PROJECT NO. RM-1

COMPREHENSIVE RESEARCH ON RICE
ANNUAL REPORT

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PROJECT TITLE: Improvement of Agronomic Practices for Rice Production

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OBJECTIVES AND EXPERIMENTS CONDUCTED TO ACCOMPLISH THEM:

The continuing main objective of this project is to develop improved rice management practices in which chemical and cultural methods of weed control are combined for more profitable rice production in California.

Specific objectives for 1980 were as follows:

Continue evaluation of new herbicides and algaecides and determine how they may be used advantageously in rice management.

1. Diphenamid (ENIDE 90W) and napropamide (DEVRINOL 50W) were evaluated for pre-emergence control of rice-field levee weeds and for rice safety in a 2-part experiment at Biggs.

2. The previously untested herbicides and formulations AXF-1124, AXF-1125, benazolin, octanoic acid ester of bromoxynil (BROMINAL), MC-10108, dimethylamine salt and isooctyl ester of MCPP, ORDRAM 10-SSRG, oxadiazon (RONSTAR 2E & 2-G), propanil (STAMPEDE 3E & STAM M-4), R-4573, R-4574, R-32645, RH-2914, Ro 13-8895, SN-81259 and thidiazuron (SN-49537) were evaluated among 4 experiments at Biggs and another near Richvale.

3. The promising experimental herbicides or formulations acifluorfen (TACKLE 2-S), bifenox (MODOWN 4-F & 10-G), butachlor (MACHETE 5-E), DOWCO 356, MBR-12325 (EMBARK 2-S), MBR-18337, ORDRAM/EXTENDER 6/1E, ORDRAM 10-LG, RH-8254 (1-G & 2-E) and RH-8817 (2-E) were re-evaluated among 8 experiments at Biggs to obtain further information regarding: (a) their safest and most effective times and rates of application, (b) species of weeds controlled, (c) the safest and most effective formulation of those with more than one available, and (d) the potential use of some in combination or in sequence with other herbicides.

4. The highly promising herbicides thiobencarb (BOLERO) and tiocarbazil (DREPAMON) were compared with molinate (ORDRAM) as chemical components of integrated weed control methods for rice in 2 experiments with continuous shallow-water management and in 2 others with discontinuous flooding

to determine: (a) efficacies of liquid and granular formulations of each herbicide applied before or after flooding, (b) efficacies of granular formulations of each herbicide applied 3 or 8 days before flooding, (c) efficacies of low-rate split applications and high-rate retreatments with each herbicide, and (d) efficacies of the herbicides as affected by pre- or post-application field drainage to soil saturation or to soil-surface dryness. These experiments were conducted at Biggs.

5. An experiment was conducted at Biggs to determine the appropriateness of 10 different registered or experimental herbicides for watergrass control in dry-seeded rice using seed coated with calcium peroxide which was prepared at Biggs with a sodium silicate adhesive.

6. In cooperation with grower John Nichols and C. M. Wick, an experiment was conducted in Glenn County to evaluate 6 sprayable herbicides for barnyardgrass control in drill-seeded, furrow-irrigated rice.

7. An experiment was conducted at Biggs to determine the 30-day dissipation of tiocarbazil from soil and water after applications of granular or liquid DREPAMON to 3 half-acre rice fields. We collected successive samples of soil and water from each field, and these are being analyzed by Charles Soderquist of California Analytical Laboratories, Inc.

8. Aerial applications of standard granular molinate (ORDRAM 10-G) and a new slow-release granular molinate (ORDRAM 10-LG) were made to different portions of a 47-acre Foundation Rice field to compare these two formulations with respect to efficacy, safety to rice varieties M-101 and M9, and environmental fates. This experiment was cooperative with Stauffer Chemical Company whose personnel collected air, soil and water samples for molinate residue analyses at Richmond.

<u>Conduct further investigations of California long-grain rice susceptibility to injury by molinate and thiobencarb and evaluate some alternatives for avoiding this injury without reduction of weed control</u>.

