PROJECT NO. RP-3

COMPREHENSIVE RESEARCH ON RICE
ANNUAL REPORT

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PROJECT TITLE: Protection of rice from invertebrate pests

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LEVEL OF 1984 FUNDING: $38,006

OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH OBJECTIVES:

Objective I: The recognition of physical and biological factors that result in fluctuation and movement of pest populations that cause economic injury to rice plants.

1) A greenhouse experiment was conducted at Davis to show if there was an effect on the hatchability of rice water weevil eggs when water was dropped below the level of oviposition.

2) A continuing survey of rice water weevil adults was made with a light trap at Biggs to determine flight periods from March to September. Records of numbers of adults of the armyworm were also kept to show periods of greatest moth activity.

3) Six field experiments in 3 counties with 3 varieties of coated-dry and uncoated-soaked rice seed were monitored for possible injury by rice seed midges.

Objective II: To determine the most effective control of rice invertebrate pests and maintain a quality of the environment compatible with the needs of society.

1) Rice water weevil - chemical control.

   a) The chitin inhibitor alsystin was tested at three rates in a postflood application in a field experiment at Biggs.

   b) Preflood and postflood treatments with granules of isophenphos and carbofuran were compared at several rates at Biggs.

2) Rice water weevil - genetic control.

   a) Studies on the tolerance of rice to the weevil were made at Biggs. Twenty-three lines were compared in 4 untreated and

4 treated (carbofuran) lines. Ten of these lines were the most promising in previous tests, and 12 were the most advanced of the plant breeders. M-9 was used as the susceptible standard.

b) Two lines that showed the most promising tolerance 1) at the beginning of plant growth, and 2) recovery following weevil infestation were compared to M-9 throughout the season in a replicated test at Biggs.

3) Tadpole shrimp - chemical control.

a) Two formulations of liquid copper sulfate were compared to copper sulfate crystals at 3 rates of each in a laboratory test at Davis.

b) A second laboratory test used Hydrothol 191 (a herbicide and fungicide) at several rates for possible shrimp control.

4) The factors affecting spiders in rice fields and their role as biological control agents were studied in the field at Biggs and the laboratory at Davis.

SUMMARY OF 1984 RESEARCH BY OBJECTIVE:

Objective I:

1) The rice water weevil oviposits in the parts of the rice plant that are covered with water. A greenhouse test last year indicated the water could be dropped below the level of the eggs in the plant tissue for variable periods during egg maturation and reduce the number of eggs that would survive. The basic experiment was repeated this year with a change in experimental design so that water would be below the area of oviposition for 1 to 7 days (7 treatments) and then returned to the original level. The rice roots were washed 25 days after oviposition to recover surviving larvae. The 1984 test showed no significant differences in the number of larvae recovered in the drain period treatments from the larvae in the continuously flooded check. The experiment needs to be repeated in 1985 because of the contradictory results of the 2 years. A well-timed drain period for 6-7 days at 1 to 2 weeks after the rice emerges through the water could be an alternative method of population reduction.

2) The light trap collections for 1984 are still being sorted and the reporting is always one year behind. In 1983 the total catch of the spring flights (overwintering weevils) was 7,366. This is 3 times higher than in 1982. The peak period was from May 13 to May 28 and then a smaller peak from June 3rd to the 5th. The collection totals can be affected by evening weather conditions and do not necessarily reflect an accurate estimate of field population, but knowing when the peak flight periods occur is important in interpreting weevil infestations in experimental

plots at different planting dates on the station.

The earliest and largest armyworm moth activity occurred between April 15th and May 20th. They were from a generation that developed on a crop other than rice and the rice was too small for oviposition by the moths at this time. The second moth flight peak occurred June 22 to 24. This was large and probably resulted from larvae on grasses on the levees or near rice fields. This was the generation that oviposited on rice. A small peak also occurred on July 15 which extended the infestation on rice. No moths were collected after July 15.

3) A project on the comparison of rice seed coated and dry to rice seed uncoated and soaked was conducted in cooperation with rice farm advisors Williams, Wick, and Scardaci. It was funded in part by UC Extension, IPM Extension, and the Rice Research Board. Rice growth, disease and the effect of seed midges were examined and a full report will be given elsewhere, but the relationship to seed midges is reported here. The coated dry and uncoated soaked seed of the varieties M-9, S-201 and M-201 were planted at 6 different locations in the Sacramento Valley. The 4 replications at each locality were seeded about 5 days after flooding and plant samples were removed for examination at 5, 10, and 20 days after planting. The percent of plants having some midge injury (not necessarily injury that would result in mortality) ranged from none to a maximum of 7.3% at the 5 day examination. At 10 days the injury ranged from 0 to 12.5%. The incidence of the injury was quite variable and no significant differences in midge injury at the 5% level were detected between coated-dry and uncoated-soaked seed for the 3 varieties at any of the 6 localities. There was a significant retarding of seedling growth for the coated-dry seed and it was expected that if midge populations were uniform and at a higher level, the injury to coated-unsoaked seed would be greater.

