COMPREHENSIVE RESEARCH ON RICE

ANNUAL REPORT
January 1, 1997 - December 31, 1997

PROJECT TITLE: Weed Control in Rice

PROJECT LEADERS AND PRINCIPAL UC INVESTIGATORS:

Project Leader:
James E. Hill, Agronomy and Range Science, U.C. Davis

Co-Principal Investigators:
W.M. Canevari, Farm Advisor, San Joaquin
B.P. Caton, Postgraduate researcher, U.C. Davis
R.G. Mutters, Farm Advisor, Butte
S.R. Roberts, Postgraduate Researcher, U.C. Davis
S.C. Scardaci, Farm Advisor, Colusa
J.F. Williams, Farm Advisor, Sutter-Yuba

LEVEL OF 1997 FUNDING: $19,222

OBJECTIVES OF PROPOSED RESEARCH:

I. To investigate the efficacy, timing and compatibility of new herbicides in water-seeded rice (including water management variations of water seeding).
II. To collaborate with plant breeders in developing herbicide-resistant technologies for water-seeded rice.
III. To conduct the research necessary to maintain safe and effective uses of existing herbicides integrated with appropriate cultural practices.
IV. To continue the exploration of rice/weed competition, weed biology and cultural practices to minimize herbicide costs and environmental impacts.

SUMMARY OF 1997 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVES:

OBJECTIVE I. To investigate the efficacy, timing and compatibility of new herbicides in water-seeded rice (including water management variations of water seeding).

Carfentrazone (F-8426). Experiments were established at several locations, including one at the RES and two sites in Sutter County (A and B). Also, FMC oversaw three experiments on the RES (unreported here). We applied carfentrazone at rates of 5, 10, 15, and 20 g ai/A, at two timings, *3-4l* and *6-7l*. These rates were lower than those used previously, so we could test injury and control at low concentrations plus the surfactant. The surfactant L-77 (0.25% v/v) was used in all treatments. Water was lowered at all applications to expose weed foliage. At the Sutter A site we were only able to test one timing, *6-7l*. Yields were taken at the RES.

At the RES, *3l* applications caused significant rice injury (Table 1) and did not completely control ricefield bulrush, but also gave some of the highest yields. The injury symptom was bronzing of the leaves, but new leaves were unaffected. Ricefield bulrush control was complete at the highest rates in the *6-7l* timing, but these treatments yielded less. Control of smallflower umbrella plant also was higher in the later timing, but never seemed complete. Conversely, at Sutter B, the *6-7l* timing seemed to cause more rice injury than the *3-4l* timing (Table 2). Control of all weeds at Sutter B was generally poorer overall, although 14.6 g/A at *3-4l* gave almost complete control of redstem and good control of Gregg's arrowhead. Aerial application of carfentrazone over a wider field area at a much higher rate, 72 g/A, controlled smallflower umbrella sedge completely.

Overall, these experiments showed that even at low rates, carfentrazone with L-77 caused some rice injury, but still controlled most sedge and broadleaf species. Questions still to be resolved are whether carfentrazone requires the surfactant, and whether it should be applied into the water or with the water drained.

V-10029 rate and timing alone or in combination with Carfentrazone (F-8426). Both of these herbicides have been tested for several years and are postemergence foliar herbicides. V-10029 controls watergrass and barnyardgrass, and carfentrazone controls broadleaf and sedge weeds. Because both herbicides may be available for use within a few years, we tested rate and timing combinations of the two for the first time. All trials were done at the RES. In the first trial, we tested combinations of two rates of V-10029, and three rates of carfentrazone at two timings. V-10029 rates were 12 and 18 g/A, while carfentrazone rates were 12, 24, and 48 g/A. L-77 (Silwet, 0.25% v/v) was used as a surfactant, and the two timings were at *3l* and *6-7l* stages. Treatments were compared to Londax (0.0625 lbs/A) plus Ordram (4 lbs/A) as a standard, which were applied at *3l* and *4l*, respectively, and ringed in aluminum. Water was lowered to expose 70% of the weed foliage for application at *3l*, but not at *6-7l*.

In the second trial rates were lowered to 9 and 12 g/A for V-10029, and to 9, 12 and 24 g/A for F8426. A single application was made at the *5l* stage. Treatments were compared to plots with Londax at 1 oz/A plus propanil at 4 lbs/A.

In the first trial, the most striking result was the severe rice injury and mortality from the herbicides alone and in combination at the *3l* timing (Table 3). Injury was much lower at the *6-7l* timing. Injury ratings matched stand ratings made about three weeks later. Because of the injury caused by combinations, watergrass control at the *3l* timing was highest when V-10029 was applied alone. However, watergrass control was greater than 60% in all early combinations. Watergrass control at the *6-7l* timing was nearly complete in all treatments with 18 g/A of V-10029. Ricefield bulrush control was 70% or more in all early treatments, but 100% in almost all late treatments.

In the second trial, rice injury clearly was reduced (data not shown), but weed pressure was insufficient for a good trial. This study will probably be repeated.

V-10029 rate and timing alone or in combination with Abolish (thiobencarb).

One weakness of V-10029 is the inability to control bearded sprangletop. Therefore, we tested combinations with Abolish to provide residual and sprangletop control. The experiment at the RES used rates of 2, 3 and 4 lbs ai/A of Abolish and 10 and 12 g ai/A of V-10029, applied at the *4-5l* stage (18 DAS). The surfactant, L-77 (Silwet, 0.25% v/v) was used in all treatments that included V-10029, but not with Abolish alone. Control treatments were Londax at 1 oz/A and Ordram at 4 lbs/A, alone and in combination. Except in controls, water was lowered to expose the weed foliage.