Three experiments were conducted at Biggs to confirm previous observations of long-grain rice (cv. L-201) injury by ORDRAM 10-G and BOLERO 10-G and of the lack of such injury by DREPAMON 5-G. Alternative methods of herbicide application, slow-release granular herbicide formulations and other thiolcarbamate herbicides also were evaluated as means of avoiding this injury without reduction of watergrass control. A fourth experiment in cooperation with Dr. S. T. Tseng evaluated 10 new long-grain rice selections for resistance to injury by BOLERO 10-G applied at 4 lb ai/A.

<u>Initiate studies of the biologic and economic impact of the weed ducksalad and evaluate some alternative methods for its control in California rice fields</u>.

Lack of personnel and scheduling problems prevented our proposed survey of ducksalad distribution and related measurements of the present and future impact of this weed on California rice production. However, a ducksalad competition experiment was initiated in an area at Biggs that was purely infested with this weed, and ducksalad control by various registered and experimental herbicides was evaluated among 4 other experiments at Biggs.

Continue efforts to improve the efficacy, safety and convenience of water-run herbicide applications in rice fields with different methods of water management.

1. The Hamilton Road Facility was used for a replicated experiment to re-evaluate water-run applications of ORDRAM 8-E and BOLERO 8-E followed by continuous flooding and of BOLERO 8-E followed by discontinuous flooding. Each treatment and a non-treatment was triplicated among separately irrigated one-acre field plots.

2. An experiment to determine the influence of watergrass plant density on the efficacy of water-run herbicides was conducted in one of the fields that received water-run molinate and in another that received thiobencarb.

3. An unreplicated experiment was conducted among separately irrigated 1/3-acre rice fields at Biggs to evaluate the potential efficacy of butachlor (MACHETE 5-E), DOWCO 356, a combination of molinate + thiobencarb, R-4574 and RH-8817 applied by the water-running method.

Conduct further evaluation of the Rope Wick Applicator for control of annual and perennial weeds on rice-field levees with glyphosate.

Three experiments were initiated to re-evaluate the use of a Rope Wick Applicator to apply glyphosate (ROUNDUP) for control of perennial growths of cattail and johnsongrass on rice-field levees at Biggs. This method was not re-evaluated for tall-weed control in short-stature rice, because cool weather and early lodging of watergrass in experimental fields prevented the development of a sufficient height difference between watergrass and cv. M9 rice at the desirable time of treatment.

SUMMARY OF 1980 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVE:

Herbicide evaluation

1. Pre-planting applications of diphenamide at 9 and 18 lb ai/A and napropamide at 4 and 8 lb ai/A all failed to control weeds on internal rice-field levees, because there was not enough rainfall after application to activate these herbicides. However, simulated spray-drift applications of diphenamide at 9 lb ai/A and napropamide at 4 lb ai/A caused mean reductions of 52 and 68 percent, respectively, of the stand of subsequently water-seeded rice in an adjacent rice seedbed. These results indicate that both of these herbicides would be hazardous to the crop if applied carelessly to rice-field levees.

2. The following previously untested experimental herbicides and formulations were found promising: benazolin (Boots Hercules), BROMINAL (Union Carbide), dimethylamine salt (DMA) and isooctyl ester (IOE) of MCPP (Boots Hercules), ORDRAM 10-SSRG (Sierra Chemical Co.), R-4574 and R-32645 (Stauffer Chemical Co.) and SN-81259 (Nor-Am).

Benazolin was ineffective alone, but it was the most outstanding additive for enhancement of aquatic-weed control by bentazon (BASAGRAN). As little as 0.25 lb ai/A of benazolin in a tank mixture with bentazon at 0.5 lb ai/A gave better post-emergence control of ducksalad, monochoria and roughseed bulrush than bentazon alone at 1 lb ai/A, while non-phytotoxic oil at 2.5% v/v and low-rate additions of mefluidide (MBR-12325 or EMBARK) or MCPP-IOE were less effective in increasing bentazon activity.

