ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
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PROJECT TITLE: Weed Control in Rice

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OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH OBJECTIVES:

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

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

III. To study the biology and physiology of rice weeds in the field, greenhouse and laboratory.

SUMMARY OF 1992 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVES:

Objective I

Develop new chemical methods of weed control in rice and improve the efficacy and safety of herbicides now in use.

New Herbicides

AC 322,140. AC 322,140 and AC 322,140 plus Ordram were evaluated for weed control in rice. AC 322,140 at rates of 0.5, 1.0 and 1.5 oz ai/A with and without Ordram (molinate) at 4 lb ai/A was evaluated for weed control and injury to rice. All applications were made May 30, at the 3ℓ stage of rice at the Rice Experiment Station, Biggs, CA. Watergrass (ECHOR) was in the 2ℓ stage of growth; ricefield bulrush (SCPMU) and smallflower umbrellaplant (CYPDI) ranged from the 2.5-3ℓ stage at the time of application. Applications of AC 322,140 and Londax (bensulfuron) were applied as a 60 DF liquid spray and Ordram was applied as a granular 10G formulation.

AC 322,140 caused early injury to the rice. Although the rice recovered by the time of the second injury rating, and produced normal yields, the early injury was marginally acceptable (Table 1). All three rates of AC 322,140 alone gave satisfactory control of ricefield bulrush, monochoria (MOOVA), and watergrass. When combined with Ordram, AC 322,140 gave broadspectrum weed control equivalent to Londax (Table 1) .

KIH 2023. KIH 2023 was tested alone for watergrass control and in combination with Londax for broadleaf control at the RES, Biggs, CA, and on the Scheidel Ranch, Pleasant Grove, CA. At Biggs, all combinations with Londax caused some injury whereas only the early treatment combinations caused injury at the Scheidel site. Broadleaf and sedge weeds were generally controlled by Londax or combinations including Londax (Tables 2 and 3). At the RES site, KIH 2023 controlled watergrass at the first (4-5ℓ), but not the second application timing (6-7ℓ). At the same site, KIH 2023 gave partial control of ricefield bulrush at the second, but not at the first application timing. Ricefield bulrush control (partial) was positively related to rate. At the Scheidel site, KIH 2023 gave good control of barnyardgrass (ECHCG) at the early (4-5ℓ), but not the late (6-7ℓ) application timing. At both sites, combinations of KIH-2023 and Londax gave broadspectrum weed control.

KIH6127. KIH 6127 was applied at 0.85 oz ai/A to dry soil prior to flooding at the RES, Biggs, CA. All combinations of KIH 6127 and Londax; Facet (quinchlorac), Ordram and Londax; or Facet, Bolero (thiobencarb) and Londax were applied to 2.5-3ℓ stage rice. After one week the flood water was removed from some of the treated plots for 7 or 14 days before reflooding.

Satisfactory watergrass control was obtained with all herbicides in all water management systems. KIH 6127 gave 80% sprangletop control when applied preflood surface and Bolero gave excellent control (95 to 100%) under drained conditions. The combination of KIH 6127 plus Londax gave excellent ricefield bulrush, smallflower umbrellaplant, and monochoria control under all 3 water management systems (Table 4). Less control was observed in the three way herbicide combinations when the floodwater was removed for 14 days. Weed control and rice yield was generally better when plots were reflooded in 7 rather than 14 days following treatment (Table 4).

Improved Uses for Existing Herbicides

Facet Combinations with Ordram, Bolero and Londax: Facet (quinchlorac) was applied alone or in combination with Ordram, Bolero, and/or Londax at the RES, Biggs, CA, at the 2-3ℓ stage of rice as a tank mixed spray solution. All treatments contained 1 qt/A crop oil concentrate (COC). The majority of watergrass was in the 3ℓ stage with some earlier germinated plants in the 5ℓ leaf stage. Ricefield bulrush was in the 1-4ℓ stage. The water depth was held at 2.5 to 4 inches at the time of application and was raised to 4 to 6 inches 48 hr following application and maintained at this level for the remainder of the growing season.

All treatments gave satisfactory watergrass control and acceptable levels of injury. The addition of Bolero at 1 and 2 lb ai/A increased sprangletop control over Facet alone and the addition of Londax increased ricefield bulrush and smallflower umbrellaplant control (Table 5).