All combinations of Abolish with V10029 produced good weed control and high yields in this experiment (Table 4). Treatments with V-10029 alone gave among the highest yields. The relatively late timing for Abolish gave less grass control in treatments with it alone, but every treatment with V-10029 gave 100% watergrass control. Adding Abolish to V-10029 increased sprangletop control by 20 to 30%. Here, V-10029 also gave excellent control of ricefield bulrush at all rates, although this seems to vary somewhat across years.

IR5790 timing and efficacy studies

IR5790 (Isagro) is a chemical tested for the first time. The company indicated that it might have efficacy on a wide spectrum of weeds, and in both 10EC and 1G formulations. We tested IR5790 on the RES in ringed plots at rates of 20 and 40 g/A (10EC) and 40 and 80 g/A (1G) at *2l* and *4l* timings. Assessments of these applications showed little weed control, so we increased rates to 40, 80, 120 and 160 g/A for both formulations in a *6l* treatment. This also gave little control, so we repeated the trial in a different RES location. In this trial, rates of the 10EC formulation were 20, 40, 80, and 160 g/A, and 40, 80, 120, and 160 g/A for the 1G formulation. Applications were made at *3l* and *5l*, and *4l* for the 10EC and 1G formulations, respectively. Water was lowered for the 10EC applications, while the 1G application was made into the water after the first 10EC treatment. Treatments were compared to standard plots of Londax at 1oz/A plus Ordram at 4lbs/A.

Watergrass pressure nearly overwhelmed these plots, showing little grass control by IR5790 (Table 5). Thus, two replications were treated with Whip to allow us to better evaluate broadleaf weed control. IR5790 controlled sedges in the *5l* treatment at rates of 80 g/A or more, but early watergrass competition may have affected these results. These trials will be repeated next year with the focus on broadleaf and sedge weed control.

OBJECTIVE II. To collaborate with plant breeders in developing herbicide-resistant technologies for water-seeded rice.

Liberty-linked (glufosinate resistant) rice.

Glufosinate is a broad-spectrum herbicide that can be used selectively in cropping systems by genetically altering the crop plants to be glufosinate resistant. This relatively new technology is only being used in a few crops. Large scale experiments were begun last year at the RES with

glufosinate resistant koshihikari provided by Louisiana State University. This year the resistant variety provided by LSU was Bengal. Glufosinate was applied postemergence at rates of 162, 243 and 324 g ai/A at *7l* rice (27 DAS) and *3-4t* rice (37 DAS), and as a split application with those timings plus an application of glufosinate at 162 g/A at the *4-5t* (39 DAS) stage. Glufosinate was also applied at the *7l* stage at 243 g/A to the California commercial rice variety M202. Carfentrazone was applied to *6-7l* rice alone at 24 and 48 g/A and at those rates at the *7l* stage with glufosinate at 162 g/A, to test whether adding carfentrazone would increase broadleaf and sedge weed control. The control treatment in this experiment was Super Wham at 4 lbs/A plus Londax at 1 oz/A. Londax-treated plots were ringed with aluminum, and water was lowered for all applications.

Control ratings and yields were quite variable in this experiment (Table 6), perhaps because the cultivar was not well-adapted to California conditions. However, split applications of Liberty clearly gave the best control, especially when begun at the early timing (*7l + 4-5t*). Early applications of Liberty alone gave good control and high yields only for rates of 600 g/ha or more. Adding Carfentrazone with Liberty at the 60 g/ha rate (*7l*) improved sedge control but increased rice injury. The benefit of split applications appeared to be increased weed foliage coverage in the second application. Because Liberty is a foliar-active material, coverage is critical for effective weed control. Finally, yields in glufosinate-treated M202 (Treatment 14 in Table 6) shows that it will be critical for growers to precisely identify field and cultivar locations to aerial appliers to avoid misapplications.

Roundup Ultra (glyphosate) efficacy

Besides glufosinate resistant crops, glyphosate resistant crops are also in development. To prepare for the possibility of Roundup resistant rice, we began greenhouse studies in 1997 to test its efficacy against water-seeded rice weeds. Pot experiments with three weed species, watergrass, smallflower umbrella sedge, and redstem, were flooded and seeded on June 25 in a U.C. Davis Agronomy greenhouse. Five replicate pots were used for each species. These were thinned one to two weeks after seeding to about four plants per pot. Rates of 12 and 24 oz/A at exposures of 1/3 and 2/3 plant height were tested. Watergrass and smallflower umbrella sedge were sprayed at 16 DAS, while redstem was sprayed at 22 DAS because of its slower growth. Untreated basins were covered during spraying. The smallflower umbrella sedge trial was repeated, starting July 25, to test the effects of mixing Roundup with Mon12000. Roundup was applied at 12 oz/A, and Mon12000 at 1/3, 2/3, or 1 oz/A, at about 14 DAS.

Control of watergrass and redstem by Roundup Ultra was effective at 24 oz/A regardless of exposure level (Table 7). Control at the lower rate depended on exposure, but was near acceptable levels. Control of smallflower umbrella sedge was low even at the highest rates, suggesting that sedges are less sensitive to Roundup. In the repeated trial, Roundup Ultra at 12 oz/A again failed to control smallflower umbrella sedge (25%), but adding Mon12000 at rates of 2/3 oz/A or more gave complete control (100%; 1/3 oz/A = 33% control). These trials suggest that Roundup may control grasses and broad leaved weeds readily, but might need to be mixed with a separate product for adequate sedge weed control.

OBJECTIVE III. To conduct the research necessary to maintain safe and effective uses of existing herbicides integrated with appropriate cultural practices.

Super Wham (propanil) efficacy and timing.

