Project Number: RM-1
1976-1977

COMPREHENSIVE RESEARCH ON RICE

ANNUAL REPORT
January 1, 1977 - December 31, 1977

I. PROJECT NUMBER AND TITLE:

RM-1 Improvement of Agronomic Practices for Rice Production

II. PROJECT LEADER AND PRINCIPAL UC INVESTIGATORS:

Project Leader: D. E. Seaman, Specialist in the Experiment Station.

Principal UC Investigators: B. W. Brandon, Senior Agricultural Technician; H. P. Wright and T. R. Woolsey, Laboratory Technicians; and C. E. Turner, Postgraduate Research Agronomist.

III. LEVEL OF 1977 FUNDING: $11,000

IV. OBJECTIVES ACCORDING TO 1977 PROPOSAL AND EXPERIMENTS BY LOCATION CONDUCTED TO ACCOMPLISH THESE OBJECTIVES:

Objective I. To determine how herbicides, algaecides and other agricultural chemicals may be used advantageously to maximize yields of new rice varieties or to reduce some costs of producing rice.

1. Experiments to evaluate new herbicides, new formulations of herbicides, sequential herbicide applications and granular herbicide combinations with respect to weeds controlled, rice injury and rice yield - Biggs.
2. Experiments to evaluate growth regulators and biostimulants - Biggs.
3. Experiments to develop and evaluate new seed coating methods and materials for rice - Biggs and Pleasant Grove.

Objective II. To develop new chemical and cultural methods for control of the early- and late-heading forms of *Echinochloa crus-galli* var. *oryzicola* in rice fields.

1. Experiments to evaluate new chemical methods of improving control of early and late watergrasses - Biggs.
2. Experiments to determine some interactions of water depth and chemical control of watergrasses among short and tall rice varieties - Biggs.
3. Continuation of an experiment to evaluate watergrass control by summer fallow systems of progressive weed-seed exhaustion - Biggs.

Objective III. To obtain a better understanding of the biology and ecology of some important aquatic weeds of California rice fields so that more effective chemical or non-chemical methods may be developed for their control.

1. Laboratory, greenhouse and field studies of the reproductive biology of roughseed bulrush - Biggs and Richvale.

2. Experiments to determine some influences of nitrogen fertilization on the competitiveness and chemical control of aquatic weeds in rice - Biggs.

V. SUMMARY OF CURRENT YEAR'S WORK (MAJOR ACCOMPLISHMENTS) BY OBJECTIVE:

Objective I. Summary of work with herbicides and other chemicals.

Hamilton Road Facility. Herbicide evaluation work this year was helped greatly by improvements we were able to complete at the new weed control research facility on Hamilton Road. The original 18-acre field was divided in half lengthwise by a drainage ditch and center road, and a new road was built along the east side to give complete perimeter access to both halves of the field. The north half then was divided by "plastic-sandwich" levees into 7 experimental areas, each with a separate inlet and outlet for independent water management. Except for rebuilding one internal levee needed for water depth control, the south half only was releveled and planted with commercial rice to defray operating costs of the facility.

New herbicide evaluation. Among the six herbicides evaluated for the first time at the Rice Experiment Station, SAN-310, R-24315 and Dowco 295 appeared fairly promising. Granular SAN-310 was particularly interesting, because pre- or post-flood applications at 3 lb ai/A gave excellent control of seedling sedges and broadleaf weeds, and post-flood applications at 5 or 6 lb ai/A gave good control of seedling watergrasses without rice injury.

A new "slow-release" granular formulation of molinate (Ordram SX) gave outstanding watergrass control after pre- or post-flood applications at rates as low as 1.5 lb ai/A. Ordram SX applied as long as 6 days before flooding without soil incorporation performed as well as Ordram 10G applied and incorporated a day before flooding at the same rate. These results, together with this formulation's lack of offensive odor, suggest that the binding action of the carrier may reduce volatility losses of molinate and improve its performance in rice fields.

Re-evaluation trials confirmed that Dowco 356 and DPX-4432 are potentially useful new herbicides for water-seeded rice. Dowco 356 is an emulsifiable concentrate that must be sprayed onto the soil surface before flooding. Although it was fairly effective at 0.5 lb ai/A, Dowco 356 gave excellent control of early and late watergrasses, roughseed bulrush and creeping spikerush at 0.75 or 1.0 lb ai/A without intolerable rice injury at 2 lb ai/A. Granular DPX-4432 gave nearly complete control of California arrowhead, roughseed bulrush and creeping spikerush at rates as low as 0.25 lb ai/A applied pre-flood without soil incorporation or at 7, 12 or 16 days after flooding and seeding rice. Post-flood applications of DPX-4432 at 0.5 lb ai/A gave nearly complete control of early and late watergrasses and appeared most selective at the time of rice emergence from the water.

