Project No. RP-1

COMPREHENSIVE RESEARCH ON RICE
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PROJECT TITLE: Weed Control in Rice

PROJECT LEADER AND PRINCIPAL UC INVESTIGATORS:

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OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH OBJECTIVES:

I. To develop new chemical methods of weed control in rice and to improve the efficacy and safety of herbicides now in use.

   A. To evaluate new herbicides two trials were conducted at the Rice Experiment Station (RES), Biggs.

   B. To develop procedures for the use of promising herbicides and to improve the use of commercially available herbicides nine trials were conducted at the RES.

II. To continue the development of integrated rice management systems for weed control.

   A. To study the influence of management practices on weed establishment and competitive ability one trial was conducted at the RES.

   B. To study the competitiveness of late developing weeds one study was conducted at the RES and one in the greenhouse at University of California, Davis (UCD).

III. To study the biology and physiology of rice weeds.

Several studies were conducted in the greenhouses and growth chambers at UCD.

SUMMARY OF 1987 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVES:

Objective I

A. Herbicide Evaluation

1. KIH 2023: KIH 2023 is a postemergence foliar applied herbicide from Kumiai Corporation. This product was applied at rates of 13, 27, and 54 g/A to 5 leaf stages of rice (lsr). The plots were drained for the first two timings, the 5 to 5.5 lsr and the 6.5 to 7 lsr, and reflooded 4 days following application to a depth of 4 to 6 in. Water was held at 4 in deep for applications at the early tillering, late tillering and boot stages of rice. KIH 2023 applied at 27 and 54 g/A controlled 10 to 20 in tall watergrass in the 4 to 6 leaf stage with no injury to the rice (Table 1). Later applications controlled less watergrass but did not injure rice. Grain yields were highest at the first two timings due to early removal of watergrass.

2. V 53482: V 53482, a product of Valent Chemical Company, was applied at the 2 to 2.5 and 6.5 to 7 lsr at rates of 10, 20, and 40 g/A. The early applications of V 53482 in 4 in of water injured rice at the highest rate and provided only limited watergrass control. The lowest rate, 10 g/A, caused no rice injury but did not control watergrass (Table 2). Later applications did not control watergrass and caused small necrotic spots on the rice leaves. Rice field bulrush was not controlled at any rate or timing by V 53482. The addition of surfactant did not increase the activity of V 53482 on watergrass.

B. Improved Procedures for Herbicide Use

Facet combinations with Ordram and Bolero: Combinations of Ordram or Bolero with Facet were applied to rice in the 2 to 2.5 lsr (2 to 3 in tall), watergrass in the 2 to 2.5 leaf stage (3 to 4 in tall) and rice field bulrush in the one leaf stage (0.25 in tall). The water was lowered to to a depth of 1 to 2 in before the herbicide application and was maintained at this level for 60 days following treatment. Facet was applied as a spray and then followed with Ordram 10G or Bolero 10G within 2 hours. Facet and Facet + Ordram provided excellent watergrass control. Facet + Bolero controlled approximately 10 percent less watergrass than the Facet + Ordram combination (Table 3).

Londax rate and timing: This experiment was designed to determine the effectiveness of Londax at lower than label rates and later stages of application. Watergrass was controlled by Ordram at all rates and timings (Londax and Ordram only, and untreated plots were included for reference). Londax controlled rice field bulrush at 2, 4, and 6 lsr, but not at 30 days after seeding. There were no differences in rice field bulrush control when the rate of Londax was lowered to 3/4 oz/A (Table 4). Thus full label rates and early timings of Londax may not always be necessary for successful rice field bulrush control.

Londax combinations with preplant incorporated Ordram: Postemergence (post) applications of Ordram are more popular than preplant incorporated (PPI) treatments because the latter often give erratic watergrass control. Post Ordram applications, however, greatly increase the potential for residues to escape in rice field drain water. We have established from previous experiments that Londax controls 40 to 60 percent watergrass. This experiment was designed to test the effectiveness of Londax in controlling watergrass missed by PPI applications of Ordram. Ordram applied PPI at 3 lb/A controlled 48 percent late watergrass whereas the same treatment followed by Londax at 1 oz/A controlled 99 percent. Weed control, rice stand, rice tillers and yield were the same whether Ordram was applied PPI or post when followed by Londax (Table 5).