Areas were expanded for the use of Super Wham (propanil) in 1997 and will probably continue to expand in the near future, especially for ground-rig applications. Therefore, several experiments were done at the RES in 1997 involving propanil alone and in combination with other chemicals. Propanil was applied alone at rates of 3, 4 and 5 lbs/A at the *5l* stage, and at 4, 5 and 6 lbs/A at the 2-3*t* stage in Block 20. Propanil was always mixed with 1 pt/A of the adjuvant, crop oil concentrate (COC). These were compared to treatments of carfentrazone (F8426) plus L-77 (0.25% v/v) at 0.1 lbs/A, and Londax and Ordram applied alone and in combination at 1 oz/A and 4 lbs/A. Carfentrazone was applied at the *4l* stage, and Londax and Ordram treatments at the *3l* stage. Londax and Ordram treatments were ringed in aluminum.

Grass pressure in Block 20 was much less than other RES plots in 1997. Propanil provided good grass control at all rates and timings (Table 8), although control at the *5l* timing was slightly higher. However, ricefield bulrush and monochoria control by propanil was low in the *5l* treatments, but excellent in the 2-3*t* treatments. Propanil applications at 2-3*t* yielded slightly better than those at the *5l* stage. Although yields in propanil-treated plots were lower than those of the Londax plus Ordram treatment, they were still high, and better than the carfentrazone and fenoxaprop treatments.

Super Wham (propanil) and Abolish (thiobencarb) combinations and timings.

Preflood and postemergence applied Abolish (thiobencarb) was tested in combination with Super Wham (propanil). Abolish was applied preflood at 4 lbs/A, alone or in combination with propanil at *6-7l* rice at rates of 4 and 6 lbs/A. Postemergence applications used Abolish at 3 and 4 lbs/A and propanil at 3, 4 and 6 lbs/A. These were applied alone or in combination at the *3l* and *6-7l* stages. The surfactant L-77 (Silwet, 0.25% v/v) was applied to all treatments in which propanil was applied alone. Water was lowered to expose weed foliage.

In this experiment, high yields were correlated most strongly with watergrass control. However, there were few significant differences in yields between most treatments (Table 9). The best watergrass control was achieved with *6-7l* stage applications of propanil, but combinations of *6-7l* propanil with preplant abolish also provided excellent watergrass control. Some *3l* treatments also controlled watergrass well. For example, propanil applied alone at 4 lbs/A at the *3l* stage was one of the two highest yielding treatments, probably because weed competition was removed early. Because propanil is foliar-active and abolish provides some residual control, the effect of abolish was probably to lengthen the period of control. No consistent effects on control ratings or yields from the addition of abolish were detectable, however.

Whip (fenoxaprop) formulations.

Whip has typically been used as an EW formulation. This experiment tested and compared an EC formulation. Whip was applied in the two formulations at rates of 20, 26 and 32 g/A at the *6-7l* stage. An experimental compound, UCX2355, was applied to control broadleaf and sedge weeds, but was applied late, so yields may have been affected by these weeds.

Rice injury in the EC treatments was slightly lower (Table 10), but grass control was higher in the EW treatments. The EC treatments showed a much stronger rate response, for both control ratings and yields. The 32 g/A EC treatment was the second-highest yielding treatment, but the EW treatments were consistently high across all rates.

Prowl (pendimethalin) safety and efficacy in water-seeded rice

Prowl (pendimethalin) is registered for use in drill-seeded rice. Previous studies had shown that Prowl injured water-seeded rice. Experiments were conducted at four sites in 1997 to test the safety and efficacy of Prowl in water-seeded conditions. Test sites were as follows: RES (U.C. Davis), Sutter County (U.C. Davis), Sacramento County (John Taylor Fertilizers), and Glenn County (Rice Researchers, Inc.).

Standard treatments in all trials were applications of Prowl at 0.5 and 1.0 lbs/A at *2l* and *4-5l* stages, with water lowered. In addition, the RES, Sutter, and Sacramento sites contained treatments of Prowl at 1.0 lbs/A plus propanil at 4 lbs/A, although the timing for the latter was at *2l*, while for the first two was *4l*. The RES and Sutter sites also had *2l* Prowl treatments of 0.33 and 0.67 lbs/A, and 0.75 and 1.5 lbs/A, respectively. These sites also contained standard treatments of Londax at 1 oz/A plus Whip at 20 g/A.

The results varied strongly by location (Tables 11a to 11d), although for the *2l* timing of Prowl mild to severe rice injury was reported at every site. Recovery seemed to vary, so that, for example, Prowl-treated yields at Glenn were high (Table 11b), but very low at Sutter (Table 11c). Because of stand damage, untreated plots yielded more than Prowl-treated plots at two sites (Tables 11a and 11c). Prowl treatments at Sutter suffered severe mortality at all rates, as shown by stand ratings and light interception data. This was corroborated by the RES trial. Clearly, these results show that severe rice injury and even mortality from Prowl are possible in water-seeded rice, but that the plants may fully recover under some circumstances (Table 11b). The cause of the differences between these trials is not known.

Weed control by Prowl varied by timing, rate, and weed species. Except at Sacramento (Table 11d) control of watergrass and sprangletop was generally high at the *2l* timing, but this was compromised by stand injury at two sites. Control of watergrass and sprangletop was unacceptable at the *4l* treatment for three sites (Tables 11bcd). Prowl gave moderate control of smallflower umbrella sedge at Sacramento (Table 11d), but no control at Sutter (Table 11c; this may have been caused in part by stand mortality). Except at Glenn, Prowl controlled weeds best in combination with another compound (Whip or propanil). The only consistently moderate to high yields across all trials were with treatments of Prowl plus propanil or whip at the *5l* to *6l*

stages. This may have been effective because propanil and whip are both exclusively foliar active materials, but Prowl could provide residual weed control in that combination.

