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 1987 FUNDING: $42,173.

OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH RESULTS:

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 continuing survey of rice water weevil and armyworm adults was made with a light trap at Biggs to determine flight periods from April to July (infestation flights).

2) Sticky traps were placed in 5 fields at Biggs for comparison with the light trap and to determine possible relationships of water weevil flights to insecticide applications and the time of planting study.

3) A survey was made at the southern edge of the known distribution of the rice water weevil in the San Joaquin Valley to see if there has been a southern extension.

Objective II: To determine the most effective control of rice invertebrate pests while maintaining environmental quality compatible with the needs of society.

1) Rice water weevil - chemical control.

a) Postflood applications of diflubenzuron were made at 0.125, 0.25, and 0.375 lb active ingredients (a.i.)/acre in paddies that were divided by soil and aluminum to prevent water movement between paddies. (Biggs RES)

b) Preflood and postflood applications of SC-0567 granules, and a postflood treatment with diflubenzuron were compared with the standard rate of carbofuran at the north edge of five seed-fields. (Biggs RES)

c) Evaluations of the experimental chemicals fortress (an organophosphate) and flufenoxuron (an insect growth regulator) were compared to the standard carbofuran in the greenhouse at UCD.

2) Rice water weevil - genetic control.

a) Studies on the tolerance of rice to the weevil were made in the field at Biggs RES with a standardized test that compared 20 cultivars.

b) A greenhouse experiment at UCD compared the tolerant line 86-2404 to the susceptible M-9 when exposed to three levels of weevil larvae on 14, 21, and 28 day old plants to provide information on the mechanism of tolerance.

c) A field experiment at Biggs RES compared the tolerant lines 85-2385 and 86-2404 to the susceptible M-9 when exposed to a natural infestation of the rice water weevil to provide information on the mechanism of tolerance. Plants were examined at 40, 65, and 100 days and yields were taken.

d) Block plantings (25' X 25') of the tolerant 85-2385 and the susceptible M-202 were made at Biggs RES to study the effect of increased plot size on tolerance.

3) Rice water weevil - cultural control.

a) A field experiment at Biggs RES compared the effect of two planting dates, determined by accumulation of day-degrees in relation to weevil flight, on the level of weevil infestation and rice yield.

b) A field experiment at Biggs RES compared three rates of seeding, 100, 200, and 300 lbs per acre, as a means of mitigating damage to rice by the weevil.

SUMMARY OF 1987 RESEARCH BY OBJECTIVE:

Objective I:

1) Light trap collections for the rice water weevil are made annually to determine peak flight periods and better interpret periods of infestations in research plots. The first peak of flight of overwintering weevils in 1987 occurred between 4/24 and 4/27 with an accumulation of about 200 day-degrees. A drop in mean temperature from 4/28 to 5/3 delayed flight until 5/4 to 5/8 when the maximum flight period occurred. Three hundred and twenty-eight day-degrees had been accumulated when 90% of the flight was completed.

The light trap also catches armyworm adults and these are recorded to obtain background information that may relate to infestations in rice. Three hundred and seventy-five moths were collected between 6/16 and 7/1. This is about 100 fewer moths than last year but is the second highest collection in the past 5 years. General comments on armyworm damage by growers indicated about an average year.

2) The cost of light traps and the necessity of a power source prevent their widespread use as an indicator of weevil flight activity but sticky traps present a reasonable alternative. Thirteen sticky traps were placed at 4 places on the station in areas associated with water weevil research. The sticky traps were put into operation at the time of flooding and traps in 3 of the 4 areas showed peak weevil flight to closely coincide with the light trap catches. The 4th area showed a slight delay in sticky trap catches but this was probably due to a later trap placement.

3) Periodically a survey is made in the San Joaquin Valley to determine if the rice water weevil has extended its distribution further south. Examinations were made for feeding scars or adult weevils on 8/3/87. Adults or scars were found in fields 2 miles west and 1 mile southwest of Merced. Four fields were examined in the Firebaugh and Dos Palos areas but no weevils or feeding scars were found.

