.1) Evaluation of the movement of RWW populations that result in economic injury to rice plants. Monitor seasonal trends (timing and magnitude) in the flight activity of the RWW.

The timing of RWW adult flight in the spring has been monitored for several years with a black light trap. Monitoring weevil flights is important to determine the levels and intervals of peak flight periods which provides important baseline data on the timing and intensity of the spring weevil flight.

In 1997, a light trap was placed at the Rice Experiment Station (RES) in Butte Co. This trap is used to provide a continuation of the light trap RWW record that began in 1962. Peak flights in 1997 occurred at the RES on 15 to 16 April and 26 to 27 April (Fig. 5). The last major peak was on 7 May. Secondary flights occurred on 6 April, and from 30 April to 2 May, 12 May, and on 19 May. May 7 marked the completion of over 90% of the weevil flight at the RES. A total of 2556 weevils were captured in 1997 at the RES. This was about 53% lower than the number caught in 1996 and very similar (~ 1% more) to the number caught (2520, 1992) 5 years ago. The location of the trap and protocol has been exactly the same over this period.

The flight timing in 1997 (date of 90% flight completion) was similar to that in 1996; however, the number was much (~50%) lower (Fig. 6). In 1997, 7 May marked the date when 90% of the season's RWW had been captured, this compared with 1 May in 1996. Even though 90% of the flight was completed, this should always be interpreted with caution. The flight in 1997 was lower; however, the remaining 10% of the weevils still could create an significant infestation. The period of flight (capture of weevils) in 1997 was about 3 weeks shorter than in 1996, and ran from 6 April to 19 May. Looking at the past five rice seasons (1993 to 1997), there was an increasing trend in numbers (~1000 to 5500) of RWW captured from 1993 to 1996, but the number dropped in 1997 to ~2500. Compared to 1996, spring of 1997 was much drier but still cool. Cooler temperatures may have delayed the emergence of RWW adults from overwintering and therefore the occurrence of the 1997 spring flight.

PUBLICATIONS OR REPORTS:

Cuneo, T. D. and L. D. Godfrey. 1997. Effect and efficacy of Dimilin on rice water weevil, *Lissorhoptrus oryzophilus* (Coleoptera: Curculionidae), greenhouse studies in California. J. Econ. Entomol. (in review)

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CONCISE GENERAL SUMMARY OF CURRENT YEAR'S (1997) RESULTS:

Larry D. Godfrey and Terry Cuneo

With the uncertain status of Furadan 5G (carbofuran) after 1998, research on alternatives to Furadan for Rice Water Weevil (RWW) control has been a major emphasis of our project for the last several years, including 1997. Considerable progress has been made and three insecticides are moving towards registration. At this time, all three are in various stages of the process. Our research in 1997 in this area was aimed at trying to better understand how to most efficiently use these products to optimize RWW control. Two of the three proposed Furadan replacement compounds are used as postflood products. As such, these insecticides have no effect on RWW larvae; they provide control by effecting the adult RWW. Therefore, proper timing is imperative for these products to work adequately. Applications made too late are ineffective. Alternatively, these materials are quite short-lived in the water, which is a favorable attribute to registration agencies. This again points to the critical importance of application timing. Unfortunately our knowledge of when and under what conditions RWW adult deposit eggs in rice plants is limited. This has not been important when control was accomplished with preplant materials, but is of the utmost importance with the postflood strategy. Therefore, in 1997 we conducted studies in this area and other aspects of RWW biology. The final emphasis was to complete a study examining yield losses from RWW under grower field conditions. Data from all these studies will be briefly summarized.

Rice Water Weevil Control

Small ring tests (8 ft^2), medium-sized basin tests (200 ft^2), grower field tests (2-3 acre blocks) were conducted with seven insecticidal active ingredients in 1997. Within the ring tests, Dimilin, Icon, and Karate (Warrior) all provided good RWW larval control; the most effective treatment of each product reduced the larval density by 95%+. Karate provided control by killing adult RWW (as indicated by the % scarred plants), Dimilin reduced plant scarring marginally but primarily controlled RWW by sterilizing the adults, and Icon directly controlled the RWW larvae. In the ring plots, the Icon treatment gave the highest yield, but all three of these products protected the grain yield well. Four other insecticidal materials were also tested in ring plots. Of these Mustang showed the most activity. The medium-sized basin tests in 1997 were unsuccessful because a severe crayfish infestation annihilated the stand and the RWW infestation of the remaining stand was nil. Two-three grower size tests were conducted each with Dimilin, Icon, and Karate. At each site, the test insecticide (three rates of Dimilin were tested) was compared with Furadan and an untreated for adult scarring, larval density, and grain yield (small hand harvests and commercial harvest). These field sites were set-up under a Research Authorization/crop destruct scenario. RWW larval control with Dimilin was moderate; however, the Dimilin treated areas yielded on average about 200 lbs./A more than Furadan 5G and 1000 lbs./A more than the untreated areas. Icon averaged 93% RWW larval control compared with the 77% control with Furadan 5G. Grain yield results were reversed (higher with Furadan than Icon), but both increased the grain yield over then untreated. Grower field testing with Warrior was initiated in 1997. Overall, larval efficacy and grain yield results were less than with Furadan. The application timing was problematic and with better timing the efficacy may more closely parallel that seen in ring studies.