BROMINAL was not as effective as MCPA in control of ducksalad and monochoria where both were applied at 1 lb ai/A, but it controlled roundleaf waterhyssop, blunt spikerush, California arrowhead and roughseed bulrush as well as MCPA with no visible rice-injury symptoms (cv. M9). Since BROMINAL controlled most of these weeds better than bentazon at 1 lb ai/A, it might become a more useful alternative for avoiding spray-drift hazards of MCPA.

The MCPP formulations were requested and evaluated mainly as alternatives for silvex (KURON), whose use in California rice was suspended in 1979. MCPP is a phenoxypropionic acid herbicide analogous to silvex, but it does not contain TCDD or "dioxin." Where each was applied alone at 1 lb ai/A, either MCPP formulation gave as good control of aquatic weeds as silvex, and they were as safe as silvex to rice (cv. M9). Either formulation of MCPP in combination with MCPA at 8 + 8 oz ae/A, respectively, was as highly effective as silvex + MCPA at the same rates in controlling California arrowhead, ducksalad, monochoria and roughseed bulrush. Previously, only pyrazolate (Sandoz's SAN-310 or Sankyo's SW-751) gave as good control of these weeds as the silvex + MCPA combination. MCPP thus appears to be a useful alternative for silvex, if the latter becomes permanently unavailable.

Post-flood applications of a slow-release granular formulation of molinate (ORDRAM 10-SSRG) at only 2.5 lb ai/A gave watergrass control equal to that by standard granular molinate at 5 lb ai/A without significant rice injury (cv. M9) at 10 lb ai/A. This formulation was prepared by Sierra Chemical Company and performed like starch-xanthide formulations of molinate that were tested previously.

A granular formulation of R-32645, applied post-flooding at only 0.75 lb ai/A, controlled watergrass as well as ORDRAM 10-G at 5 lb ai/A and was fairly active against ducksalad, monochoria and roughseed bulrush at 1.5 or 3 lb ai/A without serious rice injury (cv. M9).

Nor-Am's SN-81259 controlled only watergrass at rates as low as 0.5 lb ai/A without injuring rice (cv. M9) at 3 lb ai/A, and it performed the same whether applied before or after flooding.

3. Advance re-evaluation trials showed that bifenox, butachlor, RH-8254 and ORDRAM 10-LG were the most viable of experimental herbicides that were found promising last year. Mobil's formulation of acifluorfen (TACKLE) applied alone or in combination with either bentazon or MCPA was only partially effective against aquatic weeds at rates up to 1 lb ai/A, and its development for California rice may be discontinued. Further work with MBR-18337 also seems futile, because a very thorough re-evaluation failed to indicate sufficient efficacy and selectivity of either its granular or

liquid formulation at rates from 2 to 6 lb ai/A among a wide range of application times. Also, the liquid ORDRAM/EXTENDER formulation need not be evaluated further, because its performance was no better than ORDRAM 8-E at the same application times and rates.

Flowable bifenox (MODOWN 4-F) was found most useful this year for post-emergence control of California arrowhead, ducksalad and roughseed bulrush in combination with or in sequence to an application of granular molinate at 5 lb ai/A. Applications at 19, 26 or 33 days after flooding gave excellent control of these weeds at 1 or 2 lb ai/A without injuring rice (cv. M9) at 3 lb ai/A. The combined or sequential use of molinate insured adequate watergrass control that was not expected from bifenox alone. However, early post-emergence applications of granular bifenox (MODOWN 10-G) alone gave excellent control of late watergrass at 2 or 3 lb ai/A this year in the same trial, and it did not cause as much rice injury as in previous trials.

Butachlor (MACHETE 5-E) was included in a ring test this year in an attempt to determine whether Nor-Am's thidiazuron was synergistic to butachlor activity as was found recently in the Philippines. There was no evidence of this synergism in our trial, but butachlor alone gave excellent watergrass control and partial control of broadleaf aquatic weeds after a post-emergence application at only 0.89 lb ai/A. This application reduced the rice stand (cv. M9) by 50 percent, so further work to decrease this rice injury with thidiazuron - butachlor combinations may be worthwhile.