Objective II:

1) Rice water weevil - chemical control

   a) Alsystin, a chemical that inhibits the formation of insect chitin, was sprayed on 16 day old M-101 rice plants at 0.134, 0.268, and 0.401 lb active ingredients per acre in a field test at Biggs. The roots were washed for larvae 6 weeks after treatment and several plant growth characteristics were measured at this time. The number of larvae recovered from roots ranged from 2.45 to 2.60 per plant. There were no significant differences between the control and the treatments for numbers of larvae or plant growth characteristics, including yield. This chemical has been tested in the greenhouse and field previously and has provided adequate control. Timing of the treatment is a critical factor in relation to

plant growth and weevil flights. Additional experiments are warranted to determine the most effective timing.

b) Carbofuran, the currently recommended chemical for rice water weevil control, was tested with isophenphos, an organophosphate, in the field at Biggs. Both chemicals were used in 4 replications in granular form. Preflood applications of carbofuran were made at 0.5 and 1.0 lb ai/acre and isophenphos at 1.0 and 2.0 lbs. Postflood applications, to water, were made with the same chemicals and at the same rates 7 weeks following the initial weevil infestation. The natural weevil infestation was rather low so aluminum rings enclosing 8 sq ft were added to each replication and weevil adults were added to the rings at the approximate rate of 1 per 2 plants. Ten plants were taken from each ring and washed to recover larvae from the roots approximately 6 weeks after the artificial infestation. These plants were measured for differences and all plants in the rings were harvested at maturity for grain yield. The number of larvae recovered from the roots ranged from 11 per plant in the untreated to 2.1 per plant in the most effective control. The 2 preflood rates of isophenphos and the 0.5 lb preflood treatment of carbofuran were not significantly different from the untreated. The 1.0 lb rate of carbofuran at preflood was significantly different from the check but resulted in only a 40% reduction in larvae. Postflood treatments of isophenphos showed significant reductions of 79% (1 lb) and 84% (2 lb) from the control. Postflood treatments of carbofuran resulted in significant reductions of 49% (.5 lb) and 81% (1.0 lb). Most early plant growth characteristics and yield determinations showed the treatments not to differ significantly from the untreated at the 5% level. Isophenphos is reported to be very effective in the south but none of the preplant, preflood treatments provided adequate control in this test. Postflood treatments were made to the water because the test was superimposed on a seed field which could not be drained but it is improbable if they could be registered for treatment directly to the water in California.

2) Rice water weevil - genetic control.

Studies on the tolerance of rice cultivars to the rice water weevil have been continuing for several years in cooperation with the plant breeders at Biggs and several entomologists in the southern states.

a) The standard test (see previous annual reports) of comparing 4 replications of the treated (carbofuran) cultivar and the same untreated one under a natural weevil infestation was conducted at Biggs. Twenty-three different lines included the following which had not been included in our previous

standard tests: 4 1984 crosses and 8 of the most promising lines from the 1983 plant breeder test. Ten of the most promising lines from our previous tests were included, 2 of which had been tested for 2 years. M-9 was also included as a known susceptible line. A carbofuran treatment of 1.0 lb ai was made preflood and a second postflood treatment of 0.5 lb was made after draining at 6 weeks after planting. It became obvious when making visual ratings of the paired treated and untreated cultivars at 9 and 13 weeks after planting that the carbofuran treatments were not providing complete control of the water weevil. This prevented a within-variety comparison of tolerance and limited the tolerance test to a comparison between varieties. Highly tolerant lines were still quite evident under this heavy weevil infestation and 5 of the highest yielding tolerant lines showed a range of 44% and 55% more grain than the M-9.