Ordram Formulation: Two 15G Ordram formulations, named 15GR and 15GR-WF1153, were compared at the RES, Biggs, CA, at 3 and 4 lb ai/A at three timings; preplant incorporated (PPI), 2 and 4ℓ stages of rice. The purpose was to compare handling characteristics as well as efficacy of these two granules. The 15GR was similar to the 10G whereas the 15G-WF1153 was a sand core (small rock core) granule. The 15G was somewhat dusty whereas the 15G-WF1153 was dust free. Both 15G formulations were similar in postemergence weed control, but the 15G-WF1153 was considerably less active when applied PPI. (Table 6).

Preplant/Preflood Bolero and Molinate: A study was conducted at the RES, Biggs, CA, to determine if PPI Ordram 10G or preflood surface (PFS) Bolero 8E (Bolero 10G was also included, but of less interest) in combination with Londax could provide acceptable broadspectrum weed control. PPI or PFS applications may reduce off-site herbicide movement in ricefield tailwaters compared to conventional post applications as well as reduce the cost of application. Neither PPI Ordram alone nor PFS Bolero alone controlled watergrass as well as post 2ℓ stage applications (Table 7). PFS Bolero 8E alone was clearly an unacceptable treatment for watergrass (44% control). However, in combination with Londax, both PPI Ordram and PFS Bolero treatments were equivalent to conventional post combinations of granular Ordram or Bolero. These combinations provided broad spectrum control of all weeds (Table 7).

Postemergence Watergrass Control: Whip (fenoxaprop), Whip 360, KIH-2023, and Poast (sethoxydim) were evaluated at the RES, Biggs, CA, for late postemergence watergrass control. Ordram or Bolero were applied at 4 lb ai/A at the 1-2ℓ stage of watergrass as standard treatments. Londax was applied to all plots (except the untreated control) at 1 oz ai/A at the 2.5-3ℓ stage of rice.

Whip and Whip 360 were applied at the 2.8-3 *t* (tiller) stage of rice. Watergrass and sprangletop (LEFFA) were 12 to 14 inches tall and starting to tiller. KIH-2023 was applied at 0.63 and 0.85 oz ai/A with the addition of the surfactant Silwet @ 0.5 % v/v. Poast was applied at 1.2 and 2.4 oz ai/A with 1 quart/A of crop oil concentrate (COC). The second application of Whip, KIH-2023, and Poast was applied to 4.5 *t* rice. Watergrass was 18 to 20 inches tall and in the boot stage of growth; sprangletop was starting to head.

Both formulations of Whip gave excellent watergrass control at all rates and times of application (Table 8). The Whip 360 formulation caused early, but only temporary stunting of rice. KIH 2023 caused a slight yellowing of rice leaves and Poast + COC caused early stunting and some leaf tip burn to the rice at both timings.

<u>Flood Incorporation of PFS Bolero 8E</u>: Preflood surface (PFS) Bolero 8E may reduce the off-site movement of Bolero in rice field tailwaters. PFS applications may also provide convenience with ground equipment. An experiment was conducted to determine how soon after application Bolero must be flooded (incorporated) to avoid significant herbicide degradation and losses in weed control. Two rates of Bolero (4 and 6 lbs ai/A) were applied to the soil surface 0, 3, 6, 9, and 12 days before flooding. Watergrass was controlled below acceptable levels, but was highest when the herbicide was flooded at 0 and 3 days after application and lower when the application to flooding interval was extended to 6, 9 or 12 days (Table 9). Thus flooding should not be delayed when PFS Bolero 8E applications are used.

Objective II
Integrated Weed Management Systems

<u>Model Development for Weed Competition</u>: The rice growth model, CARICE, originally developed under an IPM grant, was completed and extensively experimented with during the past year. CARICE now exists in three languages (ACSL, C, and DYNAMO) and has the capability of simulating rice and weed growth under a variety of conditions.

Extensive experimentation with CARICE was carried out to predict the impact of various important weeds on rice productivity. In general, experimental manipulations supported the predictions of the model (figure 1) based on only three parameters (rice sowing density, weed density, and tiller equivalence factor—a measure of the effectiveness of a given weed in replacing rice tillers). These results verify that the most important stage for weed control is in the early stages of crop growth, before canopy closure.