Water management interactions with Facet: The influence of water management on efficacy of Facet at 0.5 lb/A and Facet + BCH 86401S (0.5 lb/A + 1 qt) was evaluated. Facet and Facet + BCH 86401S were applied to rice at the 2 to 2.5 lsr grown in 4 different water management regimes:

1) Management System A. Soil surface dry at time of herbicide application with different plots reflooded 4 to 6 in deep 1, 2, 3, 5 and 7 days following herbicide application.

2) Management System B. Soil surface wet but no standing water at time of herbicide application with different plots reflooded 4 to 6 in deep 1, 2, 3, 5 and 7 days following herbicide application.

3) Management System C. Plots flooded 1 to 2 in deep at herbicide application with different plots reflooded 4 to 6 in deep 1, 2, 3, 5 and 7 days following herbicide application.

4) Management System D. Plots flooded 4 to 6 in deep at time of herbicide application and water maintained at this depth.

After the 4 to 6 in water level was established Londax was applied to all plots at 1 oz/A. No rice injury was observed in any treatment, however, some rat damage thinned the rice stand in Management Systems A and B during the time they were drained. Watergrass control was excellent in all plots treated with Facet (Table 6).

Water management interactions with Poast and Whip: Poast and Whip were applied to rice in the 3 to 3.5 lsr, 5 to 5.5 lsr and at tillering followed with 3 water management regimes; 1, 2 to 4, and 4 to 6 in deep. Poast was applied at 0.09 and 0.14 lb/A + 1 qt of oil and compared to Whip applied at 0.09 lb/A plus 1 qt of oil. Floodwater was drained 1 day prior to the herbicide application and returned 4 days after the treatment. None of the treatments controlled watergrass or sprangletop. Poast applied to the 5 to 5.5 lsr and watergrass followed by reflooding to a depth of 2 to 4 in or more provided the best weed control with least injury to rice. Watergrass control was poorer in the plots followed with shallow water because of reinfestation due to newly established seedlings (Table 7).

Objective II

A. Management Practices for Weed Competitiveness

Influence of Londax on nitrogen management for rice: The purpose of this study, conducted at the Rice Experiment Station, was to determine if nitrogen efficiency is improved by removing early competition with broadleaf weeds. Londax and MCPA were applied at their normal timings over eight nitrogen rates. Based on visual symptoms, leaf tissue nitrogen and rice yield at comparative nitrogen rates, the results indicate that early weed removal by Londax improves nitrogen efficiency. Similar yields were obtained at approximately 30 lbs less nitrogen in Londax treated plots compared to MCPA treated plots. Details of this experiment will be published in the report of the Rice Experiment Station.

B. Competition in Late Developing Rice Weeds

Competition with California arrowhead: A field study was attempted at the Rice Experiment Station to determine the competitive ability of California arrowhead relative to watergrass. California arrowhead did not establish and as a result the experiment failed.

Competition with rice field bulrush: Rice field bulrush was grown with rice in the greenhouse to assess relative competitive abilities. The time of invasion of the rice field bulrush in relation to the development of rice was shown to be critical. If the rice was well established before the rice field bulrush, interference to the growth and development of the rice was minimal. However, if rice establishment was delayed, allowing the rice field bulrush to become estalbished, interference was significant and further growth and development of the rice plant was adversely affected. Thick stands of rice competed more effectively with rice field bulrush if the rice canopy closed before the rice field bulrush shoots reached the same height as the rice. When rice field bulrush received light, It became very competitive against rice. These studies suggested that rice field bulrush has the ability to invade where rice has previously established provided it receives sufficient light to maintain good growth. In contrast, rice does not have a similar ability to compete with rice field bulrush even if the rice is exposed to sufficient light to maintain good growth.