b) An additional experiment or rice water weevil tolerance included 4 replications of the three rice lines 81-2005, 83-2200, and M-9. It was designed to compare plant growth characteristics of two lines we considered highly tolerant and the susceptible M-9, all under treated and untreated conditions. The preflood and postflood carbofuran treatments were the same as in the standard test (part a) which was in the same paddy. Plant samples were taken for growth measurements at 16 days (4-7 leaf stage), 46 days (mid-tillering), 71 days (early jointing), 102 days (heading), and harvest. Larvae were recovered from the roots on the 46 and 71 day samples. The 46 day sample (which was 7 days following the 2nd carbofuran treatment) showed an average of 53% fewer larvae in the treated than the untreated replications (3.25/plant untreated, 1.56/plant treated). The 71 day sample (32 days following the 2nd treatment) showed only 3% fewer larvae in the treated than the untreated (3.17/plant untreated, 2.96/plant treated). The lack of adequate control with carbofuran prevented a comparison within a variety of the growth of infested plants with the maximum potential of the cultivar, but differences between cultivars were examined. Yields per plant were 2.26 grams for 81-2005, 2.14 grams for 83-2200, and 1.28 g for M-9. The reduction in grain for M-9 was 43% from 81-2005. Very minor differences in plant growth were observed between cultivars at 16 days. At 46 days the growth of both tolerant lines was considerably higher than M-9. The greatest difference was in the wet weight of the total plants of 83-2200 which was 4 g/plant. M-9 was 1.5 g and 81-2005 was 3.0 g. This approximate ratio of plant growth was maintained for the 3 lines throughout the season. The line 83-2200 also had a greater number of tillers and leaves and greater root development. The greatest surge in root development for 83-2200 occurred between the 71 day and 102 day examinations which was 74% greater than M-9 and 42%

greater than 81-2005. In the 1983 standard test 81-2005 had the greatest yield for the untreated replications and 83-2200 had the least reductions in plant growth for the untreated at the mid-tillering period. This type of test should be repeated when adequate chemical control can be obtained for comparisons.

3) Tadpole shrimp - chemical control.

   a) Tadpole shrimp eggs were collected with soil from a rice field in San Joaquin County. After flooding, the tadpole shrimp were collected for a replicated chemical test in the laboratory at Davis. Copper sulfate was formulated as rice crystals and two liquid formulations 5.14% and 6.36% copper expressed as copper. All three were tested at 2.5, 5.0 and 10.0 lbs/1/2 acre ft of water. One-hundred percent mortality resulted in all treatments by 29 hours after treatment and the check had only 10% mortality at this time. The standard crystals and the 6.36% liquid formulations gave 100% mortality at 5.0 and 10.0 lbs between 6.2 and 3.7 hours. The 5.14% formulation took somewhat longer, 7.7 to 13.5 hours. The liquid formulations may provide economic advantages for shrimp control in the future.

   b) Hydrothol 191, a herbicide-fungicide, was tested on the tadpole shrimp with the same procedure at 6.0, 8.5, and 11.0 lbs/1/2 acre ft of water. No shrimp mortality was observed.

4) Spiders are known to occur at high densities in the aquatic and semi-aquatic habitats associated with rice fields. They are predators on insects and other invertebrates and in some parts of the world they are known to contribute to the biological control of rice pests such as leafhoppers and planthoppers. A three year study on the potential of these predators in California rice fields began in 1983. Using several types of traps and collection devices at Modesto, Natomas, and Biggs, approximately 85 species of spiders were collected. The two wolf spiders, Pardosa ramulosa and Pirata sp. are the most abundant on the levees and surface of the paddies and represent well over half of the total specimens collected in these two habitats.

   It appears that the vast majority of the wolf spiders overwinter within the drained paddies and that spring tillage destroys a high percentage of these individuals. The relatively low populations on the levees move out into the paddies after flooding and do not build up to peak numbers until late in the season. In contrast, if no till culture is practiced, the relatively large overwintering population survives and the resulting population peaks earlier in the season and in greater numbers than full tillage fields. Traps on the levees indicated a greater

preference for high soil moisture habitats than for several vegetation types, but this needs to be confirmed with a different collection technique. Wolf spiders in the flooded paddies are most numerous among pure weed stands (Monochoria and ducksalad) than pure rice or rice-weed mixtures. Potential prey items were also most numerous among pure weed stands.

Difficulties in confining the wolf spiders and inadequate pest species infestations have delayed quantifying the predator-prey interactions but different experimental designs and immunological techniques should provide meaningful biological information in this area.

PUBLICATIONS OR REPORTS:

Grigarick, A.A., and R.K. Washino. 1983. Invertebrates. In: M.L. Flint (Technical Editor), Integrated Pest Management for Rice. Univ. of Calif. Statewide Integrated Pest Management Project, Div. of Agric. Sci. Publ. 3280, pp. 49-75.

Grigarick, A.A. 1983. Comprehensive research on rice, RP-3, 9 pp.