Grandstand (triclopyr) safety, and efficacy of split applications

Two experiments were conducted on the RES with Grandstand (triclopyr) to test 1) its safety on rice, and 2) the efficacy of split applications of Grandstand. However, we did not adequately control watergrass in these plots, which compromised both experiments. We plan to repeat these studies next year.

Efficacy of 2,4-D Amine formulations against suspected MCPA resistant arrowhead

This trial was conducted in a farmer's field near Biggs to test the efficacy of old and new 2,4-D formulations against California arrowhead suspected of being resistant to MCPA. We used the following herbicides and rates: Hi-Dep (3.8LC) at 0.75, 1.0, and 2.0 lbs/A; 2,4-D amine (3.8LC) at 0.75 and 2.0 lbs/A; and two experimental compounds, NB20567 and NB20658, at 0.75 lbs/A. Applications were made on July 10, about 40 DAS. Arrowhead control was highest with Hi-Dep at 2.0 lbs/A (Table 12), and there was a strong rate response. The experimental compounds gave partial control, but also stunted rice as much or more than other treatments.

Grandstand (triclopyr) and Super Wham (propanil) combinations

A late trial on the RES was done to test combinations of Grandstand (triclopyr) and Super Wham (propanil) for efficacy against a broad weed spectrum. Grandstand was applied alone and in combinations at 0.375 lbs/A, and propanil was applied alone and in combinations at 2, 3, 4, and 6 lbs/A. Treatments were compared to MCPA at 0.5 lbs/A alone and in combination with propanil at 4 lbs/A. Applications were made at about the *6l* stage, after weed foliage was 70% or more exposed above the water. Unfortunately, weed pressure in these plots was insufficient for a good trial. This trial may be repeated.

OBJECTIVE IV. To continue the exploration of rice/weed competition, weed biology and cultural practices to minimize herbicide costs and environmental impacts.

Cultivar competitiveness and reduced herbicide rates

The project supported four experiments at the RES which investigated differences in the competitive ability of commercial cultivars. Objectives of these studies were to see if the use of more competitive cultivars might enable lower herbicide rates to be used, thereby reducing costs and the selection pressure for weed resistance to herbicides. Support included herbicide application and field management. These experiments were funded largely by the U.C. IPM Program.

PUBLICATIONS OR REPORTS:

1996 Bayer, D. E., and J. E. Hill. Weed control in rice. *In*: Annual Report Comprehensive Rice Research. Univ. of Calif. and USDA, pp. 57–87.

1997 Caton, B.P., T.C. Foin, J.L. Breen and J.E. Hill. Phenotypic plasticity among weeds of direct-seeded rice in California. *In*: Proceedings of 16th Asian-Pacific Weed Science Society Conference. Kuala Lumpur, Malaysia. pp. 42–45.

1997 Caton, B.P., T.C. Foin, K.D. Gibson and J.E. Hill. A temperature-based model of direct-, water-seeded rice (Oryza sativa) stand establishment in California. Agricultural and Forest Meteorology, *In press*.

1997 Caton, B.P., T.C. Foin, and J.E. Hill. Phenotypic plasticity of *Ammannia* spp. in competition with rice. Weed Research, 37: 33-38.

1997 Caton, B.P., T.C. Foin, and J.E. Hill. Mechanisms of competition for light between rice (*Oryza sativa*) and redstem (*Ammannia* spp.). Weed Science, 45: 269–75.

1997 Hill, J.E., B.P. Caton, A.J. Fischer, J. Anstey, T.C. Foin, and K.D. Gibson. Rice Weed Control--New herbicides, combinations, timing, and cultural control. Abstract, 1997 Rice Field Day, Biggs, Calif., pp. 42–45.

1997 Hill, J.E., S.R. Roberts, S.C. Scardaci, and J.F. Williams. Rice herbicides and water quality: A California success story in government and industry coordination. *In*: Proceedings of 16th Asian-Pacific Weed Science Society Conference. Kuala Lumpur, Malaysia. pp. 42–45.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

The 1997 weed control program funded by the Rice Research Board focused on alternative herbicides to Londax (bensulfuron)-resistant weeds. FMC's new herbicide carfentrazone (Shark) was tested for the second year in both the station and grower's fields. In 1996 our grower field studies were nearly ideal and carfentrazone provided excellent control of the four weed species resistant to Londax, smallflower umbrellasedge, ricefield bulrush, California arrowhead and redstem. In 1997 we obtained good, but not excellent control of these species in off-station studies. In part this was attributed to lower rates, high weed infestations and poorer rice stands in the test areas. One site was infested with Gregg's arrowhead and carfentrazone was able to provide satisfactory control of this perennial weed. In studies at the RES, we found that applications of carfentrazone at the two leaf stage of rice were injurious and that, in general, the addition of surfactant at early growth stages was also injurious. Future studies of carfentrazone will need to more thoroughly evaluate the use of surfactant. The experimental herbicide V-10029 completely controlled watergrass as in past years. In 1997, V-10029 also controlled ricefield bulrush, but based on previous studies only partial control of this weed can normally be expected. Combinations of V-10029 with carfentrazone controlled both grass and broadleaf

weeds (excepting sprangletop) at very low rates of application. This combination injured rice severely at early application stages, but at later stages appeared safe. These combinations warrent further study as the combined rate could be less than 1 oz/A.

Due to regulatory changes, we were able to evaluate the use of propanil at the RES for the first time in many years. Early treatments (3-leaf rice) of propanil and propanil combined with Abolish (thiobencarb) to drained rice gave good control of both broadleaf and grass weeds. This combination is significant because propanil controlled emerged weeds while Abolish added both foliar and residual activity. Furthermore, these studies indicated that the rates of both herbicides in combination may be lowered significantly from the rates normally used for each alone.