Objective II:

1) Rice water weevil - chemical control.

a) Postflood applications of diflubenzuron, an insect growth regulator that affects the hatch of rice water weevil eggs, were made in the field at Biggs RES to provide information on rate and timing of application. This field (100 A) was selected because of its previous history of high weevil infestations and early flooding. Results of a similar test last year were not conclusive because multiple rates of the chemical were applied to a single paddy with replications separated by a minimum of 20 feet of water and rice. Movement of the chemical in the water or movement of weevils between replications was indicated by the lack of differences between treatments and the control. In 1987 the field was divided into 3 blocks of 3 replications (each 20 by 37 feet) with soil and aluminum levees. The field was flooded on 5/2. The inlet ditches were closed just prior to the applications which were made on 5/15. This was 4 days after 50% of the rice had emerged through the water. Diflubenzuron was applied at 0.125, 0.25, and 0.375 lbs a.i./acre. The inlet ditches remained closed for about 4 weeks following the applications to eliminate pesticide movement between plots. Ten cores (4 in. diameter) with one plant per core were removed from each replication 6/22-6/23. Soil was washed from the roots and the number of immature rice water weevils were recorded. Plant growth characteristics were measured from this sample and on 9/29 rice yield was taken with a combine in 10' X 15' strips.

No obvious visual differences were noted between the treatments and the control throughout the season. This was confusing because rice plants in a tolerance test at the east end of the same paddy were nearly devastated by the weevil. Sticky trap catches of weevils at this field were high from 5/4 to 5/15. The larvae recovered in the core samples of the three rates of treatments ranged from an average of 2.4 to 3.4 per core and were not significantly different from one another at the 5% level. The control averaged 7.2 larvae per core which was significantly different from all treatments. No significant differences were found in the plant growth characteristics of the cored plants. No significant differences occurred in the yield although there was a consistent trend with the lowest yield being in the control and an increase in yield with an increase in the rate of the chemical. The yield in the control was 8,406 lbs./acre and in the maximum rate of treatment yielded 9,233 lbs./acre. The lack of greater differences between the treatments and the control is difficult to explain in view of the high weevil population in the area and the care taken to avoid contamination of plots.

b) A second field experiment dealing with chemical control was conducted at Biggs. It was primarily for the purpose of testing if diflubenzuron (0.25 lb a.i./acre) could be used as a postflood border spray. The experimental organophosphate SC-0567 was also included for field evaluation as a 10% granule applied as preflood and postflood treatments at 2 lbs a.i./acre and carbofuran preplant treatment with granules (1.0 lb a.i./acre) was also included for comparative purposes and to provide requested residue information. The plots were set up at the east margin of seed-fields 102,103,106,107, and 108 in randomized complete blocks of five replications. Spray treatments were 20' X 100' and granule treatments 20' X 20'. Aluminum strips 30' long extended from the levee edge toward the center of the field to separate adjacent treatments but the west side of the plots was left open to untreated water or soil for 150 feet. The postflood diflubenzuron treatment was made on 5/19 (4 days after 50% of the plants had emerged through the water) and the postflood SC-0567 on 6/4 (after larvae had become established on the roots). On 5/22 a 300 plant examination was made in each of the five fields to determine the extent of adult feeding on the two newest leaves. An average of 74% (range 69%-86%) of the rice plants sampled had feeding scars which is usually considered to lead to an economic infestation. Ten cores (1 plant/core) were taken from each plot on 6/27-30 to record the number of larvae/core and to measure the plant growth at this time. Eight sq. ft. were harvested from each plot by hand on 9/16.

The number of larvae found in the carbofuran treatment (0.4/core) were significantly fewer than the control (3.4/core) at the 1% level but there were no significant differences among the chemical treatments at this level. Diflubenzuron had 2.3 larvae/core, SC-0567 preflood had 1.7 larvae and SC-0567 postflood had 2.0 larvae. No significant differences in plant growth characteristics at the time of the core samples or in yield were found. The number of larvae per core indicated the expected infestation did not develop to a high enough level to cause measurable plant effects.

c) A greenhouse test for weevil control was conducted at Davis with the experimental chemicals fortress (an organophosphate) and flufenoxuron (an insect growth regulator), and the standard carbofuran. Fortress, a 4% granule, was applied at 0.5 and 1.0 lb a.i./acre preflood; flufenoxuron, 5% E.C., at 0.25 lb a.i./acre; and carbofuran, a 5% granule, at 0.5 lb a.i./acre preflood. The flufenoxuron was sprayed on the rice plants the day before plants were exposed to weevils. Five replications of two rice plants in randomized complete blocks were exposed to adult weevils for oviposition for two days and removed. Soil and the two rice plants of each replication were washed and screened for immatures three weeks after infestation.