Where granular and liquid formulations of RH-8254 were compared with liquid RH-8817 and other herbicides, it was clear that liquid RH-8254 was the most promising of the new Rohm and Haas herbicides for water-seeded rice. Granular RH-8254 gave less rice injury (cv. M9) than its liquid formulation at 1 lb ai/A, but it was also less effective on watergrass. Liquid RH-8817 performed about the same at 0.5 lb ai/A as liquid RH-8254 at 1 lb ai/A; but the former severely injured rice at 1 lb ai/A, while the latter was fairly safe to rice at 2 lb ai/A. Although liquid RH-8254 at 1 lb ai/A caused greater rice stand reduction than standard molinate or thiobencarb treatments, the mean rough-rice yields were equivalent.

The performance of ORDRAM 10-LG among several experiments this year indicated that it was a likely candidate to replace the present ORDRAM 10-G formulation except in long-grain rice (see below). In one trial, ORDRAM 10-LG applied 6 days before flooding at 4 lb ai/A gave better control of early and late watergrasses than a similar application of ORDRAM 10-G, although the latter performed better at 4 lb ai/A after flooding. The slower release of molinate from ORDRAM 10-LG than from ORDRAM 10-G probably accounts for these differences in efficacy.

4. In a trial comparing granular and liquid formulations of registered and experimental thiolcarbamate herbicides in water-seeded rice (cv. M9), pre-flood applications of each at 4 lb ai/A gave the following order of watergrass control: BOLERO 10-G > BYRAM 10-G > DREPAMON SE-70 > ORDRAM 10-G > BYRAM 6-E = R-4573 (10G) > BOLERO 8-E > DREPAMON 5-G > ORDRAM 8-E > R-4573 (6E). Post-flood applications at 4 lb ai/A controlled watergrass as follows: ORDRAM 10-G = DREPAMON 5-G > DREPAMON SE-70 > R-4573 (10G) > ORDRAM 8-E = BOLERO 10-G > BYRAM 6-E > BOLERO 8-E > R-4573 (6E) > BYRAM 10-G.

Except for pre-flood DREPAMON and post-flood BYRAM, granular formulations of these herbicides performed better than their liquid formulations. Of all these treatments, only pre-flood BOLERO 10-G, pre-flood BOLERO 8-E and post-flood ORDRAM 10-G gave mean rough-rice yields significantly higher than that of the best untreated plots.

In another trial with continuously flooded, water-seeded rice (cv. M9), watergrass control by pre-flood applications of either BOLERO 10-G or DREPAMON 5-G was only slightly decreased by a delay in flooding from 3 to 8 days where each was used at 4 or 5 lb ai/A. Post-flood applications of these herbicides gave better watergrass control than pre-flood applications at equivalent rates. At the same application times and rates, DREPAMON 5-G was slightly less effective than either BOLERO 10-G or ORDRAM 10-G in control of the late form of watergrass in this experiment. Split applications of BOLERO 10-G or DREPAMON 5-G, where each was applied before and after flooding at 2.5 lb ai/A, gave similar watergrass control as single applications of each herbicide at 5 lb ai/A. However, where post-flood retreatments with ORDRAM 10-G, BOLERO 10-G or DREPAMON 5-G at 5 lb ai/A followed pre-flood applications of each at 4 lb ai/A, watergrass control and rough-rice yields were much higher than where each herbicide was applied once at 4 lb ai/A before flooding, and no increase in rice stand reduction occurred among the retreated plots.

Rice stands were reduced probably by exposure of young seedlings to low air temperatures in an experiment involving complete drainage a week after seeding and reflooding a week later. This method of water management was expected to reduce pre-flood herbicide efficacy, but pre-flood applications of ORDRAM 10-G, ORDRAM 10-LG, BOLERO 10-G and DREPAMON 5-G at 4 lb ai/A all gave excellent watergrass control in spite of drainage after application. Retreatments with each herbicide at 5 lb ai/A after reflooding gave perfect watergrass control and higher rough-rice yields, although these yields were not significantly different from those given by any of the single herbicide applications made before or after reflooding.