The use of transgenic cultivars with resistance to broadspectrum herbicides is an emerging technology for weed control in many crops including rice. Transgenic rice cultivars adapted to California are in the early stages of development and seed was not available in quantities for field testing. However, we were still able to focus our work on how this technology can be used to control weeds. We used the transgenic rice variety, Bengal, provided by Louisiana State University to evaluate timing and split applications of Liberty (glufosinate). This work demonstrated that split applications may be necessary for good weed control if these foliar active herbicides are to be used alone. In greenhouse studies at UC Davis, we tested the efficacy of Roundup (glyphosate) against the most important rice weeds in preparation for the possibility of Roundup-Ready rice. These studies showed Roundup give excellent control of grass weeds, but only moderate control of smallflower umbrella sedge.

Other experimental herbicides were tested in early field studies to evaluate their performance in California's water-seeded system. Further testing will be necessary to determine if they have a fit in water-seeded rice. Additionally, four studies on weed competition in rice were conducted as a component of a grant from the Integrated Pest Management Program at UC Davis.

Table 1. Results of 1997 Carfentrazone (F8426) trial at the RES.

						Weed control[1]						
			Rice injury		Stand	SCPMU		CYPDI	HETLI		ALISMA	
	Rate	Timing[3]	(6-20)	(7-24)	(6-26)	(6-26)	(7-24)	(7-24)	(6-26)	(7-24)	(6-26)	Yield[2]
	(g/A)		----------				(%)		----------			(lbs/A)
1	--	--	3	18	100	15	48	65	28	75	0	5681
2	5	3-4	15	11	93	70	70	83	38	65	20	6621
3	10	3-4	29	21	79	79	75	78	38	73	63	6213
4	15	3-4	19	8	85	75	65	83	13	63	51	6907
5	20	3-4	46	20	55	86	68	73	40	68	78	6729
6	5	6-7	0	14	100	88	80	90	58	78	61	6166
7	10	6-7	0	18	96	99	95	88	58	80	70	6414
8	15	6-7	4	15	95	99	100	88	66	78	88	6329
9	20	6-7	0	18	98	100	98	90	65	75	95	6592

[1] SCPMU = rice field bulrush; CYPDI = smallflower umbrellaplant; HETLI = ducksalad; ALISMA = water plaintain

[2] At 14% moisture

[3] 3-4*l* application on June 6; 6-7*l* application on June 19.

Table 2. Results of 1997 Carfentrazone (F8426) trial at Sutter County (B).

Trt	Rate	Timing[2]	Stand[1]	Weed control	
				SCPMU	SAGLO
	(g/A)		----------	(%)	----------
1	5	4	95	55	33
2	10	4	95	63	48
3	15	4	93	53	33
4	20	4	95	65	73
5	--		75	59	25
6	5	7	65	84	0
7	10	7	75	63	0
8	15	7	83	73	0
9	20	7	83	73	0

[1] All ratings made on 7-28.

[2] *4l* application on June 16; *7l* application on July 3.

Table 3. Results of the 1997 V-10029 + Carfentrazone (F8426) trial at the RES.

					Weed control[1]				
			Injury	Rice	ECHOR	LEFFA	SCPMU	CYPDI	HETLI
Treatment	Rate(s)	Timing[2]	(7-3)	(7-22)	(7-22)	(7-22)	(7-22)	(7-22)	(7-22)
	(g/A)	LSR	----------	----------	----------	(%)	----------	----------	----------
Untreated			0	75	13	85	83	73	78
V-10029	12	3	75	13	83	50	75	85	93
V-10029	18	3	88	15	78	50	83	78	93
F8426	12	3	56	38	35	55	90	93	88
F8426	24	3	61	48	38	50	78	88	78
F8426	48	3	85	28	53	63	70	88	88
V10029+F8426	12+12	3	76	18	73	58	85	85	73
V10029+F8426	12+24	3	89	13	70	60	70	93	80
V10029+F8426	12+48	3	95	35	85	68	73	100	93
V10029+F8426	18+12	3	78	23	75	65	70	93	88
V10029+F8426	18+24	3	64	20	70	68	73	95	90
V10029+F8426	18+48	3	84	18	65	78	90	100	95
V-10029	12	6-7	5	10	85	50	100	95	93
V-10029	18	6-7	10	10	85	58	100	95	100
F8426	12	6-7	0	80	15	75	100	100	93
F8426	24	6-7	0	80	5	85	100	100	100
F8426	48	6-7	0	80	18	80	90	78	95
V10029+F8426	12+12	6-7	14	10	75	50	100	100	93
V10029+F8426	12+24	6-7	35	18	65	50	100	100	100
V10029+F8426	12+48	6-7	44	30	55	53	100	100	100
V10029+F8426	18+12	6-7	18	13	78	50	100	100	88
V10029+F8426	18+24	6-7	36	15	80	53	100	100	100
V10029+F8426	18+48	6-7	20	15	80	53	100	100	95
Londax	28	3	18	53	40	55	100	100	100
Ordram	4 lbs/A	4	0	53	38	65	60	65	83
Londax+Ordram	28+4 lbs/A	4	8	40	58	65	100	100	100

[1] ECHOR = watergrass; LEFFA = sprangletop; SCPMU = ricefield bulrush; CYPDI = smallflower umbrellaplant; HETLI = ducksalad.

[2] *3l* application on June 5; *4l* on June 9, and *6-7l* on June 16.

Table 4. Results of 1997 trials with Abolish (thiobencarb) and V-10029 combinations.