During the year, CANWR, a second version of the rice model aimed more specifically at weeds was completed. This is a growth model to determine the extent to which competition for light in the canopy is the essential process of rice and weed development in water-seeded rice.

<u>Experimental Analysis for Model Support</u>: Two types of experiments were conducted; one to provide growth analysis and the second to give model validation data through the outcome of rice/weed competition. Growth analysis was needed to determine maximum rates of growth and phenological stages for use in the model. It was done for smallflower umbrellaplant,

annual arrowhead (SAGMO), and to a more limited extent, redstem (AMMCO). As in 1991, attempts to germinate and grow ricefield bulrush failed.

Growth analysis was carried out at four sites: 1) the Agronomy greenhouses, UCD, 2) the Agronomy Field Headquarters, UCD, and 3) a shade house at Environmental Horticulture, UCD. This permitted the analysis of weed growth rates under 1) optimal temperatures, 2) at temperatures where floret sterility could occur, and 3) under limited light. These experiments were initiated in June 1992 and completed in October 1992. Analysis of the arrowhead data was presented at Rice Field Day (Breen et al., 1992). These data supported the prediction of the model that annual arrowhead was not a significant factor in reducing rice productivity even though it appeared to be significant in the seedling stage in the field. Preliminary analysis for smallflower umbrellaplant and redstem is underway.

Competition experiments between rice and arrowhead and between rice and smallflower umbrellaplant were conducted with a range of weed densities in fixed (high) stands of rice. Final harvests were completed in October and the data have been partially analyzed. Smallflower umbrellaplant appears to be a much more important competitor than arrowhead, and much closer to watergrass in its impact on rice. The importance of these data is to validate the model to test whether or not it can be used on a wide range of weeds and reduce the need for extensive experimental data on every weed species found in rice.

<u>The Impact of Water- vs Drill-Seeded Rice on Weed Abundance and Competition</u>: An experiment was conducted to compare drill- vs water-seeded rice to evaluate the impact of flooded and non-flooded seedling establishment on weed abundance and control. The rationale for this work was to evaluate the possibility of reducing weed competition by breaking aquatic weed cycles with dry seedling establishment and grass weed cycles with continuous flooding. Weed control and yield were highest with the combination of Londax and Ordram regardless of the system. In drill-seeded rice the populations of grass weeds (sprangletop, barnyardgrass and watergrass) were very high and required Ordram to achieve a reasonable yield. Londax treatments had no yield due to the heavy grass pressure (note that Londax treatments at the time of the permanent flood in a drill-seeded system are too late to control grass weeds). In water-seeded rice, broadleaf/sedge populations were relatively high compared to grass (predominately watergrass) populations. Grass weed populations, however, were considerably lower in water-seeded than in drill-seeded rice. The experiment was confounded to some extent by possible movement of herbicides into ringed controls.

<u>Water Management and Facet Movement</u>: Three water management systems were established at the RES, Biggs, CA, to study Facet movement in soil. Facet was applied at 4 oz ai/A to plots with 1) 6-inch continuous flood, 2) drained/wet soil surface, and 3) drained plots after the soil surface had begun to crack. Drained/wet and drained/dry plots were reflooded in 48 hr to a depth of 6 inches and maintained throughout the season. Plots were arranged so adjacent untreated plots could be sampled to determine if Facet had moved from the treated to the untreated plots. Water samples were taken at the time of application, immediately after reflooding, and at weekly intervals for 10 weeks following reflooding in both treated and untreated plots. Watergrass control was not acceptable at this rate in any of the irrigation regimes but was best in the drained/dry treatments (Table 10). Even though Facet rates were too low to achieve watergrass control, Facet was found to move readily through the soil (Table 11ab).

Objective III
Rice Weed Biology

Greenhouse Studies of KIH 6127

Experiment 1: KIH 6127 was applied to 4 inch greenhouse pots PFS or PPI at rates of 0.42 oz, 0.85 oz and 1.27 oz ai/A. Treated pots were placed in basins and flooded to 2.4 inches above the soil surface. Soaked rice or watergrass seeds were planted into individual pots. In general, PFS treatments gave better control than did PPI treatments although the 1.27 oz rate controlled 100% of the watergrass with either PFS or PPI applications.