Rice Water Weevil Biology

Several aspects of RWW biology were studied in 1997. Although this insect has been in California for ~40 years, these areas were never important when preventive, preplant controls were used. The timing of RWW adult flight in the spring has been monitored for several years with a black light trap. Peak flights in 1997 occurred at the RES on 15-16 April, 26-27 April, and 7 May. Secondary flights occurred on 6 April, 30 April-2 May, 12 May, and 19 May. May 7 marked the completion of over 90% of the weevil flight at the RES. A total of 2556 weevils were captured in 1997 at the RES. This was about 53% lower than the number caught in 1996 and very similar (~ 1% more) to the number caught 5 years (1992) ago. The location of the trap and protocol has been exactly the same over this period.

The timing of RWW oviposition, relative to plant growth stage, was at the RES and from a Butte Co. grower field. RWW oviposition started at the 2 leaf stage and peaked at the 3 leaf stage. Some oviposition continued until the 5 leaf stage. This oviposition timing is much earlier than previously thought and will influence when postflood treatments should be applied.

The influence of the straw management treatments on rice water weevil populations was examined in 1997. The presence of a winter flood compared with nonflooded conditions consistently influenced rice water weevil populations. Rice water weevil larval populations were reduced in the winter flooded plots and averaged 0.35 and 0.9 larvae/plant in the winter flooded and nonflooded plots, respectively. The straw tillage treatment (burning, incorporation, rolling, and baling) did not effect larval population density. The differences could be important because they were of the magnitude such that economically important populations were reduced to noneconomical levels. The reason for these differences is uncertain at this time, but will be investigated in future studies. Straw management treatments had no effects on early-season seedling pests (tadpole shrimp, crayfish, and seed midge).

Rice Water Weevil Damage to Rice

Eight grower fields were studied in 1997 to assess the amount of damage RWW inflicts to rice. Different RWW levels were achieved by sampling at several distances from the levees. The % scarred plants and larval density generally declined as the distance from the levee increased (% scarred averaged 42% at 5 ft. and 5% at 45 ft., larval density averaged 1.5 at 5 ft. and 0.5 at 45 ft.). Grain yields were lowest at the 5 ft. sampling zone and relatively constant at 15-45 ft. In addition in 1997, none of the 8 fields sampled had damaging RWW larval populations at distances greater than 50 ft. from the levee. This again differs from 1996 when 3 of the 9 fields sampled had damaging larval populations in the 45 ft. sample. The 1997 results bode well for the perimeter insecticide treatment strategy. In rings at the RES, the relationship between scar counts, larval density, and grain yield was studied. These studies were in an abbreviated format compared with past years. Three years of intensive ring studies showed a grain yield loss of 80-100 lbs. per each RWW larva. In 1997, a ~102 lb./A yield loss per each RWW larva (0.9% per larva) was found. These values are ~one-fourth the values found in 1996 studies, but comparable to the 1993-95 studies. This may reflect the more favorable growing season in 1997 compared with 1996; the plant was better able to withstand the RWW feeding.

Table 1. Stand rating evaluation and RWW adult leaf feeding scar data, 1997.

Treatment	Rate (lbs.AI/A)	Timing	Rating	% Scarred Plants
1. Furadan 5G	0.5	PPI	1.7	23.5 b-h
2. Mustang 1.5EW	0.03	3-5 leaf	1.2	15.0 f-k
3. Mustang 1.5EW	0.05	3-5 leaf	1.5	4.0 jk
4. Mustang 1.5EW+oil	0.03+1qt	3-5 leaf	1.5	6.4 i-k
5. Dimilin 2L	0.125	1st emerg.	1.5	40.0 ab
6. Dimilin 2L	0.125	50% emerg.	2.2	20.0 d-i
7. Icon 70FS	0.0325	5-7d postflood	1.7	13.4 g-k
8. Dimilin 2L	0.125	10d aft.50% em.	2.2	43.0 a
9. Dimilin 2L	0.125	15d aft.50% em.	1.5	27.0 a-g
10. Icon 70FS	0.0325	PPI	1.7	10.0 h-k
11. Icon 70FS	0.025	PPI	1.7	23.4 b-h
12. Dimilin 2L	0.125	5d aft 50% em.	1.7	34.0 a-e
13. EXP90949A 1.5G	0.1	PPI	2	28.0 a-g
14. EXP90949A 1.5G	0.2	PPI	2	24.0 b-h
15. EXP61096 100EC	0.1	PPI	1.7	22.0 c-i
16. EXP61096 100EC	0.2	PPI	2.5	18.0 e-k
17. EXP61096 100EC	0.1	5-7 d post	2.2	24.4 b-h
18. EXP61096 100EC	0.2	5-7 d post	1.5	35.0 a-d
19. Karate 1EC	0.03	3 leaf	1.7	3.4 jk
20. Warrior 1CS	0.03	3 leaf	2.2	2.4 k
21. Warrior 2CS	0.03	3 leaf	1	1.4 k
22. Beauveria bassiana	$1x10^7$ conidia/cm	5-7 d post	1.7	37.4 a-c
23. Bacillus popilliae	~10 lbs./A	pre-emerge	2.2	31.4 a-f
24. Untreated	---	---	2.5	35.0 a-d

Table 2. RWW immature density data from ring plots, number of RWW per plant, 1997.