Treatment	Rate(s)[1]	Stand	Weed control[2] ECHOR		SCPMU		HETLI		LEFFA	CYPDI	Yield
		(6-28)	(6-28)	(7-22)	(6-28)	(7-22)	(6-28)	(7-22)	(7-22)	(7-22)	(lbs/A)
		----------	----------		----------	(%)	----------		----------	----------	----------
Untreated	--	60	0	30	25	58	0	75	83	68	2096
Abolish	2 lbs/A	95	39	40	25	70	0	95	90	90	3226
Abolish	3 lbs/A	90	50	43	15	48	20	75	93	65	4463
Abolish	4 lbs/A	100	40	40	33	50	15	80	100	75	3199
V-10029	10 g/A	91	98	100	98	100	100	100	70	100	7684
V-10029	12 g/A	70	100	100	100	100	100	100	65	100	7179
Abolish+V10029	2 lbs/A+10 g/A	94	100	100	100	100	100	100	85	100	8442
Abolish+V10029	2 lbs/A+12 g/A	86	100	100	100	100	100	100	88	100	7529
Abolish+V10029	3 lbs/A+10 g/A	96	100	100	100	98	100	100	98	98	7829
Abolish+V10029	3 lbs/A+12 g/A	84	100	100	100	100	100	100	88	95	8219
Abolish+V10029	4 lbs/A+10 g/A	100	100	100	100	100	98	100	98	100	7834
Abolish+V10029	4 lbs/A+12 g/A	94	100	100	100	100	100	100	98	100	7551
Londax	1 oz/A	100	73	68	100	100	25	100	70	100	5371
Ordram	4 lbs/A	68	8	30	8	68	8	80	93	83	1601
Londax+Ordram	1 oz/A+4 lbs/A	100	65	63	100	100	28	100	78	100	4613

[1] All applications made on 6-11, 4-5 LSR.

[2] ECHOR = watergrass; SCPMU = ricefield bulrush; HETLI = ducksalad; LEFFA = sprangletop; CYPDI = smallflower umbrellaplant.

Table 5. Results of second 1997 IR5790 trial at the RES.

				Weed control[1]			
				ECHOR	SCPMU	HETLI	CYPDI
Trt	Compound	Rate(s)	Timing[2]	(6-20)	(6-20)	(6-20)	(7-22)
		(g/A)	LSR	----------	(%)	----------	
1	Untreated			0	0	0	55
2	10EC	50	3	15	18	0	75
3	10EC	100	3	35	25	0	55
4	10EC	200	3	33	58	10	85
5	10EC	400	3	58	78	53	65
6	10EC	50	6	25	63	23	60
7	10EC	100	6	25	65	0	75
8	10EC	200	6	58	88	28	80
9	10EC	400	6	50	98	20	70
10	1G	100	4	8	28	25	60
11	1G	200	4	13	23	13	60
12	1G	300	4	3	18	10	65
13	1G	400	4	8	30	40	85
14	Londax+Ordram	1 oz/A+4 lbs/A	4	55	100	65	80

[1] ECHOR = watergrass; SCPMU = ricefield bulrush; HETLI = ducksalad; CYPDI = smallflower umbrellaplant. Data for 6-20 are means of four reps, while that for 7-22 are for two reps.

[2] *3l* application on May 19; *4l* on May 28; *6l* on June 2.

Table 6. Results for 1997 trial with Liberty (glufosinate) on transgenic rice (Bengal).

Trt	Compound(s)	Rate(s)	Timing[1]	Stand		Weed control[2]				Yield[3]
						ECHOR		SCPMU		
		(g/ha)		(6-28)	(7-24)	(6-28)	(7-24)	(6-28)	(7-24)	(lbs/A)
						(%)				
1	Untreated	--	--	93	80	25	30	23	73	879
2	Liberty	400	7 l	99	23	45	50	53	65	1948
3	Liberty	600	7 l	61	14	98	93	96	95	3024
4	Liberty	800	7 l	81	10	100	100	96	100	2981
5	Liberty	400	3-4t	68	10	24	95	25	95	2046
6	Liberty	600	3-4t	100	5	44	98	33	98	2361
7	Liberty	800	3-4t	100	13	33	100	71	100	2920
8	Liberty	400 + 400	7 + 4-5t	100	6	66	95	60	100	4097
9	Liberty	600 + 400	7 + 4-5t	93	10	46	95	20	100	3607
10	Liberty	800 + 400	7 + 4-5t	71	5	100	98	95	100	3380
11	Liberty	400 + 400	3-4t + 4-5t	80	14	49	98	20	95	3003
12	Liberty	600 + 400	3-4t + 4-5t	100	11	0	95	0	100	2096
13	Liberty	800 + 400	3-4t + 4-5t	50	14	50	98	40	100	2650
14	Liberty[4]	600	7 l	100	85	49	98	48	98	1362
15	Liberty[4]	600	--	93	40	66	85	74	90	3087
16	Liberty+F8426	400 + 60	7 l	75	11	60	63	75	100	3092
17	Liberty+F8426	400 + 120	7 l	53	8	74	78	73	93	2902
18	F8426	60	6-7 l	94	43	65	38	69	85	1385
19	F8426	120	6-7 l	100	73	3	25	75	95	905
20	Londax+Propanil	70 g/A + 4 lbs/A	6-7 l	98	5	95	93	98	100	3442

[1] l = leaf stage rice; t = tiller. *6-7l* application on June 19; *1-2t* on June 21; *3-4t* on July 1; *4-5t* on July 3.
[2] ECHOR = watergrass; SCPMU = ricefield bulrush
[3] lbs/A at 14% moisture
[4] M202, non-resistant

Table 7. Results of 1997 greenhouse trial for efficacy of RoundUp Ultra (glyphosate).