Experiment 2: KIH 6127 was applied at 0.85 oz ai/A to rice and watergrass at water depths of 0, 1.4 and 2.8 inches. When KIH 6127 was applied to the soil (0 water depth), to simulate drained conditions, no control was observed. At water depths of 1.4 and 2.8 inches control was increased.

Experiment 3: The addition of the surfactant Silwet @ 2 % to KIH 6127 at 0.42, 0.85 and 1.27 oz ai/A did not increase watergrass control. The 10% WP formulation of KIH 6127 was difficult to keep in solution at normal spray solution volumes.

Laboratory Studies of Perennial Arrowhead

Perennial Arrowhead (SAGLO): Laboratory studies showed 4 to 5 shoot buds located in a circular pattern on the apical end of the tuber. Although tubers germinated poorly under laboratory conditions, it was apparent that the most apical bud, and not uncommonly the second oldest bud, would break dormancy at nearly the same time to produce shoots and ultimately plants. Rarely could the remaining buds be induced to break dormancy by removing the original shoots. However, preliminary examination of the buds with light microscopy indicated that all 4 or 5 buds were completely formed and should have been able to produce viable shoots. Studies on the factors controlling germination from the tubers will be continued.

Ricefield Bulrush: Greenhouse studies have shown that ricefield bulrush can live for several seasons relying on the rhizome for regeneration of new shoots. The internodes are short and compact with generally one shoot bud at each node. The buds apparently are not strongly influenced by apical dominance and seem to continually germinate and send up shoots that ultimately terminate into flowering stalks. This characteristic is what spreads out flowering and seed production over most of the summer. Seedheads produced in the early part of the growth cycle are larger and produce more seed than seedheads produced later in the year. The rhizome appears to continue to grow throughout the season. Plants that have arisen from rhizomes require higher rates of Londax to control than plants arising from seed.

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CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Two sets of trials were conducted in aluminum rings on the RES by private companies to evaluate new experimental herbicides for rice. Additionally, three more advanced experimental herbicides, AC 322,140, KIH 2023 and KIH 6127 were evaluated for weed control. AC 322,140 controlled broadleaf and sedge weeds, but slightly injured rice. KIH 2023 provided acceptable watergrass control at the 4-5*ℓ* stage, but control was unacceptable at later stages. In previous experiments, Facet was unable to control watergrass alone, but in 1992, 4-8 oz ai/A Facet successfully controlled watergrass by itself. We have no explanation for the differences in control. As in previous years, combinations of Facet with low rates of Ordram or Bolero controlled watergrass. The application of preflood treatments of Ordram in combination with Londax was successful for the third consecutive year. Both PPI Ordram and PFS Bolero, controlled watergrass in combination with Londax in 1992. Without Londax, however, control was unacceptable. Two formulations of Ordram were tested for dust emission and efficacy. Both were approximately equal in weed control, but the 15G WF1153 was superior to the 15G in dust emission. Several herbicides including Whip, Poast and KIH 2023 were tested in combination with Londax for late postemergence grass control. These three herbicides controlled watergrass as late as the 4-5 *ℓ* stage of rice. PFS Bolero 8E was incorporated by the floodwater at different intervals. Results indicated that PFS applications should be flood incorporated within 3 days following the application.

Growth models were developed to support the evaluation of rice/weed management. The model predictions have been validated against experimental data sufficiently well to support continuing work in this area. The data indicate for a variety of weeds, that events prior to the closure of the canopy are the important determinants of the actual impact of weeds on rice productivity. Some important weeds like smallflower umbrellaplant and water-grass should be controlled as early as possible, while others like annual arrowhead, while visually important, are unlikely to have a significant impact on the rice crop.

An experiment to compare stand establishment methods with respect to weed abundance and control showed that grass weeds are highest in drill-seeded rice and aquatic weeds are highest in water-seeded rice. In drill-seeded rice, grass weed competition is very high requiring a grass herbicide to achieve a reasonable yield.

A number of greenhouse experiments were conducted to determine the best method for applying the grass herbicide, KIH 6127. In general, preflood surface (PFS) treatments were superior to post treatments and increasing water depth provided better control. Laboratory experiments showed that the most apical buds of perennial arrowhead germinate while the remaining buds remain dormant. Studies on ricefield bulrush showed that plants can regenerate from rhizomes for several seasons and that this characteristic is, in part, responsible for the almost continuous appearance of these plants throughout the season. Additionally, ricefield bulrush plants arising from rhizomes require higher rates of Londax for control.