In another experiment where post-seeding drainage was followed by very gradual reflooding to encourage bearded sprangletop, very little sprangletop growth occurred. Consequently, sprangletop control was difficult to determine with confidence. However, at 87 days after initial flooding, there were no sprangletop plants among any of the plots that received BOLERO 10-G before or after flooding at 4 or 5 lb ai/A, while a mean of 4.8 sprangletop plants per 344 sq-ft plot occurred among untreated plots. Plots treated similarly with ORDRAM 10-G or DREPAMON 5-G had means of 0 to 1.8 or 1 to 7.8 sprangletop plants per plot, respectively, which may indicate that these herbicides are not as effective as BOLERO in control of this grassy weed.

5. In the experiment to evaluate herbicide usage in dry-seeded (broadcast & harrowed), calcium peroxide-coated rice (cv. M9), pre-flood applications of BOLERO 10-G, BYRAM 10-G, DOWCO 356 (4E), DREPAMON 5-G, ORDRAM 10-G, ORDRAM 10-LG, RH-8254 (2E) and RH-8817 (2E) all gave satisfactory watergrass control at appropriate use rates. However, all except DREPAMON 5-G caused unacceptable rice-stand reductions. Post-flood applications of BOLERO 10-G, BYRAM 10-G, DREPAMON 5-G, ORDRAM 10-G and ORDRAM 10-LG all were

similarly effective on watergrass and safe to the rice. These results suggest that post-emergence weed control would be most appropriate with peroxide-coated rice, because pre-emergence herbicides are placed too close to the buried seed for adequate selectivity. This would preclude future use of DOWCO 356, RH-8254 and RH-8817 for weed control in this method of planting rice, because they cannot be used safely after flooding.

6. Applications of BOLERO 8-E, BYRAM 6-E, MACHETE 5-E, MODOWN 4-F and RONSTAR 2-E all failed to control barnyardgrass and other weeds in drill-seeded, furrow-irrigated rice, whether they were made before seeding, at the time of seeding or after rice and weeds emerged from the soil. The only effective treatment was propanil (STAMPEDE 3-E) applied 25 days after the first irrigation at 4 lb ai/A. This method of planting produced fair rice stands, but the field became densly infested with barnyardgrass and other row-crop weeds. Without a herbicide like propanil it probably would not be practicable to grow drilled rice by furrow irrigation.

7. Analytical results are not yet available regarding the dissipation of tiocarbazil from soil and water after its application to each of 3 half-acre rice fields. Both DREPAMON 5-G and DREPAMON SE-70 gave excellent watergrass control where applied 7 days after seeding at 5 lb ai/A, but the pre-flood application of DREPAMON SE-70 at 5 lb ai/A failed to control the late form of watergrass satisfactorily, and this was detrimental to an aquatic herbicide evaluation experiment where complete watergrass control was needed.

8. The aerial applications of ORDRAM 10-LG and ORDRAM 10-G at the Rice Experiment Station both resulted in excellent watergrass control at 4.5 lb ai/A, and there was no evidence of injury either to cv. M-101 or cv. M9 rice. Ground observers of the applications noted that the ORDRAM 10-LG was much less dusty and less smelly than ORDRAM 10-G. Reduction of the dust and odor problems of ORDRAM 10-G may justify a future change to the ORDRAM 10-LG formulation for greater environmental safety.

Herbicide usage in long-grain rice (cv. L-201)

This year's results confirmed that the thiolcarbamate herbicides molinate (ORDRAM) and thiobencarb (BOLERO) were hazardous to water-seeded, long-grain rice (cv. L-201) at rates as low as 4 lb ai/A, while tiocarbazil (DREPAMON) was safe to this variety at rates as high as 10 lb ai/A. Furthermore, in two experiments, pre-flood applications of ORDRAM 10-G and BOLERO 10-G caused slightly greater reductions of rice stand, height and grain yield than post-flood applications at rates required for satisfactory control of watergrass. BOLERO 10-G consistently was more injurious than ORDRAM 10-G at the same application rates and times. However, split applications of either herbicide, pre- and post-flood at 2.5 lb ai/A or applied twice after flooding at 2.5 lb ai/A, gave excellent watergrass control with greater safety to cv. L-201 than corresponding single applications at 5 lb ai/A. Although these split applications of ORDRAM 10-G were safe enough to cv. L-201, similar applications of BOLERO 10-G still caused unacceptable injury of this rice variety.