Objective III

Rice Weed Biology

Several greenhouse, growth chamber and laboratory studies were conducted at UC Davis on the physiology of rice field bulrush and redstem. The purpose of the rice field bulrush research was to 1) determine the time and location of plant regeneration from the rhizome and 2) determine the possibility of Londax resistance in a population collected from Butte County. The purpose of research on redstem was to learn how this weed can establish after germinating late in a rice stand.

Rice field bulrush: Rice field bulrush seed was collected from a Londax-treated field in Butte County. Plants of a known Londax susceptible population and the Butte County population were grown from seed in a greenhouse at UC Davis and treated with Londax at 0.03 and 0.06 lb/A at the 2 leaf stage of rice field bulrush. Based on these greenhouse studies the plants found in the Londax treated field in Butte County did not appear to be resistant to Londax. All treated plants appeared to be arrested in growth and severely stunted (Table 8).

Smallflower umbrellaplant: Smallflower umbrellaplant seed germination tests were evaluated using different exposures to light. Imbibed seed were subjected to full sunlight at UC Davis for varying periods of time. These studies suggested that at least 12 hours of continuous light followed by light-dark regimes are required for germination. When seed were exposed for 12 hours followed by continuous dark, germination did not occur. This suggests a sophisticated mechanism for seed survival. A short exposure to light followed by burial in the soil, such as might occur under cultivation, would not allow the seed to germinate. Only seed lying on the soil surface exposed to alternating light and dark seems to be able to germinate.

Redstem: Competition studies revealed that redstem seeds germinated and small seedlings survived even after the rice canopy had closed. In stands where light intensity was reduced by more than 50 percent the seedlings were very spindly and rarely exceeded a height of 6 to 9 inches. Most of the photosynthates were partitioned into producing stem growth. If the seedling reached an area of light intensity above 50 percent of full sunlight the seedling would rapidly elongate and initiate new leaves. Once the redstem shoot reached the top of the rice canopy it branched and produced numerous leaves. At this time photosynthates were shifted from producing primarily shoot growth to producing leaves and stems.

Herbicidal activity of KIH 2023: In greenhouse tests, KIH 2023 controlled 6 to 20 in tall watergrass in the 2 to 6 leaf stages at rates of 7.5 to 30.0 g/ha. There was little or no injury to rice. KIH 2023 was active when applied postemergence and was ineffective as a preemergence herbicide. Watergrass covered with water at the time of application was not controlled as more 50 percent of the leaf surface had to be covered with spray solution for effective control. Adjuvants added to the spray solution greatly increased the activity of KIH 2023 on watergrass. Siliwet increased watergrass control more than 30 times compared with KIH 2023 alone, but slightly increased the injury to rice. KIH 2023 also controlled rice field bulrush. Seventeen rice cultivars grown in California were tolerant to KIH 2023 applied at rates effective for watergrass control.

Combinations of Facet + Ordram, Facet + Bolero, and Facet + Londax:

Facet + Ordram. Combinations of Facet + Ordram controlled watergrass under greenhouse conditions better than either herbicide applied alone. Applications to watergrass in the 3 to 4 leaf stage were more effective than those made to larger watergrass. The best control of watergrass was in those treatments where the watergrass foliage was most exposed by lowering the water at the time of application.

Facet + Bolero. When combinations of Facet + Bolero were applied to watergrass under greenhouse conditions, watergrass control was similar to the combinations with Ordram. However, the overall control was slightly better when Facet + Bolero was applied into water than when Facet + Ordram was applied into water.

Facet + Londax. Combinations of Facet + Londax were less effective than combinations of Facet + Ordram or Facet + Bolero. However, combinations of Facet + Londax provided near perfect rice field bulrush control.

When BCH86401S, an adjuvant, was added to Facet spray solutions, the activity of Facet on watergrass control was markedly increased. Fairly large watergrass, 5 to 5.5 leaf stage, was effectively controlled when one-half or more of the foliage was covered.