Way, M.O., A.A. Grigarick, and S.E. Mahr. 1984. The aster leafhopper (Homoptera: Cicadellidae) in California rice: Herbicide treatment affects population density and induced infestations reduce grain yield. Jour. Econ. Entom. 77: 936-942.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

The effect of drying on eggs of the rice water weevil was examined by lowering the water level below the oviposition sites in the rice stem for 1 to 7 days. The results did not show a significant (5%) reduction in the survival of the eggs as was observed in 1982. An additional experiment is planned to search for an explanation of the contrasting results of the two years and determine the potential for this alternative method of control.

Light trap collections taken in 1983 and counted in the winter of 1984 showed armyworm moth flights to peak between April 15th and May 20th and again between June 22 and 24. The latter peak probably was the end of a generation on grasses near rice fields and levees and was the generation that infested the rice.

The effect of coated dry seed and uncoated soaked seed on the level of seed midge infestations was examined with 3 varieties of rice planted at 6 locations. The low levels of midge infestations at the 6 localities resulted in no significant differences (5%) in midge injury between the coated and uncoated seeds or seedling growth. This cooperative study also included the measurement of plant growth characteristics which will be reported in the IPM annual report because of multiple funding.

A field test with chitin inhibitor Alsystin for control of the rice water weevil showed no significant differences between the number of weevil larvae recovered in the treated and untreated paddies. Previous tests have provided adequate control, but timing of the application is very critical and a second application to the foliage may be necessary if the infestation is prolonged.

A field test for control of the rice water weevil with granular formulations of carbofuran and isophenphos was made preflood (1 day) and postflood (7 days). One lb and 2 lbs/acre active ingredients of isophenphos preflood and .5 lb carbofuran showed no significant differences in larvae recovered from the untreated. A 1.0 lb rate (preflood) of carbofuran provided only a 40% reduction in larvae. The postflood applications of isophenphos showed significant larval reductions of 79% (at 1 lb) and 84% (at 2 lbs) from the untreated. Postflood applications of carbofuran resulted in significant reductions of larvae of 49% (at .5 lb) and 81% (at 1 lb). These levels of larval reduction by carbofuran are well below that found in most previous tests.

Continuing studies on the tolerance of rice cultivars to the rice water weevil consisted of two parts. A standard test compared 22 of the most promising tolerant lines with the susceptible M-9 under treated (carbofuran 1.0 lb preflood and 0.5 lb postflood drain) and untreated paired replications. The carbofuran did not provide adequate weevil control so accurate within the same variety comparisons could not be made, but comparisons between different lines were possible. Under a very heavy weevil infestation 5 of the highest yielding tolerant lines showed a range of 44% to 55% more grain than the M-9. A second test dealing with tolerance included the lines 81-2005 and 83-2200 and M-9 under the same experimental design but plant growth characteristics were compared at 16, 47, 71, 102 days and at harvest. The same problem resulted from inadequate control with carbofuran but comparisons between lines were made. No significant differences in plant growth were observed at 16 days. At 46 days the growth of both tolerant lines was considerably greater than M-9 and these differences were maintained throughout the season. Line 83-2200 had the greatest difference in top and root growth. The greatest surge in root growth of 83-2200 was between the 71 and 102 day examinations which was 74% greater than M-9 and 42% greater than 81-2005. Yields were 2.26 g/plant for 81-2005, 2.14 g/plant for 83-2200, and 1.28 g for M-9.

The tadpole shrimp was tested in the laboratory with copper sulfate crystals and two liquid formulations of copper sulfate at 2.5, 5, and 10 lbs of ai/1/2 acre ft of water. One-hundred percent mortality occurred in all treatments by 29 hours, with only 10% mortality in the untreated control. The crystals and one liquid copper formulation caused 100% mortality in 6.2 and 3.7 hours at 5 and 10 lbs. A second test with Hydrothol 191, a herbicide-fungicide, resulted in no mortality of rates up to 11 lb ai/1/2 acre ft of water.

Spiders have been shown to be important general predators of a number of rice pests throughout the world. The first two years of a three-year study have collected approximately 85 species associated with rice fields. The wolf spiders Pardosa ramulosa and Pirata sp. are the most abundant on the levees and surface of the paddies and represent well over half of the total specimens collected. Trapping studies indicate the majority of wolf spiders overwinter in the drained paddies and spring tillage destroys a high percentage of them. In contrast, if no till culture is practiced, a high percentage of the overwintering poulation survives and their population peaks earlier in the season. Wolf spiders in flooded paddies are more numerous in pure seed stands than pure rice or rice-weed mixtures. Potential prey species were also most numerous among pure weed stands.