The hypothesis that slow-release granular formulations of molinate and thiobencarb would be safer to cv. L-201 than present commercial formulations was found only partially true. In three different experiments, pre-flood applications of the slow-release formulations ORDRAM 10-LG and BOLERO 5-BG were indeed as safe or safer than pre- or post-flood applications of their respective standard formulations at equivalent rates. However, post-flood applications of ORDRAM 10-LG at 4 lb ai/A caused similar rice injury as ORDRAM 10-G at 5 lb ai/A, and post-flood BOLERO 5-BG at 5 lb ai/A was about twice as injurious to cv. L-201 rice as BOLERO 10-G at the same rate. This suggests that the soil may somehow ameliorate the rice-toxicity of slowly released molinate or thiobencarb after pre-flood applications, while rice seedlings may absorb higher and more harmful concentrations of these herbicides when they are released slowly after post-flood applications at the two-leaf stage of rice growth.

In an experiment where 10 different thiolcarbamate herbicide formulations were screened at 10 lb ai/A for long-grain rice safety, cv. L-201 rice was completely killed by post-flood applications of BOLERO 10-G, BOLERO 5-BG, BOLERO 5-CG and R-32645, and it was severely injured by post-flood applications of ORDRAM 10-G, ORDRAM 10-LG, ORDRAM 10-SXG and R-4573. All of these (except R-32645 which was not tried) were much safer when applied to the soil before flooding. DREPAMON 5-G and BYRAM 10-G both were evaluated as safe to cv. L-201 whether applied pre- or post-flood. Indeed, DREPAMON 5-G caused very little injury where applied at 10 lb ai/A on the day of seeding or at 1, 3 and 7 days after seeding.

The cooperative field trial with CCRRF rice breeder S. T. Tseng showed that 3 of the 10 long-grain rice selections or varieties had promising resistance to injury by a post-flood application of BOLERO 10-G at 4 lb ai/A. Stands of these potential replacements for cv. L-201 were reduced less than 15 percent and they yielded more than 70 cwt/A of dry rough rice. Dr. Tseng now includes thiolcarbamate-herbicide resistance as a requirement in the development of future long-grain rice varieties for California.

Water-run herbicide application

1. Water-run applications of BOLERO 8-E at 4 lb ai/A that were followed by continuous flooding gave a mean yield of 61.3 cwt/A (dry rough rice) even though watergrass control was incomplete (81 percent) among the triplicate one-acre plots. Similar water-run applications of ORDRAM 8-E at 4 lb ai/A averaged 75 percent control of late watergrass and a mean grain yield of 45.6 cwt/A. Where the plots were drained 8 days after initial flooding and then gradually reflooded, watergrass control by water-run BOLERO 8-E at 4 lb ai/A was very poor and the mean grain yield was only 11.8 cwt/A. Virtually no rice was harvested from the replicate untreated plots where late watergrass predominated at a mean density of 57 plants per sq-m (about 5/sq-ft).

These continuously flooded water-run applications of ORDRAM and BOLERO were more effective than those conducted last year, probably because the plots were treated during shorter flooding periods. This year, all plots were flooded within 1 or 2 hours with water-flow rates of 6 to 10 cfs, and the herbicide-injection rates were adjusted to coincide closely with the time required for complete flooding of each plot. The higher flow rates enabled the herbicide-containing water to flow over the soil surface without subirrigating ahead of the water front so that the surface soil was contacted initially with treated water. Pre-wetting the soil either by subirrigated "filtered" water or rainfall apparently reduces the efficacy of water-run herbicide applications.