Treatment	Rate (lbs. AI/A)	Timing	RWW Immatures/Plant 18, 19 June	1-Jul	Ave.	Avg./Core
1. Furadan 5G	0.5	PPI	0.40 f-h	0.61 e-g	0.50	0.62
2. Mustang 1.5EW	0.03	3-5 leaf	0.40 f-h	0.50 e-g	0.45	0.65
3. Mustang 1.5EW	0.05	3-5 leaf	0 h	0 g	0.00	0.00
4. Mustang 1.5EW+oil	0.03+1qt	3-5 leaf	0.15 f-h	0.25 fg	0.20	0.22
5. Dimilin 2L	0.125	1st emerg.	1.01 b-e	2.52 ab	1.76	2.12
6. Dimilin 2L	0.125	50% emerg.	0.17 f-h	0.56 e-g	0.36	0.45
7. Icon 70FS	0.0325	5-7d postflood	0.89 c-f	1.56 b-d	1.22	1.60
8. Dimilin 2L	0.125	10d aft.50% emg.	0.15 f-h	0.05 g	0.10	0.10
9. Dimilin 2L	0.125	15d aft.50% emg.	0.83 c-g	0.37 e-g	0.60	0.65
10. Icon 70FS	0.0325	PPI	0.05 gh	0 g	0.02	0.02
11. Icon 70FS	0.025	PPI	0.20 f-h	0.64 e-g	0.42	0.52
12. Dimilin 2L	0.125	5d aft. 50% emg.	0.1 f-h	0.20 g	0.15	0.20
13. EXP90949A 1.5G	0.1	PPI	1.21 a-d	0.94 d-g	1.07	1.12
14. EXP90949A 1.5G	0.2	PPI	0.43 d-h	0.88 d-g	0.65	0.82
15. EXP61096 100EC	0.1	PPI	1.14 b-e	2.02 a-d	1.58	2.02
16. EXP61096 100EC	0.2	PPI	0.82 c-g	0.81 d-g	0.81	0.87
17. EXP61096 100EC	0.1	5-7 d post	1.11 b-e	2.43 a-c	1.77	2.00
18. EXP61096 100EC	0.2	5-7 d post	1.80 ab	2.99 a	2.39	2.57
19. Karate 1EC	0.03	3 leaf	0 h	0.03 g	0.01	0.02
20. Warrior 1CS	0.03	3 leaf	0.05 gh	0 g	0.02	0.02
21. Warrior 2CS	0.03	3 leaf	0.08 gh	0.10 g	0.09	0.10
22. <u>Beauveria bassiana</u>	$1x10^7$conidia/cm^2	5-7 d post	1.20 a-d	0.90 d-g	1.05	1.45
23. <u>Bacillus popilliae</u>	~10 lbs./A	pre-emerge	1.50 a-d	1.21 c-f	1.35	1.85
24. Untreated	---	---	1.99 a	1.51 b-f	1.75	2.22

Means within columns followed by same letter are not significantly different.

Table 3. Effects of RWW damage on rice grain yield from ring plots, 1997.

Treatment	Rate (lbs.AI/A)	Timing	Grain Yield (g/ ring)	Est. Grain Yield (lbs./ acre)
1. Furadan 5G	0.5	PPI	1015.5 e-g	11532.0
2. Mustang 1.5EW	0.03	3-5 leaf	1025.5 e-g	11713.4
3. Mustang 1.5EW	0.05	3-5 leaf	1148.0 b-g	12974.5
4. Mustang 1.5EW+oil	0.03+1qt	3-5 leaf	1254.7 ab	14130.2
5. Dimilin 2L	0.125	1st emerg.	983.2 fg	11233.2
6. Dimilin 2L	0.125	50% emerg.	1290.5 ab	14545.2
7. Icon 70FS	0.0325	5-7d postflood	1117.2 a-e	12545.6
8. Dimilin 2L	0.125	10d aft 50% em.	1168.7 a-e	13285.3
9. Dimilin 2L	0.125	15d aft 50% em.	1044.8 a-c	11887.3
10. Icon 70FS	0.0325	PPI	1308.1 a	14670.8
11. Icon 70FS	0.025	PPI	1094.3 a-e	12291.7
12. Dimilin 2L	0.125	5 d aft. 50% em.	980.3 fg	11224.9
13. EXP90949A 1.5G	0.1	PPI	1026.5 b-e	11799.0
14. EXP90949A 1.5G	0.2	PPI	1264.1 ab	14111.1
15. EXP61096 100EC	0.1	PPI	1156.3 a-c	13094.4
16. EXP61096 100EC	0.2	PPI	1177.8 a-d	13153.7
17. EXP61096 100EC	0.1	5-7 d post	1066.2 b-e	11947.2
18. EXP61096 100EC	0.2	5-7 d post	1004.3 e-g	11321.8
19. Karate 1EC	0.03	3 leaf	1202.8 a-e	13641.1
20. Warrior 1CS	0.03	3 leaf	1168.7 a-e	13259.4
21. Warrior 2CS	0.03	3 leaf	1229.6 a-e	13770.8
22. Beauveria bassiana	$1x10^7$ conidia/cm^2	5-7 d post	1071.2 a-e	12169.7
23. Bacillus popilliae	~10 lbs./A	pre-emerge	972.6 g	11135.4
24. Untreated	---	---	983.5 fg	11131.4

Means within columns followed by same letter are not significantly different.