A new granular formulation of R-12001 (previously designated MV-687) consistently gave better control of early and late watergrasses than granular molinate at similar rates and times of application. Unfortunately, it caused rather severe growth retardation and stand reduction among rice varieties M9 and S6 at only 5 lb ai/A, so its development may be discontinued.

In a trial comparing 16 different pairs of herbicides applied in sequence, all gave excellent control of the prevalent weeds, including early and late watergrasses, California arrowhead, roughseed bulrush and creeping spikerush.

These sequential combinations consisted of an initial application of Dowco 356 (pre-flood at 0.75 lb ai/A), granular Drepamon (post-flood at 4 lb ai/A), granular Bolero (post-flood at 4 lb ai/A) or granular Ordram (post-flood at 4 lb ai/A) followed at 45 days after seeding rice by a foliar application of bentazon (Basagran) at 1 lb ai/A, triclopyr (Dowco 233) at 1 lb ai/A, GCP-6137 at 3 lb ai/A, or MCPA at 1 lb ai/A. In each sequential treatment, the first herbicide mainly controlled the watergrasses, and the second one controlled the sedges and broadleaf weeds.

Efforts to improve the efficacy of triclopyr and bentazon by spray solution additives were only partially successful. Adding a surfactant (Dynawet at 0.5% v/v) to the amine salt of triclopyr failed to enhance control of broadleaf weeds and sedges and caused this formulation to injure rice nearly as much as the ester formulation of triclopyr where applied 41 days after seeding. However, the performance of triclopyr was improved without rice injury where the surfactant was used with triclopyr applications made 64 days after seeding. Weed control by bentazon applications at 41 days after seeding was consistently improved by addition of a phytobland oil (SUN-11 at 5% v/v) to the spray solution, but the oil was somewhat detrimental to rice yield even though none of the usual injury symptoms was observed.

Single applications of several granular herbicide combinations gave excellent control of watergrasses and prevalent broadleaf weeds and sedges. The most promising were Drepamon, benthiocarb or molinate paired either with bentazon or perfluidone (Destun) and applied at appropriate times after flooding. In combinations with bentazon at 2 lb ai/A, it seemed necessary to use any of the grass herbicides at 4 lb ai/A for satisfactory watergrass control. However, where combined with perfluidone at 1 lb ai/A, similar control of broadleaf weeds and sedges was obtained, and Drepamon, benthiocarb or molinate could each be used at 3 lb ai/A without loss of watergrass control.

Growth regulators and biostimulants. The growth regulators Dikegulac and MBR-12325 and the biostimulant Ergostim all failed to affect the growth and grain yield of water-seeded rice, var. M5, in any favorable way after applications at rates and times suggested by their manufacturers. However, MBR-12325 incidentally was found to have remarkable herbicidal activity on roughseed bulrush. Applications of MBR-12325 at the 1-2 tiller stage of rice killed roughseed bulrush without affecting other weeds at only 1 or 2 oz ai/A.

Seed coating materials and methods. Rice seed with weighted fungicidal coatings prepared with talc, Difolatan and the polymeric adhesive Durakoat were water-sown among most of the field trials this year in lieu of presoaked seed. The resulting stands were very uniform, with hardly any seedling drift, and the grain yields were excellent. For example, coated M5 yielded 75 cwt/A at 14% moisture after aerial seeding at about 125 lb/A (uncoated equivalent weight) in the south half of the Hamilton Road Facility.

Many different agricultural chemicals were tested as additives for possible beneficial effects in multipurpose seed coatings. Perfluidone and MBR-16349 performed best among 12 new herbicides carried in seed coatings for combined weed control and planting. Coatings containing the insecticides Bux, carbofuran or a mixture of carbofuran and methiocarb all failed to give significant protection of rice seedlings from rice water weevil. The urea-formaldehydes Nitraform and Uramite were found promising as sources of nitrogen for rice seed coatings. Substitution of zinc oxide or zinc oxysulfate for zinc lignosulfonate in coating formulas using either Durakoat or XD-8145 as adhesives improved the tenacity of the coatings after water seeding.

Objective II. Summary of work with early and late watergrasses.

Chemical control of watergrasses. Most of this year's weed control trials were conducted in fields that are severely infested with both the early- and late-heading forms of watergrass (*Echinochloa crus-galli* var. *oryzicola*) where control of each could be rated separately. Separate ratings seemed desirable, because there were indications last year that the late form ("rice-mimicgrass") was more resistant to herbicides than the early form. It now appears that both forms of watergrass have about the same ability to evade chemical control, and that herbicide treatments that control one usually control the other as well. Observed differences in control probably are related to population differences in the fields, since the form with a higher population density is more likely to have some survivors after herbicide treatment than the less dense form.