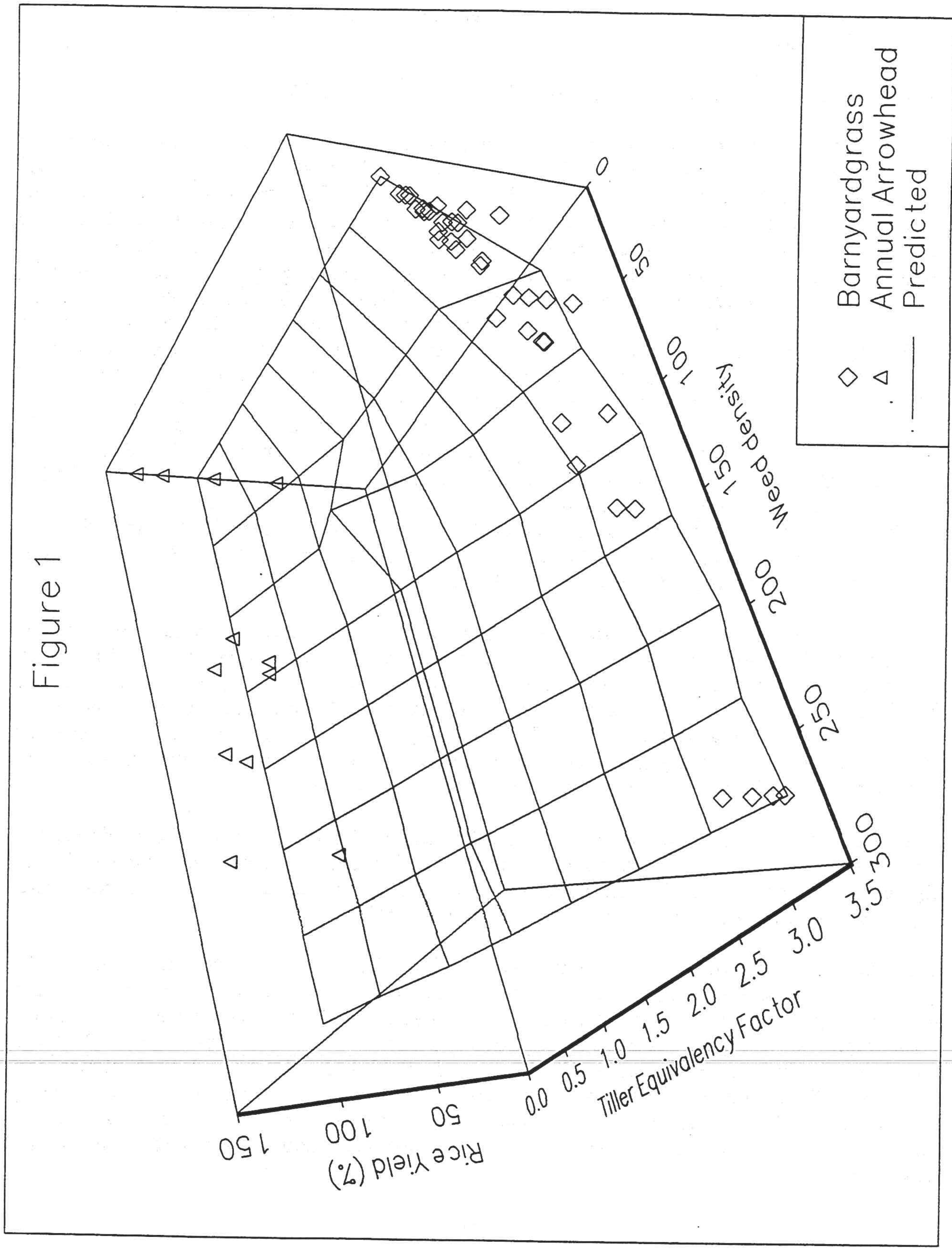

Figure 1
Barnyardgrass
Annual Arrowhead
Predicted
Weed density
0
50
100
150
200
250
300
Tiller Equivalency Factor
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Rice Yield (%)
50
100
150

Table 1. Evaluation of AC322,140 alone and in combination with Ordram for rice weed control. All applications made at the 3-leaf stage of rice.