Examination of adults after removal from the plants showed 100% to be dead in the carbofuran treatment and 5 to 15% dead in the other treatments. Carbofuran showed a significantly higher level of control of larvae, 0.4 larva/replication, than the other treatments. Fortress at 0.5 lb had 16.2 larvae/replication; Fortress at 1.0 lb had 7.6 larvae; and flufenoxuron had 4.0 larvae. The control had 17.8 larvae/replication and was not significantly different from the low rate of fortress. No significant differences in plant growth were recorded at the time larvae were sampled.

2) Rice water weevil - genetic control.

Weevil control through the development of one or more tolerant or resistant lines is a goal of this objective that continues to make progress. Resistance in the form of antibiosis or xenosis has not been found in these studies so efforts have concentrated on the incorporation of several sources of tolerance into lines having suitable agronomic qualities in cooperation with the plant breeders at Biggs. The mechanism of this tolerance is also being studied.

a) A standard field test for tolerance (see previous annual reports) compared 4 replications of the treated (carbofuran) cultivar and the same untreated one under a natural weevil infestation. Thirteen of the most promising lines from the Biggs plant breeder's test of 1986 were used in the standard test for the first time. Four lines of high ranking were carried over from the 1986 standard test and one from both the 1985 and 1986 tests. M-202 and M-9 were used as susceptible lines for comparison. The natural infestation of weevils was very high this year. Inadequate control of broadleaf weeds by a missed airplane application put additional stress on the weevil infested plants in this test. The carbofuran provided adequate control for comparisons with untreated plots but there was light weevil injury in the treated plots. The injury in the treated plots was ranked highest for the two susceptible lines.

The 7 lines showing the least reduction in yield were 87-2388, 87-2322, 87-2333, 87-2336, 87-2358, 87-2302, and 86-2404. The reductions for these 7 ranged from 5.8% to 25.8% while the reductions in yield of M-202 was 50.4% and M-9 was 48.9%. A combination summary of overall growth characteristics including yield showed the least affected by the weevil to be 87-2388, 87-2322, 86-2404, 87-2302, 87-2302, 87-2305, and 87-2336. The most promising line of 1986 (86-2404) ranked third in this test for overall growth effects and seventh in effect upon yield. The greater reduction in yield in 1987 of 86-2304 over 1986 could indicate greater weevil pressure but several of the newer higher yielding lines appear to have greater potential for weevil tolerance.

b) A greenhouse test was conducted at UCD to attempt to provide information on the mechanism of tolerance of 86-2404, the most tolerant line of the 1986 standardized test. M-9 was used as the susceptible cultivar. Five replications of each cultivar were planted in pots for each larval exposure. They were infested with 1st instar weevil larvae at the rates of 0, 20, 40, and 60 larvae/plant with 1 plant/pot. This infestation was repeated on separate plants that were 14, 21, and 28 days old. Three weeks after each infestation the larvae were recovered from the roots by washing in a sieve and the plant growth characteristics were recorded.

The following results were noted for these greenhouse conditions: 1) Noninfested plants- plant weight, number of tillers, and root growth characters were greater for M-9 than for 86-2404 for all three plant ages although not always significantly so. Plant height was greater for 86-2404. 2) Plants infested at 14 days showed less growth for all measured characters at 20, 40, and 60 larvae for both susceptible and tolerant lines at a 1% level of significance. There was no significance between the three levels of larvae or between lines. 3) For plants infested at 21 days the 20 larvae level of infestation for the tolerant line showed no significant differences in the 7 measured growth characters from the noninfested. The susceptible line showed significant reduction in growth at the 20 larvae level in 4 of the 7 characters. At the 40 larvae level the tolerant line showed significant reduction in growth in 3 of the 7 characters while the susceptible line showed a significant reduction in all 7 characters. At the 60 larvae level the tolerant line showed significant reduction in growth in 4 of the 7 characters while the susceptible line again showed significant reductions in all 7 characters. 4) For plants infested at 28 days there was no significant reduction in growth from the noninfested plants for tolerant or susceptible lines at any of the 3 levels of larvae.