Table 4. Average number RWW per core & plant, scar counts, rice grain yield - grower fields, Sacramento Valley, Dimilin 1997.

County Site Treatment	20-Jun RWW per core	3-Jul RWW per core	RWW ave/core	20-Jun RRW per plt.	3-Jul RRW per plt.	RWW ave/plt	% Scarred Plants	Hand Est. Yield (lbs./A)	Machine Est. Yield (lbs./A)
Sutter									
Untreated	1.60	2.00	1.80	1.28	1.14	1.21	28.75	10530	10903
Ring data	5.00	4.00	4.50	3.57	3.33	3.45	na	5897	
Dim 2L (8 oz)	0.85	1.55	1.20	0.77	1.03	0.90	20.25	10373	11133
Ring data	1.60	10.40	6.00	1.60	4.33	2.97	na	7847	
Dim 2L (12 oz)	2.00	2.50	2.25	1.14	1.28	1.21	49.25	9230	11353
Ring data	2.20	6.20	4.20	1.00	3.10	2.05	na	8391	
Dim 2L (16 oz)	2.15	4.10	3.12	1.95	1.86	1.91	31.25	10497	11062
Ring data	0.60	1.20	0.90	0.33	0.46	0.40	na	8495	
Furadan 5G	1.35	1.20	1.27	0.84	0.84	0.84	54.00	9923	10315
Ring data	2.20	5.20	3.70	0.85	0.85	0.85	na	7556	

County Site Treatment	12-Jun RWW per core	30-Jun RWW per core	RWW ave/core	12-Jun RRW per plt.	30-Jun RRW per plt.	RWW ave/plt	% Scarred Plants	Hand Est. Yield (lbs./A)	Machine Est. Yield (lbs./A)
Butte									
Untreated	0.15	0.40	0.27	0.11	0.31	0.21	25.25	9717	8855
Ring data	0.00	0.40	0.20	0.00	0.40	0.20	16.00	6959	
Dim 2L (8 oz)	1.00	0.70	0.85	0.17	0.71	0.44	26.25	10056	10437
Ring data	0.00	0.40	0.20	0.00	0.22	0.11	14.00	6299	
Dim 2L (12 oz)	1.00	2.15	1.57	0.13	1.44	0.79	51.50	10568	10595
Ring data	0.20	2.20	1.20	0.11	1.37	0.74	40.00	8277	
Dim 2L (16 oz)	0.20	0.55	0.37	0.03	0.32	0.18	44.00	10463	10494
Ring data	0.20	0.00	0.10	0.11	0.20	0.15	34.00	6874	
Furadan 5G	0.20	0.05	0.12	0.04	0.04	0.04	12.50	9836	10992
Ring data	0.00	0.00	0.00	0.00	0.00	0.00	10.00	7234	

20 adults added to each ring before Dimilin applications

Table 5. Influence of Dimilin 2L in grower field tests on average leaf damage, RWW larval density and grain yield, hand and machine harvested samples, 1997.

Treatment	Type	% Scarred Plants	RWW Per Plant	Hand Harvest (g/plot)	Hand Est. Yield (lbs/A)	Machine Est. Yield (lbs/A)
1. Dimilin (8 oz)*	Plot	23.2	0.67	1295.0	10214.8	**10785.2**
	Ring	14.0	1.54	667.0	**7072.9**	
2. Dimilin (12 oz)*	Plot	50.4	1.00	1265.2	9898.9	**10973.7**
	Ring	40.0	1.39	786.0	**8333.9**	
3. Dimilin (16 oz)*	Plot	37.6	1.04	1360.1	10480.3	**10778.0**
	Ring	34.0	0.27	721.4	**9017.4**	
4. Furadan 5G	Plot	33.2	0.44	1250.5	9879.2	**10653.3**
	Ring	10.0	0.42	695.1	**7395.0**	
5. Untreated	Plot	27.0	0.71	1293.3	10123.6	**9878.9**
	Ring	16.0	1.82	598.3	**6427.8**	

* Averaged over the Sutter and Butte County Sites

Table 6. Average number RWW per core & plant, scar counts, rice grain yield - grower fields, Sacramento Valley, Icon 1997.