PUBLICATIONS OR REPORTS:

Brandon, D. M., J. E. Hill, S. R. Roberts and B. W. Brandon. 1990. Effect of broadleaf weed control on N requirement of water-seeded rice. 23rd Rice Technical Working Group Meeting. February 26-28, 1990, Biloxi, MS. p. 120-121.

Hill, J. E., M. Lee, B. J. Finlayson, R. J. Schnagl and S. R. Roberts. 1990. Reduction of herbicides in rice field drain waters of the Sacramento Valley. Agronomy Abstracts, p. 39.

Hill, James E. and David E. Bayer, 1990. Integrated systems for rice weed control. Proceedings, 42nd Annual California Weed Conference, San Jose, California, January 15-17, 1990. p. 85-89.

Hill, James E., Stacey R. Roberts, J. F. Williams, and David E. Bayer. 1990. Flexibility in rates and timing with bensulfuron for broadleaf weed control in water-seeded rice. 23rd Rice Technical Working Group Meeting, February 26-28, 1990, Biloxi, MS. p. 134-135.

✓Scardaci, S. C., S. R. Roberts, J. F. Williams and J. E. Hill. 1990. Water management effects on rice weed growth. California Agriculture 44:8.

Smith, Roy J., Jr., and James E. Hill. 1990. Weed control technology in U.S. rice. In: Pest Management in Rice. Elsevier Science Publishers Ltd., Barking, England. p. 314-327.

✓Williams, J., S. Roberts, J. Hill, S. Scardaci. 1990. Water management effects on weed control and agronomic performance of rice in California. 23rd Rice Technical Working Group Meeting. February 26-28, 1990, Biloxi, MS. p. 121-122.

✓Williams, J. F., J. E. Hill, S. R. Roberts, S. C. Scardaci, and G. Tibbitts. 1990. Water management effects on weed control and crop performance in California rice production. Agronomy Abstracts, p. 162.

Williams, J. F., S. R. Roberts, J. E. Hill, S. C. Scardaci and G. Tibbits. 1990. Water management effects on rice weed control and crop performance. California Agriculture 44:6-10.

Bayer, D. E., J. E. Hill, B. W. Brandon, S. R. Roberts, E. Roncoroni, and S. C. Scardaci. 1989. Weed control in rice. Annual Report, Comprehensive Rice Research. University of California and U.S.D.A. p. 1-14.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

In 1990 a limited number of new herbicides were tested for their possibility of controlling weeds in water seeded rice. One new experimental herbicide, KIH 2023, looked extremely promising for watergrass control at rates well below those of the currently used grass control herbicides. Combinations of Facet (BAS 514) with Ordram and Bolero for watergrass control also looked promising, especially in view of the previous erratic results of Facet alone in previous studies. Continuing studies with Londax rate and timing indicated, as in previous years, that lower than label rates and later times of application may control broadleaf weeds and sedges when preferred or necessary. Studies with the late postemergence grass herbicides, Poast and Whip, showed relatively poor control.

Studies on the interaction of management practices with herbicides indicated that early weed removal with Londax may provide improved nitrogen use efficiency. Studies in the greenhouse indicated that rice field bulrush was especially competitive once the weed canopy was allowed to reach the same height as rice.

A population of rice field bulrush reported to be tolerant to Londax in 1989 field applications was tested against susceptible populations in the greenhouse. Results indicated that the reported population was also susceptible. Smallflower umbrellaplant germination studies showed that short exposures to light would not trigger germination but that 12 hours of light followed by alternating light and dark periods were required.

Table 1. Effect of KIH 2023 on rice and rice weeds applied at 5 different stages of growth.