This test clearly showed that the youngest plants are most susceptible to weevil injury. Tolerance did not play a role for the 14 day old plants but was a factor in lowering the extent of injury at the 21 day infestation when compared to the susceptible line. By 28 days the rapid rate of plant growth in the greenhouse appeared to overcome most of the effect of feeding by the larvae. The 3 levels of larval feeding appeared to be progressively greater in their detrimental effect upon the plant as indicated at the 21 day plant age exposure. Larvae recovered in the 3 infestation levels at the end of the test did not closely reflect larval numbers at placement. Ten percent of the larvae used for the 14 day old plants were recovered, 33% were recovered from the 21 day test, and 38% were recovered from the 28 day plant age test. A partial explanation for this high mortality in the 14 day plant age test may be due to lack of larval food due to heavy root pruning but this was not the case in the 28 day plant age test. Unknown larval mortality factors were present at some time during the test that were not correlated with cultivar or plant age.

c) A test similar to the standard test for tolerance was conducted at Biggs RES in a field adjacent to the standard test. The tolerant lines 85-2385 and 86-2404 and the susceptible M-9 were used. Plant samples and larval counts were made in paired treated (carbofuran) and untreated units (8 sq. ft.) at 40, 65, and 100 days after planting. One additional treated and untreated unit for each cultivar in each replication was included that was not disturbed to order to obtain yield. The purpose of the test was to see if some difference in growth could be noted by sampling throughout the season to provide information on the mechanism of tolerance. An adequate level of a natural weevil infestation occurred and an adequate level of chemical control resulted so that meaningful comparisons could be made.

The fewest number of larvae were found in the 40 day sample, the maximum number occurred in the 65 day sample and the numbers dropped off at the 100 day sample as immature development was being completed. The 40 day sample showed no significant difference in larval numbers between cultivars in the untreated plots or between treated plots but all treated plots had significantly fewer larvae than the untreated which showed adequate control at this time. At 65 days there were no significant differences in the untreated plots between cultivars or between cultivars of the treated plots. By this time (65 days) the chemical was no longer functioning and there was no difference in larval numbers between treated and untreated.

The plant growth characteristics of treated cultivars were not significantly different from each other throughout the test. Untreated cultivars showed the following differences: 1) At 40 days M-9 showed a significant reduction from 85-2385 in 3 of the 7 plant characteristics that were measured and from 86-2404 in 4 of the 7 characteristics. Growth of 85-2385 and 86-2404 were not significantly different at this time. 2) At 65 days M-9 showed a significant reduction from 85-2385 and 86-2404 in 6 of the 7 characters Growth of 85-2385 and 86-2404 were not significantly different at this plant age.. 3) At 100 days M-9 showed no significant differences from 85-2385 in 7 of 7 plant growth characters but did show significant reductions from 86-2404 in 5 of the 7 characters. Differences between 85-2385 and 86-2404 growth were still insignificant except 86-2404 had significantly more tillers.

Grain yields from this test showed the untreated of M-9 to be significantly (1%) reduced from the treated by 41%. The same comparison for 85-2385 showed a 20% reduction and for 86-2404 a 16% reduction. The untreated 86-2404 yielded 36% more grain than M-9 and 40% more than 85-2385 while the treated 86-2404 yielded 9% more grain than treated M-9 and 36% more than 85-2385. Only the latter difference was significant.

A review of these results showed that during the early and mid-part of the season both 86-2404 and 85-2385 demonstrated a greater tolerance to the weevil than M-9. During the latter part of the season all three cultivars showed some recovery from reduced weevil pressure on the plants but this recovery was greatest for 86-2404. The 85-2385 continued to show more growth than M-9 but the differences were not significant. The grain yield for treated 86-2404 and M-9 was similar but greater than 85-2385 whereas the yield for untreated plants of 86-2404 significantly higher than the other two cultivars.

d) Previous experiments with tolerant cultivars have been plantings of 8 or 16 sq. ft. that have been separated by various amounts of open water which is believed to attract a greater number of weevils. Because of the increased amount of seed of 85-2385 that became available we decided to examine the effect of the weevil on larger plantings of this cultivar. Three replications, each 625 sq. ft., of 85-2385 and M-202 were randomized in 3 blocks. The plots were adjacent to each other and the levee to avoid open water. A visual ranking of degree of weevil injury (1=extreme injury to 10=no visual effect) was made by two people at 51 days after planting and yield was taken by a combine that cut a 10' X 15' strip from each plot.