County Site Treatment	% Scarred Plants	23-Jun RWW per core	7-Jul RWW per core	RWW ave/core	23-Jun RWW per plt	7-Jul RWW per plt	RWW ave/plt	Hand Est. Yield (lbs./A)	Machine Est. Yield (lbs./A)
Sutter									
Untreated	25.75	0.60	1.00	0.80	0.67	0.64	0.65	8516*	8074
Icon 80 WG	10.25	0.15	0.00	0.07	0.14	0.00	0.07	8045*	8370
Furadan 5G	13.25	0.55	0.10	0.32	0.52	0.07	0.30	8778*	9914

County Site Treatment	% Scarred Plants	26-Jun RWW per core	8-Jul RWW per core	RWW ave/core	26-Jun RWW per plt	8-Jul RWW per plt	RWW ave/plt	Hand Est. Yield (lbs./A)	Machine Est. Yield (lbs./A)
Butte									
Untreated	40.25	3.30	0.95	2.12	1.65	0.53	1.09	5604	4332**
Icon 80 WG	16.00	0.15	0.05	0.10	0.09	0.03	0.06	3766**	4868**
Furadan 5G	24.50	0.20	0.10	0.15	0.17	0.06	0.11	5982	6056

* Yields compromised by herbicide phytotoxicity in first 30 feet from levee.

** Yields compromised by aggregate sheath spot.

Table 7. Influence of Icon 80 WG in grower field tests on average leaf damage, RWW larval density, and grain yield, hand and machine harvested samples, 1997.

Treatment	% Scars	RWW Per Plant	Hand Harvest (g/plot)	Est. Hand Yields (lbs./A)	Est. Mach. Yields (lbs./A)
1. Icon*	13.1	0.06	905.6**	5905.6*	6619
2. Fur. 5G*	18.9	0.2	988.1	7379.9	7985**
3. Unt*	33	0.87	958.5	7059.7	6203**

* Averaged over the Sutter and Butte County sites.

** Yields compromised aggregate sheath spot at Butte Co. site.

Table 8. Average number RWW per core & plant, scar counts, rice grain yield - grower fields, Sacramento Valley, Warrior 1997.

County Site Treatment	% Scarred Plants	17-Jun RWW per core	2-Jul RWW per core	RWW ave/core	17-Jun RWW per plt	2-Jul RWW per plt	RWW ave/plt	Hand Est. Yield (lbs./A)
Colusa-1								
Untreated	47.75	2.55	1.65	2.10	2.04	1.22	1.63	12112
Warrior 1EC	23.25	2.75	2.75	2.75	2.29	1.40	1.84	10090
Furadan 5G	19.25	0.20	1.50	0.85	0.20	0.86	0.53	8233

County Site Treatment	% Scarred Plants	27-Jun RWW per core	9-Jul RWW per core	RWW ave/core	27-Jun RWW per plt	9-Jul RWW per plt	RWW ave/plt	Hand Est. Yield (lbs./A)
Colusa-2								
Untreated	8.00	1.40	0.40	0.90	0.96	0.23	0.59	10295
Warrior 1EC	24.00	0.45	0.40	0.42	0.37	0.22	0.29	9328
Furadan 5G	na	na	na	na	na	na	na	na

County Site Treatment	% Scarred Plants	24-Jun RWW per core	7-Jul RWW per core	RWW ave/core	24-Jun RWW per plt	7-Jul RWW per plt	RWW ave/plt	Hand Est. Yield (lbs./A)
Placer								
Untreated	18.75	0.15	0.25	0.20	0.12	0.18	0.15	10178
Warrior 1EC	22.50	0.10	0.10	0.10	0.07	0.08	0.07	10456
Furadan 5G	10.75	0.40	0.85	0.62	0.33	0.36	0.34	12306

Table 9. Influence of Warrior™ 1EC in grower field tests on average leaf damage, RWW larval density and grain yield, hand and machine harvested samples, 1997.

Treatment	% Scars	RWW Per Plant	Hand Harvest (g/plot)	Est. Yield (lbs./A)
1. Warrior 1EC*	23.25	0.73	1220.5	9958.08
2. Furadan 5G*	15	0.43	1155.96	10269.6
3. Untreated*	24.83	0.79	1222.61	10861.6

* averaged over three grower sites

Table 10. Relationship among scar incidence, larval density, and rice grain yield, 1997.

Infestation Level	% RWW Scarred Plants	RWW Larval Density/Core 17-Jun	RWW Larval Density/Core 3-Jul	Est. Yield (lbs./A)
0 adults/plant	6.8 c	2.0 a	3.0 a	11766 a
0.4 adults/plant	41.3 b	14.1 b	13.8 b	8138 b
0.6 adults/plant	55.0 a	16 b	24.7 c	8662 b

Table 11. Average percentage scarred plants, RWW larvae density, and grain yield at various distances from levee in grower field threshold test, 1997.

Distance from Levee (ft)	% Scarred Plants	Larvae per Plant 12 - 25 June	Larvae per Plant 25 June - 9 July	Larvae per Plant Avg.	Est. Grain Yield (lbs./A)
5	41.5	1.5	1	1.3	9170
15	25.4	0.9	0.9	0.9	9950
25	12	0.5	0.4	0.5	9460
35	7.1	0.3	0.3	0.3	9990
45	5.4	0.5	0.3	0.4	9780