Treatment	Rate	Growth Stage[1]			Rice Injury[2]	% Weed Control		Yield
		Rice	ECHOR	SCPMU		ECHOR	SCPMU	
	(g/A)							(lb/A)
Untreated	--				0	0	0	1470
KIH 2023	13	5-5.5ℓ	4-4.5ℓ	5-6ℓ	0	95	15	5390
KIH 2023	27				0	100	63	5700
KIH 2023	54				0	100	81	7640
KIH 2023	13	6.5-7ℓ	5.5-6ℓ	6-7ℓ	0	77	38	4320
KIH 2023	27				0	95	75	5810
KIH 2023	54				0	100	93	5830
KIH 2023	13	tiller	tiller	flower	0	72	95	3740
KIH 2023	27				0	73	95	3330
KIH 2023	54				0	80	80	3840
KIH 2023	13	late	late	flower	0	65	80	2660
KIH 2023	27	tiller	tiller		0	72	80	2740
KIH 2023	54				0	87	0	2360
KIH 2023	13	boot	head	head	0	10	0	2230
KIH 2023	27				0	17	0	2000
KIH 2023	54				0	17	0	1990

ECHOR = watergrass; SCPMU = rice field bulrush (formerly roughseed bulrush)

[1]ℓ = leaf
[2]0 = no injury; 10 = all rice killed

Table 2. Evaluation of V 53482 for the control of watergrass and rice field bulrush and injury to rice.

Treatment	Rate	Growth Stage[1]			Rice Injury[2]	% Weed Control		Yield
		Rice	ECHOR	SCPMU		ECHOR	SCPMU	
	(g/A)							(lb/A)
Untreated	--				0	0	0	1670
V 53482	10	2.2-2.5ℓ	2.5ℓ	0.5-1ℓ	1	10	0	800
V 53482	20	2.2-2.5ℓ	2.5ℓ	0.5-1ℓ	2	13	0	770
V 53482	40	2.2-2.5ℓ	2.5ℓ	0.5-1ℓ	7	35	0	440
V 53482	10	6.5-7ℓ	5.5-6ℓ	6-7ℓ	1	0	0	1750
V 53482	20	6.5-7ℓ	5.5-6ℓ	6-7ℓ	1	0	0	1330
V 53482	40	6.5-7ℓ	5.5-6ℓ	6-7ℓ	1	0	0	1260
V 53482	10+.2%[3]	tiller	tiller	flower	0	0	0	1610
V 53482	20+.2%[3]	tiller	tiller	flower	0	0	0	1890
V 53482	40+.2%[3]	tiller	tiller	flower	0	0	0	1580

ECHOR = watergrass; SCPMU = rice field bulrush (formerly roughseed bulrush)

[1]ℓ = leaf
[2]0 = no injury; 10 = all rice killed
[3]Plus 0.2% surfactant Siliwet 77

Table 3. The influence of Facet and Facet + Ordram or Facet + Bolero on weed control in rice.

Treatment	Rate	Rice Injury*	Rice Ht	% Weed Control ECHOR	SCPMU	LEFFA	Yield
	(lb/A)		(in)				(lb/A)
Untreated	--	0	29	3	28	90	1200
Facet	0.5	0	31	100	43	48	4980
Ordram	5.0	1	29	68	45	93	3160
Bolero	4.0	0	30	63	38	98	3050
Facet + Ordram	0.25+2	2	30	100	8	83	3210
Facet + Ordram	0.5+1	0	31	100	20	53	3780
Facet + Ordram	0.5+2	0	33	100	50	95	4950
Facet + Ordram	0.5+3	0	33	100	45	95	5690
Facet + Bolero	0.5+1	0	31	98	30	70	3960
Facet + Bolero	0.5+2	1	30	93	35	81	4290
Facet + Bolero	0.5+3	0	32	93	53	93	5670

ECHOR = watergrass; LEFFA = sprangletop; SCPMU = rice field bulrush (formerly roughseed bulrush)

*0 = no injury; 10 = all rice killed

Table 4. Londax rate and timing for rice field bulrush control, 1990.