The mean visual rating was 8.1 for 87-2385 and 5.2 for M-201. The mean yields were 3070 kg.for 85-2385 and 3087 kg. for M-201 which was not significantly different. This obvious early tolerance of 85-2385 and later absence of significant difference in grain weight from the susceptible was very similar to the results obtained in the previous experiment but a serious weed problem in this field may have influenced the results.

3) Rice water weevil - cultural control.

a) Planting rice after 90% of the rice water weevil flight has been completed may be a method of escaping rice plant injury without the cost of a preventative chemical control. Weevil flight is dependent upon an accumulation of temperature units for development of their flight muscles and the initiation of flight by overwintering weevils to flooded areas to seek oviposition sites. With this in mind we decided to have three planting dates based on the accumulation of 100, 200, and 300 day-degrees. The accumulation of day-degrees began on Jan.1 and was based on a minimum threshold of 63 degrees F. Because of a very warm spring and rapid accumulation of day-degrees the land was not prepared for the first planting until April 26. At this time 197 day-degrees had been accumulated so the third planting was to be extended in day-degrees. Because of problems in seepage into adjacent paddies the experiment was eventually limited to two planting dates and the land to be used for one planting was used as a buffer to contain seepage. This left 4 replications for each of 2 planting dates. Each replication was 20' X 120'. The second and latest planting date was made on May 11 when 388 day-degrees had been accumulated. The light trap catches showed that 90% of the weevil flight was completed between May 8 and May 11. The plots were planted with M-201 at 150 lbs/acre 2 days after flooding. Counts of leaf scars from weevil feeding were made on 300 plants per replication in the first planting on May 18 and in the second planting on June 8. Ten cores (1 plant/core) were removed from each replication, washed for weevil immatures and the plant growth measured on

June 8 (1st planting) and July 1 (2nd planting). Harvest was made with combine cuts of about 10' X 80'.

Leaf scar counts showed 92.4% of the plants to be scarred in the first planting and 64.8% in the second planting. Core samples yielded 3.1 immatures per core in the first planting and 3.3 in the second planting. Plant growth was greater for all plant characteristics measured in the second planting. Examples were 5.5g wet weight (2nd planting) to 2.7g (1st planting), 0.33g dry root wt. (2nd) to 0.11g (1st), and tillers 6.7 (2nd) to 4.5 (1st). These differences would have been significant if the replications had been randomized but the seepage prevented this and an analysis of variance would not be valid. The first planting yielded an average of 2324kg/replication at 18.4% moisture and the second planting 2958kg at 23.8% moisture. Their conversion to 21% moisture would show no significant difference in weight. The second planting was considerably greener and should have been allowed to mature and harvested later but the combine was only available on one date. A late planting governed by the accumulation of day-degrees and weevil flight may only be feasible under certain climatic conditions but this information may provide alternatives that would be of value and the experiment should be repeated under more controlled management and different climatic conditions.

b) A field experiment was set up at Biggs RES to test the hypothesis that different seeding rates could affect the potential severity of weevil injury to rice plants. Five replications of six treatments were set up in 15' X 15'plots that contained M-201 seed planted at 100, 200, and 300 lbs per acre on 4/29. One-half of plots were treated with carbofuran (1 lb a.i./acre) to compare with the untreated plots. Because of uneven hand seeding two 1sq.m. areas "typical" of the seeding rate were staked within each plot for observations. Stand densities measured in these areas averaged 10.5 plants per square foot for the 100 lb seeding rate, 27.7 plants for the 200 lb rate, and 61.2 plants for the 300 lb rate. On 6/16 the plots were visually rated by two people on the extent of apparent weevil injury (1 being extreme weevil injury and 10 no apparent injury). Ten cores (4" dia.) were taken from each unit on 6/17-27 to record the number of weevil immatures per plant. On 9/17-18 the entire units were harvested from each plot. Fertilizer streaks and bird damage required the elimination of some replications.