Influence of Straw Management Treatments on RWW Adult Scarring - 1997

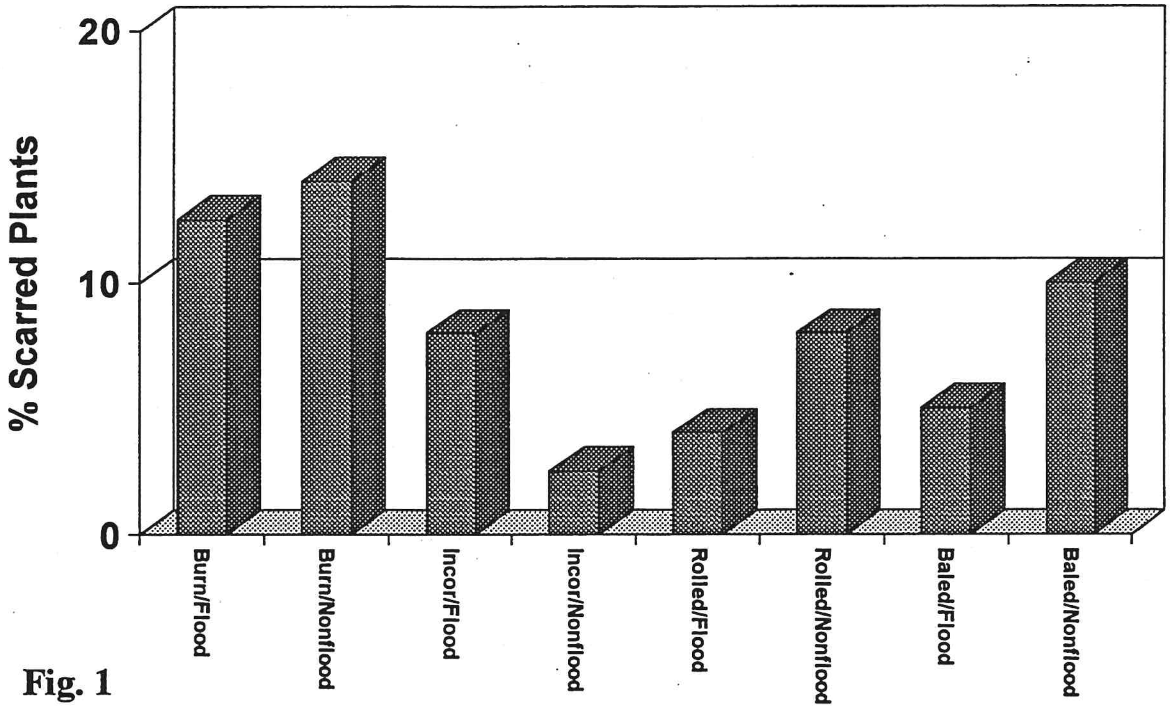


Fig. 1

Influence of Straw Management Treatments on RWW Larvae - 1997

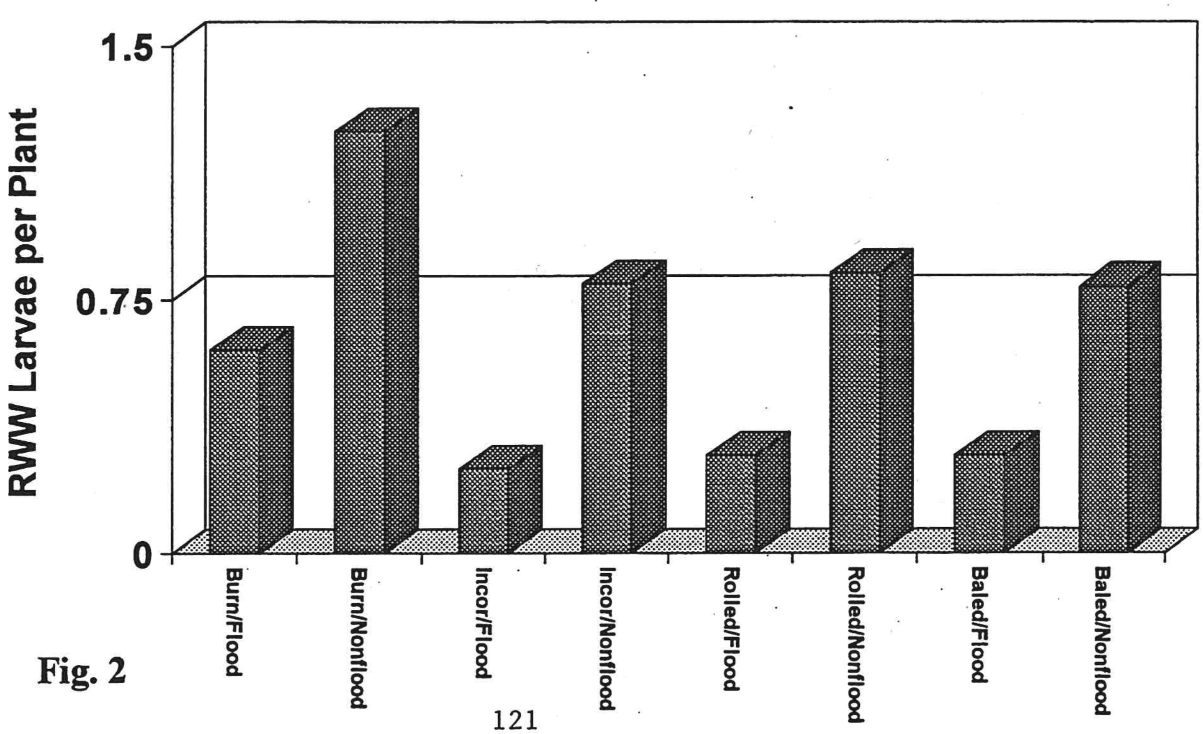


Fig. 2