Treatment	Rate	Timing[1]	% Weed Control ECHOR	% Weed Control SCPMU	Rice Stand[2]	Rice Tillers	Rice Weight	Yield at 14% Moisture	% Moisture at Harvest
	(lb/A)					(m^2)	(g/m^2)		
Untreated	---	--	0	2	8.9	497	557	2720	15.8
Londax	0.63	2 lsr	48	100	9.5	710	867	6250	15.4
Ordram	4.0	2 lsr	100	18	9.2	554	1021	5580	13.7
Londax + Ordram	0.63+4.0	2 lsr	100	100	10.0	757	1139	7570	13.7
Londax + Ordram	0.63+4.0	4 lsr	100	100	10.0	792	1192	6470	12.9
Londax + Ordram	0.63+4.0	6 lsr	100	100	10.0	726	1124	6810	12.7
Londax + Ordram	0.63+4.0	30 DAS	100	66	9.8	702	1004	6320	13.9
Londax + Ordram	0.47+4.0	2 lsr	100	100	10.0	685	1417	8050	13.0
Londax + Ordram	0.47+4.0	4 lsr	100	98	9.5	716	1228	6810	13.6
Londax + Ordram	0.47+4.0	6 lsr	96	100	10.0	645	1173	6400	14.4
Londax + Ordram	0.47+4.0	30 DAS	100	81	9.9	616	850	5870	14.4
CV %	---	--	5.9	10.4	21.9	18.1	26.1	15.7	6.4
LSD (.05)	---	--	6	12	8	176	397	1420	1.3

ECHOR = watergrass; SCPMU = rice field bulrush

[1]lsr = leafstage rice; DAS = days after seeding
[2]0 = no stand; 10 = excellent stand

Table 5. A comparison of PPI and postemergence Ordram in combination with Londax, 1990.

Treatment	Rate	Timing[1]	% Weed Control ECHOR	% Weed Control SCPMU	Rice Stand[2]	Rice Tillers	Rice Weight	Yield at 14% Moisture	% Moisture at Harvest
	(lb/A)					(m^2)	(g/m^2)		
Untreated	---	--	0	2	8.9	497	557	2830	15.8
Ordram	3.0	PPI	48	12	7.8	447	556	3530	14.5
Londax	0.63	2 lsr	48	100	9.5	710	867	6250	15.4
Ordram	4.0	2 lsr	100	18	9.2	554	1021	5580	13.7
Londax + Ordram	0.63+3.0	2 lsr+PPI	99	100	9.8	736	1228	7150	13.7
Londax + Ordram	0.63+4.0	2 lsr	100	100	10.0	756	1140	7570	13.7
CV (%)	---	--	11.6	20.7	7.6	17.3	24.2	16.9	6.9
LSD (.05)	---	--	9	17	1.0	161	327	1410	1.5

ECHOR = watergrass; SCPMU = rice field bulrush

[1]lsr = leafstage rice; PPI = preplant incorporated
[2]0 = no stand; 10 = excellent stand

Table 6. The influence of water management on weed control with Facet.

Treatment	Rate	Days to reflood	% Weed Control ECHOR	% Weed Control LEFFA	Yield
	(lb/A)				(lb/A)
	Management System A				
Untreated	--	3	17	0	840
Facet	0.5	1	100	30	2160
Facet + BCH 86401S	0.5+1qt	1	100	50	4610
Facet	0.5	2	100	43	4140
Facet + BCH 86401S	0.5+1qt	2	100	56	4760
Facet	0.5	3	100	60	4390
Facet + BCH 86401S	0.5+1qt	3	100	37	3170
Facet	0.5	5	100	27	2210
Facet	0.5	7	100	17	2880
	Management System B				
Untreated	--	3	0	57	640
Facet	0.5	1	73	63	3910
Facet + BCH 86401S	0.5+1qt	1	100	50	4530
Facet	0.5	2	100	47	4010
Facet + BCH 86401S	0.5+1qt	2	100	70	4630
Facet	0.5	3	100	53	4640
Facet + BCH 86401S	0.5+1qt	3	100	47	4230
Facet	0.5	5	100	67	5160
Facet	0.5	7	100	30	2360
	Management System C				
Untreated	--	3	0	97	3510
Facet	0.5	1	100	93	6800
Facet + BCH 86401S	0.5+1qt	1	100	90	5880
Facet	0.5	2	100	90	5830
Facet + BCH 86401S	0.5+1qt	2	100	90	6390
Facet	0.5	3	100	90	6340
Facet + BCH 86401S	0.5+1qt	3	100	90	5770
Facet	0.5	5	100	90	6080
Facet	0.5	7	100	90	6250
	Management System D				
Untreated	--	0	67	90	3430
Facet	0.5	0	100	70	6540
Facet + BCH 86401S	0.5+1qt	0	100	90	6400