Trt	Rates	Exposure[1]	Weed control[2]		
			ECHOR	CYPDI	AMMCO
	(oz/A)		(%)		
1	Untreated	--	0	0	0
2	12	33	60	10	80
3	12	66	75	20	85
4	24	33	99	45	90
5	24	66	100	55	95

[1] Percent of plant height above water surface.
[2] ECHOR = watergrass; CYPDI = smallflower umbrellaplant; AMMCO = redstem.

Table 8. Results of 1997 trial on efficacy of Super Wham (propanil) at the RES.

Treatment[1]	Rate(s)	Injur	Weed control[2]			Yield[3]
			ECHO	SCPMU	MOOVA	
	(lbs/A)	(7-25)	(7-25)	(7-25)	(7-25)	(lbs/A)
Untreated	--	8	58	50	75	4905
Propanil	3	15	90	65	68	6528
Propanil	4	13	95	75	85	6976
Propanil	5	23	100	80	78	6395
F8426	0.11	20	80	65	68	6241
Ordram	4	1	95	55	90	6899
Londax	0.0625	4	70	73	98	7692
Londax+Ordram	0.0625+	3	88	90	100	8808
Propanil	4	25	88	90	88	6447
Propanil	5	10	85	100	100	7383
Propanil	6	10	90	100	100	7996
Whip	0.15	14	98	58	93	6264

[1] Propanil applied in mixture with 1 pt/A crop oil concentrate (Herbimax); F8426 = carfentrazone, applied with 0.25% v/v L-77 (Silwet); Londax and ordram treatments were ringed with aluminum.
[2] ECHOR = watergrass;.SCPMU = ricefield bulrush; MOOVA = monochoria (not differentiated from ducksalad).
[3] lbs/A at 14% moisture.

Table 9. Results of 1997 trial on combinations of Super Wham (propanil) with Abolish (thiobencarb) at the RES.

				Weed control[3]					
			Stand	ECHOR		SCPMU		HETL	
Treatments[1]	Rate(s)	Timing[2]	(7-6)	(7-6)	(7-22)	(7-6)	(7-22)	(7-6)	Yield[4]
	(lbs/A)		----------		(%)	----------			(lbs/A)
Untreated			75	0	28	13	90	8	2933
Abolish	4	*PPS*	100	88	63	24	53	93	5157
Propanil	4	6-7	95	97	98	100	99	100	8280
Abolish + propanil	4+4	*PPS* + 6-7	100	100	100	100	100	100	8476
Propanil	6	6-7	99	99	98	100	100	75	8426
Abolish + propanil	4+6	*PPS* + 6-7	98	100	100	100	100	100	8953
Abolish	3	3	99	90	65	83	60	53	6717
Propanil	3	3	100	99	88	96	85	28	7230
Abolish + propanil	3+3	3	98	80	90	90	94	79	7696
Abolish	4	3	100	96	95	78	70	35	7599
Propanil	4	3	100	96	80	100	89	43	8963
Abolish + propanil	4+4	3	99	100	98	96	88	99	7500
Abolish + propanil	4+4	3 + 6-7	96	100	100	100	100	100	6614
Abolish + propanil	4+6	3 + 6-7	91	50	100	55	100	63	7217
Abolish	3	6-7	98	60	35	70	85	65	1953
Propanil	3	6-7	98	93	75	100	99	98	8885
Abolish + propanil	3+3	6-7	98	95	93	93	100	75	8960
Abolish	4	6-7	100	60	33	88	98	63	3328
Propanil	4	6-7	100	97	91	99	100	88	7532
Abolish + propanil	4+4	6-7	99	94	88	100	100	95	7733

[1] Propanil applied with 1 pt/A crop oil concentrate (Herbimax) when applied without Abolish.

[2] *PPS* = preflood surface application.

[3] ECHOR = watergrass;.SCPMU = ricefield bulrush; HETLI = ducksalad.

[4] lbs/A at 14% moisture.

Table 10. Results of 1997 trial on Whip (fenoxaprop) formulations at the RES.

Treatment	Rate	Stand (7-6)	Injury (7-6)	ECHOR control[1] (7-6)	ECHOR control[1] (7-24)	Yield[2]
	(g/A)	----------	----------	(%)	----------	(lbs/A)
Untreated	--	93	0	0	0	551
EW(68.5)	20	98	8	88	60	5046
EW	26	98	10	72	90	6017
EW	32	93	15	100	98	5091
EC(80.5)	20	100	0	46	50	2107
EC	26	98	10	84	83	4509
EC	32	96	11	90	85	5763

[1] ECHOR = watergrass.

[2] lbs/A at 14% moisture.

All applications on June 19.

Table 11a. Results for the 1997 Prowl test at the RES (by U.C. Davis).

Treatment	Rate(s)	Timing[1]	Light interception[2] (6-5)	Injury (7-25)	Weed control[3] ECHOR (7-25)	SCPMU (7-25)	MOOVA (7-25)	Yield[4]
	(lbs/A)		----------	----------	(%)	----------	----------	(lbs/A)
Untreated	--	--	19	3	75	78	83	4408
Prowl	0.33	2l	12	5	100	65	80	4455
Prowl	0.50	2l	4	13	100	58	90	4015
Prowl	0.66	2l	2	14	100	60	85	3882
Prowl	1.00	2l	0	30	100	50	78	3608
Londax+Whip	0.0625+0.06	2-3t+3-4t	37	3	100	100	100	4723
Prowl	0.50	5l	30	3	88	80	78	3951
Prowl	1.00	5l	22	3	95	75	75	4179
Whip	0.06	5l	10	14	100	83	78	3851
Prowl+propanil	1 + 4	5l	16	6	90	90	88	4110

[1] l = leaf stage rice, t = tiller. 2l application on May 18; 4-5l on May 28; 2-3t on June 11; and 3-4t on July 1.