		Rice injury		Weed control*					
				SCPMU		ECHOR	HETLI		
Treatment	Rate	(6/12)	(7/28)	(6/12)	(7/28)	(7/28)	(6/12)	Yield	Moisture
	(oz ai/A)	*(%)*		*(%)*				*(lb/A)*	*(%)*
AC322,140	0.5	10	0	100	70	80	100	9340	18.8
AC322,140	1.0	12	0	97	83	90	100	8700	18.1
AC322,140	1.5	22	0	100	93	87	100	9130	18.8
AC322,140 + Ordram	0.5 + 64.0	13	0	100	97	100	100	9730	18.0
AC322,140 + Ordram	1.0 + 64.0	22	0	100	83	90	100	10330	17.5
AC322,140 + Ordram	1.5 + 64.0	23	0	100	100	100	100	9770	18.0
Londax + Ordram	0.5 + 64.0	7	0	100	87	100	100	9790	18.4
Londax + Ordram	1.0 + 64.0	5	0	100	100	100	100	8810	17.2
Londax	1.0	8	0	100	80	87	100	9330	17.7
Ordram	64.0	5	0	95	60	100	85	8790	17.9
Untreated	—	0	0	7	7	50	1	6900	18.3
CV %		54.8	0.0	4.7	—	—	0.3	7.9	4.5
LSD (0.05)		11	NS	7	—	—	1	1230	1.4

*SCPMU = ricefield bulrush, ECHOR = watergrass, HETLI = ducksalad

Table 2. Effect of KIH2023 alone and in combination with Londax on rice and rice weeds applied at different stages of growth, Biggs RES.

Treatment	Rate	Growth stage	Rice injury (7/2)	Weed control* SCPMU (7/2)	SCPMU (9/2)	HETLI (7/2)	LEFFA (7/2)	CYPDI (7/2)	ECHOR (9/2)	Yield	Moisture
	(oz ai/A)		*(%)*	*(%)*						*(lb/A)*	*(%)*
KIH2023	0.43	4-5ℓ	0	15	20	0	28	15	96	5760	19.0
KIH2023	0.64		0	22	15	2	38	82	96	5920	18.8
KIH2023	0.86		0	8	0	0	20	42	92	5380	19.2
KIH2023	0.43	6-7ℓ	0	50	40	8	12	80	69	7610	18.9
KIH2023	0.64		0	59	58	0	55	60	66	7590	18.6
KIH2023	0.86		2	74	84	35	45	72	91	8430	18.8
Londax	1.0	2-4ℓ	2	100	100	100	10	100	76	9290	17.5
KIH2023 + Londax	0.43 + 1.0	4-5ℓ + 2-4ℓ	11	100	100	100	12	100	97	9650	18.7
KIH2023 + Londax	0.64 + 1.0		16	100	100	100	5	100	100	9610	17.8
KIH2023 + Londax	0.86 + 1.0		2	100	100	100	32	100	100	9940	18.8
KIH2023 + Londax	0.43 + 1.0	6-7ℓ + 2-4ℓ	14	100	100	100	32	100	96	9710	17.6
KIH2023 + Londax	0.64 + 1.0		16	100	100	100	50	100	100	9420	18.9
KIH2023 + Londax	0.86 + 1.0		25	100	100	100	52	100	100	9180	17.9
Ordram	64.0	2-4ℓ	0	85	88	20	100	100	100	9490	18.9
Ordram + Londax	64.0 + 1.0	2-4ℓ + 2-4ℓ	0	100	100	100	100	100	100	10190	18.0
Bolero	64.0	2ℓ	0	48	39	99	100	100	81	7880	18.6
Bolero + Londax	64.0 + 1.0	2ℓ + 2-4ℓ	0	100	100	100	100	100	99	9680	17.7
Untreated	—		0	2	10	2	28	10	0	4400	21.2
CV %			88.3	19.4	17.6	12.2	51.7	27.9	8.0	10.4	5.5
LSD (0.05)			7	19	17	10	33	32	10	1230	1.4

*SCPMU = ricefield bulrush, HETLI = ducksalad, LEFFA = sprangletop, CYPDI = smallflower umbrellaplant, ECHOR = watergrass

ℓ = leaf stage rice

Table 3. Effect of KIH2023 alone and in combination with Londax on rice and rice weeds applied at different stages of growth, Sutter County, 1992.