2. The hypothesis that watergrass control by water-run herbicides decreases with increasing severity of watergrass infestation still is unproved, because the results of an experiment to test this hypothesis were not conclusive. In fields treated with water-run ORDRAM or BOLERO at 4 lb ai/A, surviving watergrass densities were the same among subplots seeded with watergrasses at rates from 0 to 200 seeds/sq-m. However, nearly three times as many late-watergrass plants as early-watergrass plants survived these water-run herbicide applications, and fewer of each form of watergrass survived the BOLERO treatment than they did the ORDRAM treatment. These results tend to support last year's hypothesis that the late form of watergrass is more difficult to control than the early form by water-run molinate or thiobencarb. The fact that late watergrass was the predominant form surviving among the other water-run applications also supports this hypothesis.

3. DOWCO 356 at 1 lb ai/A was the most promising of all the new herbicides or herbicide combinations applied by the water-running method this year. It gave nearly complete control of watergrass and California arrowhead and good control of roughseed bulrush without very serious rice injury (cv. M9). Water-run MACHETE at 2 lb ai/A and RH-8817 at 0.5 lb ai/A both gave excellent early weed control, but they injured the rice severely and the weeds regrew later among the thinned rice stands. Water-running a mixture of ORDRAM and BOLERO at 2 lb ai/A of each was not as effective as other separate water-run applications of these herbicides. Water-run BYRAM (R-4574) at 4 lb ai/A was harmless to the rice, but it was ineffective on watergrass and probably should have been used at a higher rate for better control.

Levee-weed control by rope-wick application of glyphosate

This year's visual estimates of cattail control by last year's rope-wick application of glyphosate (ROUNDUP) indicated that about 30 percent regrowth occurred where the applications were made bidirectionally, but the cattails regrew nearly 100 percent where treated in only one direction. Apparently, some of the glyphosate solution must contact all of the cattail leaves so that downward herbicide translocation will be sufficient to prevent regrowth from underground stems or rhizomes during the next growing season. As the applicator is moved through a stand of cattails, some leaves protect others from contact, and bidirectional treatment enables more leaves to receive the glyphosate than unidirectional treatment.

The final results of this year's experiments will not be available until the regrowth from treated stands of cattail and johnsongrass can be measured. These experiments were conducted after the weeds had flowered in July, using a 20-ft rope wick applicator that was offset-mounted on a DAZIG-type ground rig to apply glyphosate (30% ROUNDUP solution by volume) along either side. Cattail knockdown by September was best among the bidirectional treatments, while johnsongrass stem-kill was excellent among both unidirectional and bidirectional treatments.

PUBLICATIONS OR REPORTS:

Seaman, D. E. 1979. Project RM-1, Improvement of agronomic practices for rice production. In: Annual Report Comprehensive Rice Research 1979, Univ. of Calif. and U. S. Dept. of Agric., pp. 22-28.

Seaman, D. E. 1980. Rice weed control news. In: Program for Rice Field Day, Calif. Rice Exp. Sta., Biggs, Sept. 3, pp. 10-18.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

During the past year, this project was mainly concerned with improving the chemical components of integrated weed control methods for water-seeded rice. Thirty experiments were conducted at the California Rice Experiment Station to accomplish proposed specific objectives regarding: (a) evaluation of new herbicides and herbicide formulations, (b) herbicide usage in long-grain rice, (c) water-run herbicide application, and (d) levee-weed control by rope-wick application of glyphosate.

Herbicide evaluation. The following experimental herbicides and formulations were found promising in preliminary evaluation experiments: benazolin, an octanoic acid ester of bromoxynil, a dimethylamine salt and an isooctyl ester of MCPP, a slow-release granular molinate from Sierra Chemical Company, R-4574 (BYRAM), R-32645 and SN-81259. Benazolin enhanced the control of aquatic weeds by bentazon (BASAGRAN), bromoxynil may be a useful alternative for MCPA, the MCPP formulations performed like silvex (KURON) and with MCPA controlled ducksalad and other aquatic weeds as well as silvex plus MCPA, the Sierra molinate formulation controlled watergrass at only 2.5 lb ai/A, R-4574 is odorless and was safer to rice than molinate, R-32645 controlled watergrass at only 0.75 lb ai/A and some aquatic weeds at higher rates, and SN-81259 controlled watergrass at rates as low as 0.5 lb ai/A whether applied before or after flooding.