[2] Percent of incident light intercepted by the plant canopy, measured at the water surface with a sunfleck ceptometer.

[3] ECHOR = watergrass;SCPMU = ricefield bulrush; CYPDI = smallflower umbrellaplant; MOOVA = monochoria.

[4] lbs/A at 14% moisture.

Table 11b. Results for the 1997 Prowl test in Glenn County (by Rice Researchers, Inc.).

			Rice injury				Weed control[3]				
			Vigor loss	Stand[1]		Root[2]	ECHOR			LEFFA	
Treatment	Rate(s)	Timing[4]	(6-12)	(6-12)	(6-21)	(6-12)	(6-21)	(6-28)	(8-11)	(8-11)	Yield
	(lbs ai/A)	LSR	----------	----------	----------	(%)	----------	----------	----------	----------	(lbs/A)
Untreated	--	--	0	0	2	0	6	0	0	0	5581
Prowl	0.50	2	26	14	12	36	88	89	91	98	9760
Prowl	1.00	2	48	25	30	70	93	98	99	100	9890
Untreated	--	--	--	--	3	--	12	0	0	0	5842
Prowl	0.50	5	--	--	5	--	16	5	0	0	5524
Prowl	1.00	5	--	--	6	--	17	23	5	5	6965
Whip	0.13	5	--	--	28	--	97	97	99	100	8137
Prowl + Whip	1.0 + 0.125	5	--	--	11	--	97	94	98	100	8507

[1] Stand reduction.
[2] Root biomass reduction.
[3] ECHOR = watergrass; LEFFA = sprangletop.
[4] *2l* application on June 5; *5l* on June 15.
[5] lbs/A at 14% moisture.

Table 11c. Results for the 1997 Prowl test in Sutter County (by U.C. Davis).

Treatment	Rate(s)	Timing[1]	Light interception[2]	Stand	Weed control[3]					Yield[4]
					ECHOR	AMMCO	SAGMO	CYPDI	HETLI	
	(lbs/A)		(6-2)	(7-23)	(7-23)	(7-23)	(7-23)	(7-23)	(7-23)	(lbs/A)
			----------	----------	----------	(%)	----------	----------	----------	
Untreated	--	--	6	93	0	50	95	5	68	3126
Prowl	0.50	*3l*	0	25	88	33	13	0	23	2044
Prowl	0.75	*3l*	0	15	100	55	75	0	20	2232
Prowl	1.00	*3l*	0	23	88	48	90	0	38	1183
Prowl	1.50	*3l*	0	15	93	28	5	0	5	1270
Londax+Whip	0.0625 + 0.06	*2-3t+3-4t*	5	98	90	55	88	79	65	8416
Prowl	0.50	*6l*	7	94	10	88	90	8	53	4258
Prowl	1.00	*6l*	10	89	33	78	90	0	50	4403
Whip	0.13	*6l*	5	100	60	85	85	30	65	6597
Prowl+propanil	1 + 4	*6l*	2	88	88	65	90	33	53	5279

[1] *l* = leaf stage rice, *t* = tiller. *3l* application on May 21; *6l* on May 29; *2-3t* on June 10; *3-4t* on July 2.

[2] Percent of incident light intercepted by the plant canopy, measured at the soil/water surface with a sunfleck ceptometer.

[3] ECHOR = watergrass;.AMMCO = redstem; SAGMO = arrowhead; CYPDI = smallflower umbrellaplant; HETLI = ducksalad.

[4] lbs/A at 14% moisture.

Table 11d. Results for the 1997 Prowl test in Sacramento County (by John Taylor Fertilizers).

			Rice injury				Weed control[3]					
			Stand[1]		Root[2]		ECHOR			LEFFA		
Treatment	Rate(s)	Timing[4]	(5-21)	(6-4)	(5-21)	(6-4)	(5-21)	(6-4)	(6-16)	(5-21)	(6-4)	(6-16)
	(lbs ai/A)	LSR	----------				(%)					
Untreated	--	--	0	0	0	0	0	0	0	0	0	0
Prowl	0.50	2	0	0	13	7	67	33	33	73	37	30
Prowl	1.00	2	4	4	17	8	83	50	47	77	63	53
Propanil	4	2	0	0	0	0	87	70	65	53	43	30
Prowl+Propanil	1+4	2	8	8	23	7	90	88	87	90	87	87
Prowl+Abolish	1+4	2	5	5	23	7	90	77	77	90	85	83
Untreated	--	--	0	0	0	0	0	0	0	0	0	0
Prowl	0.50	4	0	0	0	0	78	50	48	63	55	50
Prowl	1.00	4	0	0	0	0	81	78	73	85	78	74
Propanil	0.13	4	0	0	0	0	78	78	76	56	55	48
Prowl+Propanil	1.0 + 0.125	4	0	0	0	0	88	80	79	85	79	78

[1] Stand reduction

[2] Root pruning

[3] ECHOR = watergrass;.LEFFA = sprangletop.

[4] *2l* application on May 12; *4l* on May 14.

Table 12. Results for the 1997 2,4-D Amine formulations trial in Butte County.

Compound	Formulation	Rate	SAGMO control	Rice stunting
		(lbs/A)	(%)	
Untreated			38	3
Hi-dep	3.8LC	0.75	49	11
Hi-dep	3.8LC	1.00	53	8
Hi-dep	3.8LC	2.00	85	5
2,4-D Amine	3.8LC	0.75	69	5
2,4-D Amine	3.8LC	2.00	68	8
NB20567	1.9LC	0.75	33	15
NB20658	4.0LC	0.75	56	8