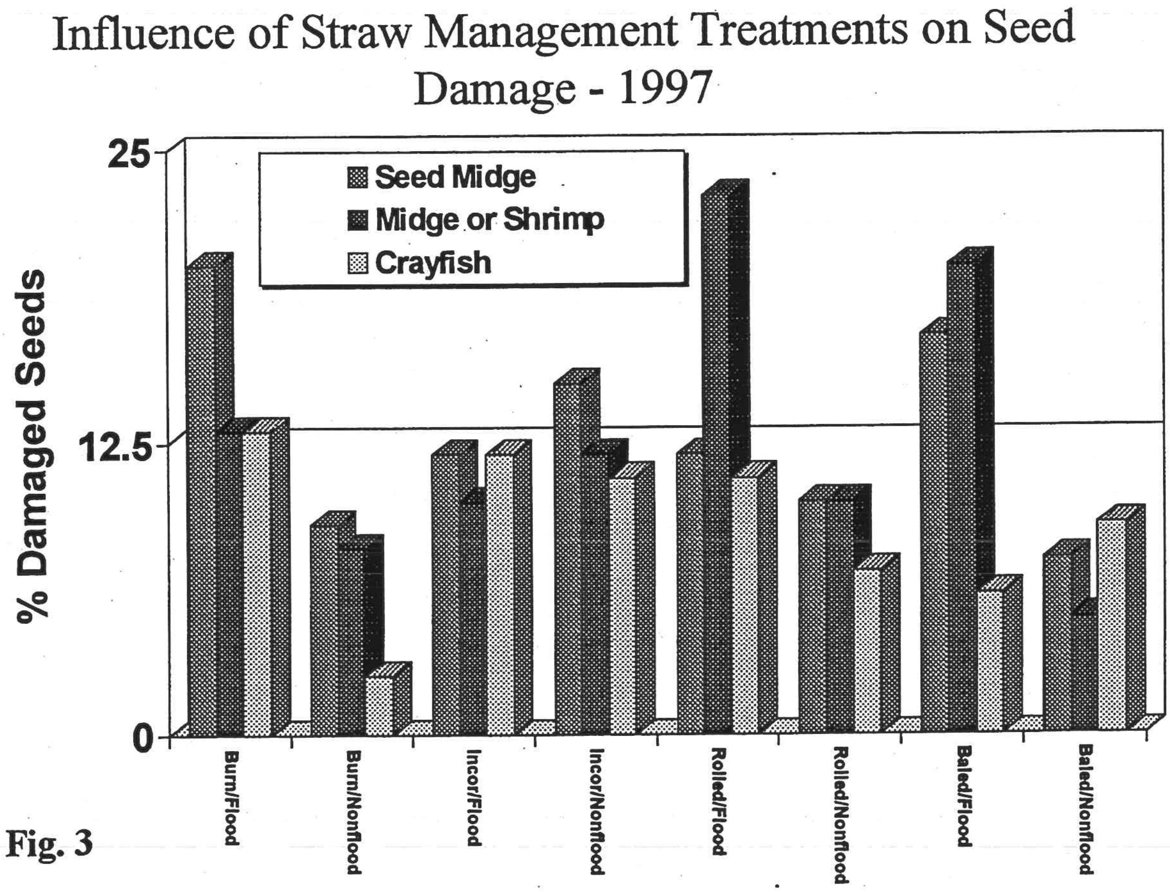

Influence of Straw Management Treatments on Seed Damage - 1997
Seed Midge
Midge or Shrimp
Crayfish
% Damaged Seeds
25
12.5
0
Burn/Flood
Burn/Nonflood
Incor/Flood
Incor/Nonflood
Rolled/Flood
Rolled/Nonflood
Baled/Flood
Baled/Nonflood