The visual ratings for the treated plants were 5.6, 7.1, and 7.8 for the 100, 200, and 300 lb seeding rates. This indicated less than desirable weevil control. The untreated ratings were 3.6, 5.2, and 6.7 for the 100, 200, and 300 lb seeding rates. Both ratings indicated a decrease in weevil injury with an increase in seeding rate with the greatest differences to occur between the 100 and 200 lb rate. The number of larvae /plant recovered for the treated was 2.8, 3.5, and 2.4 for 100, 200, and 300 lbs and for the untreated 3.3, 4.3, and 5.4 larvae. The differences were not significant for the treated rates. The 5.4 larvae found in the untreated 300 lb rate was significantly higher than the 3.3 of the 100 lb rate. This may be due a greater survival of larvae due to more available roots for food. No significant difference was found in the grain yield between the untreated rates. The 300 lb treated rate was significantly lower than the lower seeding rates. Since this high seeding rate had the most favorable visual rating earlier it may have run out of fertilizer at the time of grain formation. This experiment bears repeating under more favorable growing conditions and improved methodology. More plant and larval sampling periods are needed during the season.

PUBLICATIONS OR REPORTS:

Grigarick, A.A. 1986. Comprehensive research on rice, RP-3, 11pp.

Grigarick, A.A. 1987. Interaction of pests with rice water management practices. Section on objectives 3-6, invertebrate pests. IPM Cooperative Project 9 pp.

Oraze, M.J. 1987. The spider fauna and ecology of Pardosa ramulosa(Araneae: Lycosidae) in flooded rice fields of northern California. UCD PhD thesis 77pp.

Smith, K.A. 1987. Toxicological and ecological impact of diflubenzuron and triflumuron on the rice water weevil, Lissorhoptrus oryzophilus Kuschel (Coleoptera: Curculionidae), and on non-target organisms found in California rice fields. UCD PhD thesis 105 pages.

Way, M.O., A.A. Grigarick, S.E. Mahr, M.J. Oraze, and K.A. Smith. 1986 Evaluation of three drop traps for sampling aster leafhoppers (Homoptera: Cicadellidae) in rice. Jour. Econ. Entom. 79:1711-1713.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Light trap catches of the rice water weevil in 1987 began in a similar pattern to the previous two years with a peak flight beginning the 3rd week of April. However, a drop in mean temperature from 4/28 to 5/3 delayed the main flight until the first week of May. About 100 day-degrees more than the previous two years had accumulated before 90% of flight was completed. Weevil catches in sticky traps, a more flexible and economical alternative to light traps, showed the same patterns of weevil flight.

A survey of the southern most extension of the distribution of the rice water weevil in San Joaquin Valley showed it to be no further south than Merced County.

A field test for rice water weevil control with diflubenzuron (an insect growth regulator) evaluated 3 rates of the compound applied just after mean emergence of rice from the water. The treated plants had significantly fewer larvae on the roots than the control but there were no significant differences among the treated plants. Neither plant growth or yield showed significant differences. Yields ranged from 8,400 to 9,200 lbs./acre.

A second field test for weevil control used diflubenzuron as a post flood border spray, pre-and postflood treatments of the experimental SC-0567, and preflood applied carbofuran. Only carbofuran had significantly fewer larvae than the control and no significant differences were found in plant growth or yield.

A greenhouse test for rice water weevil control was made with the experimental chemicals fortress at 0.5 and 1.0 lb. a.i./acre (preflood), flufenoxuron 0.25 lb (postflood spray), and carbofuran 0.5 lb. (preflood). The fewest larvae were found in the carbofuran treatment. Fortress (1.0 lb.) and flufenoxuron also had significantly fewer larvae than the control. No significant differences in growth were found in the 3 week old rice plants. Flufenoxuron is an insect growth regulator that warrants further investigation.