Treatment	Rate	Growth stage	Rice injury (7/13)	Weed control* LEFFA (7/13)	LEFFA (9/16)	CYPDI (7/13)	HETLI (7/13)	ALSPA (7/13)	AMMCO (9/16)	ECHOR (9/16)
	(oz ai/A)		*(%)*	*(%)*						
KIH2023	0.43	4-5*ℓ*	0	10	64	12	0	0	98	88
KIH2023	0.64		6	25	58	0	0	22	100	85
KIH2023	0.86		11	28	68	0	5	35	100	79
KIH2023	0.43	6-7*ℓ*	0	30	65	12	8	12	100	45
KIH2023	0.64		0	41	70	22	8	18	100	70
KIH2023	0.86		0	40	59	10	32	25	100	56
Londax	1.0	2-4*ℓ*	0	5	42	100	92	100	100	18
KIH2023 + Londax	0.43 + 1.0	4-5*ℓ* + 2-4*ℓ*	19	18	42	96	95	100	100	69
KIH2023 + Londax	0.64 + 1.0		22	18	42	98	95	100	100	52
KIH2023 + Londax	0.86 + 1.0		28	20	28	100	100	100	100	74
KIH2023 + Londax	0.43 + 1.0	6-7*ℓ* + 2-4*ℓ*	0	22	55	100	99	100	100	51
KIH2023 + Londax	0.64 + 1.0		0	10	62	100	91	100	100	32
KIH2023 + Londax	0.86 + 1.0		9	30	55	100	92	100	100	71
Ordram	64.0	2-4*ℓ*	0	95	95	70	0	20	70	100
Ordram + Londax	64.0 + 1.0	2-4*ℓ* + 2-4*ℓ*	0	100	98	100	100	100	98	100
Bolero	64.0	2*ℓ*	0	100	99	95	12	5	78	85
Bolero + Londax	64.0 + 1.0	2*ℓ* + 2-4*ℓ*	0	98	95	100	100	100	95	85
Untreated	—		0	30	72	5	2	15	100	51
CV %			116.0	38.8	26.1	19.1	20.7	22.0	10.1	25.9
LSD (0.05)			09	22	24	17	15	18	14	25

*SCPMU = ricefield bulrush, HETLI = ducksalad, LEFFA = sprangletop, CYPDI = smallflower umbrellaplant, ALSPA = water plantain, AMMCO = redstem, ECHOR = watergrass

ℓ = leaf stage rice

Table 4. Influence of water management[1] and rate and application time of combinations of KIH6127, Londax, Facet, Ordram, and Bolero for rice weed control, Biggs RES.

Treatment	Rate	Growth stage	Rice injury	Weed control[2]					Plant height	Yield
				ECHOR	LEFFA	SCPMU	CYPDI	HETLI		
	(oz ai/A)		(%)	(%)					(in)	(lb/A)
1. KIH6127	0.85	PFS	0	98	80	35	80	15	36	8060
2. KIH6127+Londax	0.85+1.0	2.5-3ℓ	0	100	25	100	100	100	35	7900
3. KIH6127+Londax	0.85+1.0	2.5-3ℓ	0	95	45	90	100	100	36	10260
4. KIH6127+Londax	0.85+1.0	2.5-3ℓ	0	100	50	100	100	100	35	9770
5. Facet+Ordram+ Londax	4.0+32.0+1.0	2.5-3ℓ	0	100	95	80	100	100	37	9910
6. Facet+Ordram+ Londax	4.0+32.0+1.0	2.5-3ℓ	0	100	80	95	100	100	35	9950
7. Facet+Ordram+ Londax	4.0+32.0+1.0	2.5-3ℓ	0	95	65	65	100	100	36	6930
8. Facet+Bolero+ Londax	4.0+32.0+1.0	2.5-3ℓ	0	90	100	90	100	100	36	7880
9. Facet+Bolero+ Londax	4.0+32.0+1.0	2.5-3ℓ	0	100	95	50	65	50	31	8180
10. Untreated	–	–	0	10	40	0	30	10	35	6900