Fig. 3

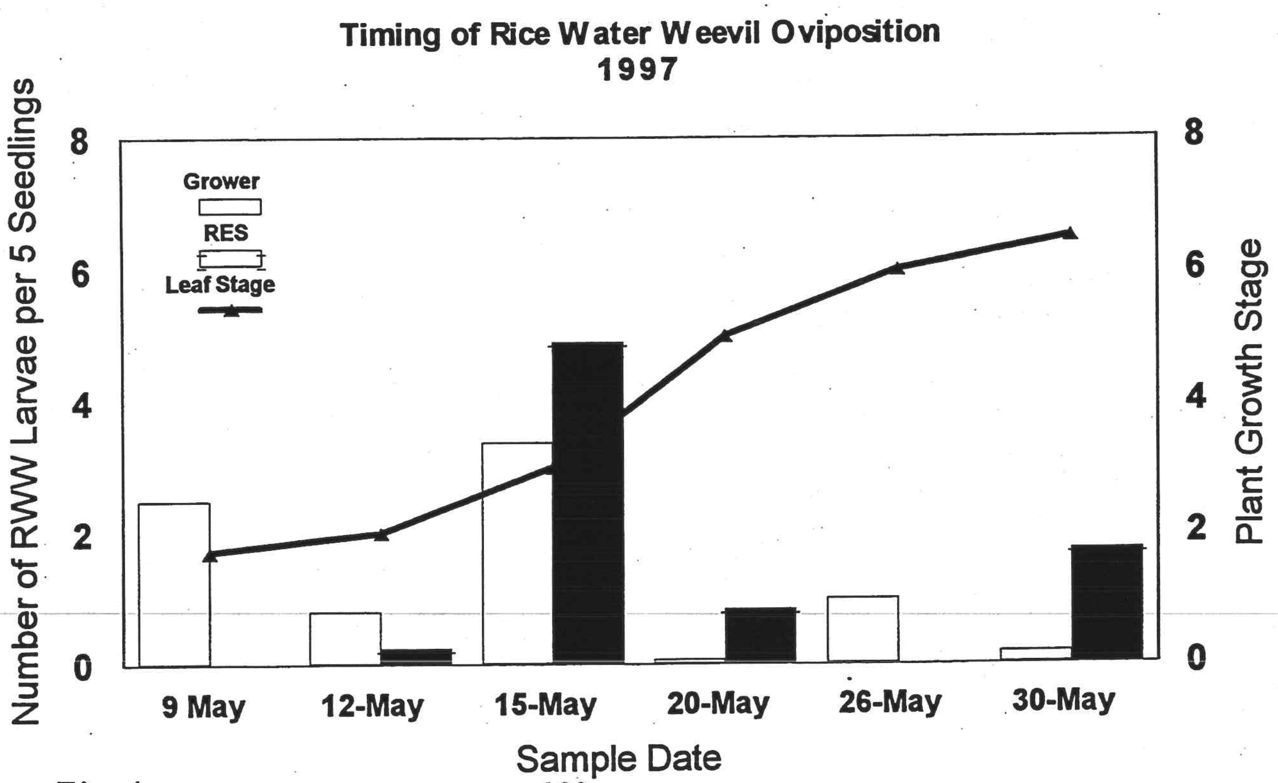

Timing of Rice Water Weevil Oviposition
1997
Grower
RES
Leaf Stage
Number of RWW Larvae per 5 Seedlings
Plant Growth Stage
8
6
4
2
0
9 May
12-May
15-May
20-May
26-May
30-May
Sample Date

Fig. 4

Rice Water Weevil Flight, RES - 1997

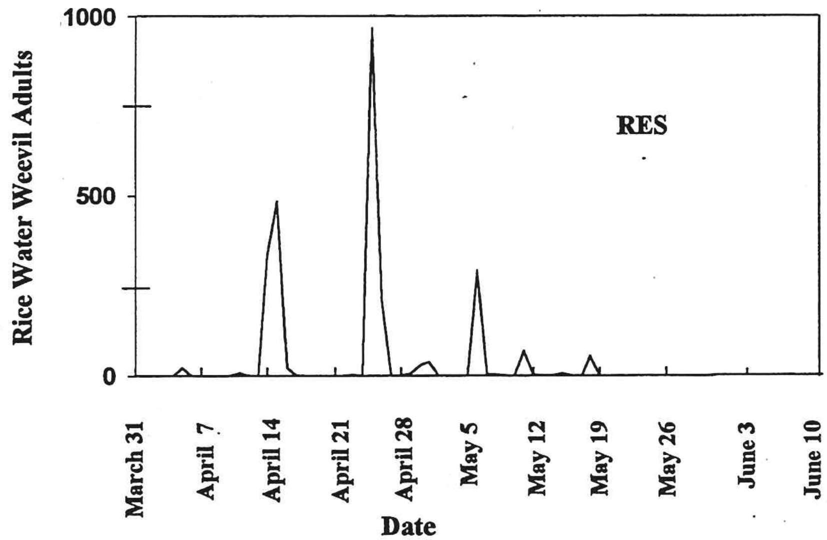
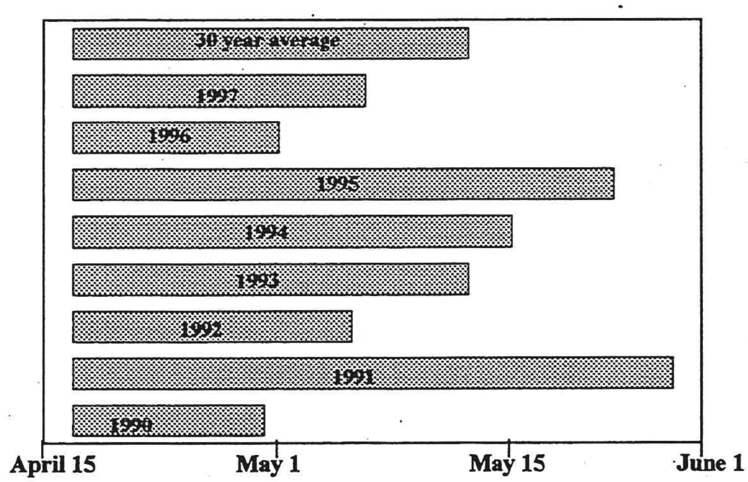


Fig. 5

Rice Water Weevil Flight Period - RES

Completion of 90% of Flight *



* based on black light trap captures

Fig. 6