The standard test for evaluating rice water weevil tolerance this year contained 13 of the most promising lines from the plant breeder's test of 1986, 4 of the high ranking lines from the standard tolerance test of 1986 and 1 line used in the previous 2 years in the standard test. M-9 and

M-202 were used as susceptible lines for comparison. The 7 lines showing the least reduction in yield due to the weevil were 87-2388, 87-2322, 87-2333, 87-2336, 87-2358, 87-2302, and 86-2404. The grain reductions for these ranged from 5.8% to 25.8% while the reductions in yield for M-202 was 50.4% and M-9 was 48.9%. Six of the new selections ranked higher than the most tolerant of last year which shows continuing progress.

A greenhouse test to provide information on mechanism of tolerance to the rice water weevil compared 86-2404 to the susceptible M-9 at infestations of 0, 20, 40, and 60 larvae per plant at plant ages of 14, 21, and 28 days. The test clearly showed that the youngest plants are most susceptible to weevil injury. Tolerance did not play a role in preventing injury to 14 day old plants but was a factor in lowering the extent of injury during the 21 day infestation when compared to the susceptible line. By 28 days the rapid rate of plant growth in the greenhouse appeared to overcome most of the effect of feeding of the larvae. Larvae recovered from the three infestation levels were considerably fewer than the number at placement. Unknown larval mortality factors were present at some time during the test that were not correlated with cultivar or plant age.

A field test similar to the standard test for tolerance to the rice water weevil compared the tolerant lines 85-2385 and 86-2404 to the susceptible M-9. These comparisons were made with paired treated and untreated plots in which larval and plant growth samples were taken at 40, 65, and 100 days after planting and yield at the end of the season. The results showed that during the early and mid-part of the season both 86-2404 and 85-2385 demonstrated a greater tolerance to the weevil than M-9. During the latter part of the season all three cultivars showed some recovery from reduced weevil pressure but this recovery was greatest for 86-2404. The 85-2385 continued to show more growth than M-9 but the differences were not significant. The grain yield for treated 86-2404 and M-9 was similar but greater than 85-2385 whereas the yield for untreated plants of 86-2404 was significantly higher than the other two cultivars (36% more than M-9 and 40% more than 85-2385.

Increased seed of the tolerant 85-2385 permitted the planting of a larger plot size (625 sq. ft.) than previous tests to examine the effect of a larger plot size on infestation levels and rice water weevil tolerance. The susceptible M-202 and 85-2385 were replicated 3 times. A visual rating (1=extreme injury to 10=no injury) of damage at 51 days after planting was 8.1 for 85-2385 and 5.2 for M-202. Yields were not significantly different which is similar to the results found for 85-2385 in the previous test on mechanism of tolerance but a serious broadleaf problem may have influenced the results.

Planting rice after 90% of the rice water weevil flight has been completed may be a method of escaping rice plant injury without the cost of a preventative chemical control. Weevil flight is dependent upon temperature both as an accumulation of heat units for wing muscle development in overwintering weevils and as a maximum to initiate daily flight. Two flooding and planting dates were used to test this. The first was on April 26 when 197 day-degrees had accumulated and the second was on May 11 when 388 day-degrees had accumulated. Ninety percent of the weevil flight was completed between May 8 and 11. Weevil leaf scar counts (5/18) showed 92.4% of the plants to be scarred in the first planting and 64.8% in the second planting (6/8). Plant growth on these two dates was considerably greater for the second planting. The yields were relatively close but the harvest was done on the same day. The grain of the first planting contained 18.4% moisture and the second planting 23.8% moisture. A late planting governed by the accumulation of day-degrees and weevil flight may only be feasible under certain climatic conditions but this information may provide alternatives that would be of value and the experiment should be repeated.

The possibility that plant stand may affect the severity of weevil injury was tested with plantings of 100, 200, and 300 pounds of seed per acre in treated and untreated small plots. The resulting seedlings averaged 10.5, 27.7, and 61.2 plants per square foot. A visual evaluation of injury (1=very severe to 10=no injury) ranked the untreated plots 3.6 for the 100lb. rate, 5.2 for the 200lb. rate and 6.7 at 300lbs. There were significantly more larvae per plant on the untreated plants at the 300lb. rate than the 100lb. rate. Yields of rice in the three seeding rates were not significantly different for the untreated but the experiment should be repeated because of problems that cut down the number of available replications.