ECHOR = watergrass; LEFFA = sprangletop

Table 7. Comparison of Poast and Whip when applied at three different growth stages of rice and weeds followed by different water management practices.

		Growth Stage[1]			Rice	% Weed Control		
Treatment	Rate	Rice	ECHOR	LEFFA	Injury[2]	ECHOR	LEFFA	Yield
	(lb/A)							(lb/A)
			Water depth: 1 in					
Untreated	--				1.3	5	8	689
Poast	.09+1qt	3-3.5ℓ	3-4ℓ	2ℓ	2.5	13	38	406
Poast	.14+1qt				5.5	20	60	646
Whip	.09+1qt				5.0	20	65	718
Poast	.09+1qt	5-5.5ℓ	5.5ℓ	4ℓ	4.0	8	68	413
Poast	.14+1qt				5.0	40	70	842
Whip	.09+1qt				4.5	30	63	755
Poast	.09+1qt	tiller	tiller	tiller	2.5	20	40	515
Poast	.14+1qt				3.5	18	38	464
Whip	.09+1qt				3.5	8	50	421
			Water depth: 2-4 in					
Untreated	--				1.0	23	28	1945
Poast	.09+1qt	3-3.5ℓ	3-4ℓ	2ℓ	1.0	28	35	3332
Poast	.14+1qt				1.5	48	63	4457
Whip	.09+1qt				2.0	60	85	4856
Poast	.09+1qt	5-5.5ℓ	5.5ℓ	4ℓ	1.0	43	55	3702
Poast	.14+1qt				1.5	58	88	3913
Whip	.09+1qt				2.0	63	88	4043
Poast	.09+1qt	tiller	tiller	tiller	1.0	28	40	2729
Poast	.14+1qt				1.0	33	53	3165
Whip	.09+1qt				1.5	38	70	3166
			Water depth: 4-6 in					
Untreated	--				0.3	23	60	3114
Poast	.09+1qt	3-3.5ℓ	3-4ℓ	2ℓ	1.0	60	43	4014
Poast	.14+1qt				1.0	68	65	5270
Whip	.09+1qt				1.0	63	80	4769
Poast	.09+1qt	5-5.5ℓ	5.5ℓ	4ℓ	1.3	55	68	4058
Poast	.14+1qt				1.0	65	88	5437
Whip	.09+1qt				1.8	63	85	4552
Poast	.09+1qt	tiller	tiller	tiller	0.5	43	83	2831
Poast	.14+1qt				0.8	65	80	4581
Whip	.09+1qt				1.0	63	88	4072

ECHOR = watergrass; LEFFA = sprangletop; SCPMU = rice field bulrush (formerly roughseed bulrush)

[1] ℓ = leaf
[2] 0 = no injury; 10 = all rice killed

Table 8. Response of three collections of rice field bulrush seed to Londax.

Treatment	Rate	Height	Maximum Leaf Stage
	(lb/A)	(cm)	
	Site 1 Butte County		
Untreated	--	22.0	14.0
Londax	0.03	1.5	2.5
Londax	0.06	1.5	2.0
	Site 2 Butte County		
Untreated	--	23.3	14.0
Londax	0.03	1.5	2.5
Londax	0.06	1.5	2.0
	Susceptible Seed		
Untreated	0.03	25.4	14.0
Londax	0.03	1.5	2.5
Londax	0.06	1.5	2.5