Of all the new herbicides now under investigation, benthiocarb (Bolero) and Drepamon have been most consistent in giving improved control of watergrasses. Granular formulations of each of these gave nearly perfect control of both forms of watergrass where applied at 4 lb ai/A either to the soil surface before flooding or post-flood at the 1-2 leaf stage of watergrass among several of this year's trials. The same degree of watergrass control also was given in these trials where pre- or post-flood applications of granular molinate (Ordram) were made at 4 lb ai/A instead of at the present legal label rate of 3 lb ai/A. Improved control of both forms of watergrass and correspondingly increased rice grain yields have consistently resulted from molinate treatments at rates of 4 or 5 lb ai/A.

Some possible advantages of making split applications of molinate or Drepamon were investigated in another trial. Only slight differences in watergrass control were apparent whether either herbicide was applied before flooding and again after flooding or twice after flooding at rates of 1.5 + 1.5 or 2 + 2 lb ai/A. However, a single preflood or postflood application of either herbicide at 4 lb ai/A performed better than corresponding split treatments totalling 3 or 4 lb ai/A in this trial.

Other watergrass studies. Results of this year's experiments concerning interactions of water depth and chemical control of watergrasses have yet to be analyzed, so they cannot be discussed with confidence at this time. The summer fallow experiment must be continued for another season before the effects of different treatments can be determined with respect to weed seed exhaustion from the soil.

Objective III. Summary of aquatic weed biology studies.

Roughseed bulrush (*Scirpus mucronatus*) is an aquatic sedge that has become a serious weed in northern California rice fields and appears to be spreading southward. It is a native of Eurasia and was introduced into California more than 30 years ago. Although it mainly grows from seed (achenes) as an annual plant in our area, it was found really to be a perennial and capable of vegetative regrowth from over-wintering rhizomes formed during the previous summer. Plants that sprout from rhizomes develop precociously and begin flowering about 30 days after rice-field flooding, or about half the time it takes seedlings to flower. Such vegetative regrowths have been found highly resistant to MCPA applied later than 35 days after rice seeding, and their presence may explain some recent reports of poor control by this herbicide.

Rhizomes of roughseed bulrush dug from undisturbed areas of rice fields in January and February sprouted soon after transplanting to flooded pots of soil in the greenhouse, but those from areas that were chisel-plowed the previous September mostly failed to sprout. Freshly dug rhizomes contained about 60% moisture and were found very susceptible to loss of viability by drying or freezing. Over 90% were killed by only 2 days exposure to ambient air or by 4 hours in a freezer. Autumn plowing probably kills most of these rhizomes by uprooting and exposure to winter frosts (if any) and desiccation. However, it appears likely that vegetative regrowth of roughseed bulrush could be serious in spring-plowed fields after mild winters if sufficient time is not given for the rhizomes to be killed by drying. Even a few of these regrowths surviving chemical control would be harmful sources of seed in a rice field.

Seed production by roughseed bulrush is very prolific. A random sampling of matured seedling plants in rice averaged about 5 productive culms per plant and 450 seed per culm. A dense infestation in an "organic" rice field near Richvale was calculated to have produced over 2 billion seeds per acre. About 8 months after harvest, seeds of this weed were about 65% viable in water with or without dissolved oxygen, and they germinated nearly 5 times better in light than in darkness. Seedlings were found to originate from the top 2 mm of soil in flooded fields, and increasing flood depth from 0 to 6 inches decreased germination and seedling survival about 7 fold. Seeds sown onto continuously saturated soil in the greenhouse took about 6 weeks to complete germination, and most of the viable seeds germinated during the fifth and sixth week.

VI. PUBLICATIONS OR REPORTS:

Seaman, D. E. 1977. Influences of water management on rice stands and weed control. In: Program for Rice Field Day, Calif. Rice Exp. Sta., Biggs, Sept. 7, 1977, pp. 2-6.

Wick, Carl M. and Donald E. Seaman. 1977. Weeds commonly associated with Butte County rice production. Unnumbered mimeo, Univ. of Calif. Cooperative Extension - Butte County, October 1977, 4 pp.

Smith, Roy J., Jr., Wayne T. Flinchum and Don E. Seaman. 1977. Weed control in U.S. rice production. USDA Agricultural Handbook No. 497, 78 pp.

VII. CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Several new herbicides and new herbicide formulations were found promising, and investigations were continued to assist with the further development of Dowco 356, DPX-4432, triclopyr, bentazon, perfluidone, GCP-6137, benthiocarb and Drepamon.

The early and late forms of watergrass were found to have similar abilities to evade chemical control, and severe infestations of them were controlled nearly completely and consistently by the unregistered herbicides benthiocarb and Drepamon or by molinate at higher-than-legal rates.

Perennial regrowths of roughseed bulrush from rhizomes, which mature precociously and are resistant to MCPA, were found potentially serious in rice fields if the rhizomes are not destroyed by drying or freezing before spring flooding. The prolific seed production and annual seedling growth of this weed account for its main impact in rice fields.