Advance re-evaluation trials showed that bifenox (MODOWN), butachlor (MACHETE), RH-8254 and a slow-release granular molinate from Stauffer Chemical Company (ORDRAM 10-LG) were the most viable of promising experimental herbicides and formulations. Flowable bifenox was found most useful for post-emergence control of aquatic weeds where molinate was used for watergrass control. Butachlor gave good broad-spectrum weed control at less than 1 lb ai/A. Applied before flooding at 1 lb ai/A, liquid RH-8254 was found highly effective on watergrass, and it was not seriously injurious to rice at twice that rate. The performance of ORDRAM 10-LG among several experiments indicated that it was a likely candidate to replace the present ORDRAM 10-G formulation, because it was less odorous and dusty when applied by aircraft, and it generally controlled watergrass as well or better than ORDRAM 10-G at equivalent rates.

Where different thiolcarbamate herbicides were compared, most granular formulations performed better than liquid formulations of the same herbicides, and outstanding watergrass control and highest rough-rice yields resulted from pre-flood applications of granular and liquid thiobencarb

(BOLERO) and a post-flood application of granular molinate. A delay of flooding from 3 to 8 days only slightly decreased watergrass control by pre-flood applications of granular thiobencarb or tiocarbazil (DREPAMON), although post-flood applications of these herbicides gave better watergrass control. Granular tiocarbazil was slightly less effective than either granular molinate or granular thiobencarb in control of the late form of watergrass. Efficacies of pre-flood applications of granular molinate (both standard and slow-release), thiobencarb or tiocarbazil were unaffected by field drainage, which, probably by exposure of young seedlings to low temperatures, reduced the rice stands. No bearded sprangletop plants survived thiobencarb treatments in a trial involving temporary drainage to soil-saturation, but the occurrence of a few sprangletop plants among molinate- and tiocarbazil-treated plots may indicate that these herbicides are less effective on this grassy weed. Finally, post-emergence weed control was found most appropriate for dry-seeded, calcium peroxide-coated rice, because most pre-emergence herbicides were unacceptably harmful to the buried and subsequently flooded rice.

Herbicide usage in long-grain rice. This year's results confirmed that molinate and thiobencarb were hazardous to water-seeded variety L-201 rice at rates as low as 4 lb ai/A, while tiocarbazil was safe at rates as high as 10 lb ai/A. Slow-release granular molinate and thiobencarb were as safe or safer than their respective standard formulations when applied before flooding, but they were more hazardous after flooding. The most promising methods for safe and effective weed control in variety L-201 were the use of low-rate split applications of granular molinate or the future use of tiocarbazil after its registration. Another potential answer to this problem would be the development of a new, herbicide-resistant long-grain variety for California, such as one of the three selections found to have promising resistance to injury by thiobencarb this year.

Water-run herbicide application. The performance of water-run applications of molinate or thiobencarb was improved by more rapid flooding, which enabled the herbicide-treated water to flow over the soil surface without subirrigating ahead of the water front. Both herbicides were less effective on the late form of watergrass than on the early form when applied by this method, but thiobencarb was the more effective on both forms. Separate applications of granular molinate or thiobencarb gave more complete control of both watergrasses in adjacent fields than these water-run applications at equivalent rates. DOWCO 356 was found the most promising of alternative herbicides applied by the water-running method.

Rope-wick application of glyphosate. The rope wick applicator definitely was found useful for safe and effective control of perennial weeds on rice-field levees with glyphosate (ROUNDUP), although this usage still has not been approved by EPA. Cattail control was better where 30 percent ROUNDUP solution was applied bidirectionally, because the herbicide contacted more foliage than where it was applied in only one direction. However, stem-kill of johnsongrass in this year's trials indicated that unidirectional applications may be sufficient to control this perennial weed.