[1]Water management treatments corresponding to herbicide treatments:

1. 6" continuous flooding
2. 6" continuous flooding
3. drain after 7 days, reflood in 7 days
4. drain after 7 days, reflood in 14 days
5. 4" continuous flood
6. drain in 7 days, reflood in 7 days
7. drain in 7 days, reflood in 14 days
8. drian in 7 days, reflood in 7 days
9. drain in 7 days, reflood in 14 days
10. 6" continuous flooding

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

ℓ = leaf stage rice

PFS = pre-flood surface

Table 5. Evaluation of Facet with crop oil concentrate in combination with Ordram, Bolero and Londax, applied at the 2-3 leaf stage of rice, Biggs RES.

Treatment	Rate	Rice injury (7/28)	Weed control* ECHOR (7/28)	LEFFA (7/28)	CYPDI (7/28)	SCPMU (7/28)	Plant height	Lodging	Yield
	(oz ai/A)	(%)	(%)				(in)	(%)	(lb/A)
Facet	4.0	0	97	87	63	3	34	20	5820
Facet	8.0	0	97	73	53	7	35	17	6910
Facet+Ordram	4.0+16.0	0	80	83	87	43	35	33	7220
Facet+Ordram	4.0+32.0	0	90	60	30	0	35	13	5060
Facet+Ordram	8.0+16.0	0	100	83	73	37	34	3	6890
Facet+Ordram	8.0+32.0	0	100	90	67	37	35	33	7280
Facet+Ordram +Londax	4.0+16.0+1.0	0	97	73	100	67	35	16	7050
Facet+Ordram +Londax	4.0+32.0+1.0	0	100	77	100	90	36	33	8780
Facet+Londax	4.0+0.5	3	65	63	83	60	35	3	6660
Facet+Londax	8.0+0.5	0	100	77	100	67	35	20	8750
Facet+Londax	4.0+1.0	0	90	70	100	87	36	0	8920
Facet+Londax	8.0+1.0	0	100	60	100	100	35	17	8720
Facet+Ordram +Londax	4.0+16.0+0.5	0	65	63	83	40	35	10	6400
Facet+Ordram +Londax	2.0+16.0+0.5	0	93	70	100	67	35	26	8050
Facet+Bolero	4.0+16.0	0	100	100	100	60	35	20	8610
Facet+Bolero	4.0+32.0	0	100	100	100	37	36	30	7700
Facet+Bolero	8.0+16.0	0	97	100	93	30	35	3	7880
Facet+Bolero	8.0+32.0	0	97	100	100	43	35	13	8200
Facet+Bolero +Londax	4.0+16.0+1.0	0	97	97	100	73	35	27	8280
Facet+Bolero +Londax	4.0+32.0+1.0	0	95	100	100	97	37	37	8320
Facet+Bolero +Londax	4.0+16.0+0.5	0	93	100	100	77	35	33	9220
Facet+Bolero +Londax	2.0+32.0+0.5	0	63	100	97	57	35	30	7560
Untreated	—	0	10	40	30	0	35	3	4280
CV %		830.7	21.7	14.3	20.0	53.1	3.7	100	18.0
LSD (0.05)		NS	31	19	28	45	2	32	2220

*ECHOR = watergrass, LEFFA = sprangletop, CYPDI = smallflower umbrellaplant, SCPMU = ricefield bulrush

Table 6. A comparison of Ordram formulations on rice weed control, Biggs RES.

Treatment	Rate	Growth stage	Weed control* SCPMU (7/2)	SCPMU (9/2)	HETLI (7/2)	LEFFA (7/2)	CYPDI (7/2)	ECHOR (9/2)	Yield	Moisture
	(oz ai/A)		(%)						(lb/A)	(%)
Ordram 15GR WF1153	64.0	PPI	23	20	0	13	27	90	5160	17.6
Ordram 15GR	64.0	PPI	55	60	0	100	100	93	6210	15.9
Ordram 15GR WF1153	48.0	2ℓ	88	75	17	100	100	99	7480	16.0
Ordram 15GR	48.0	2ℓ	90	95	3	100	100	98	7550	15.9
Ordram 15GR WF1153	64.0	2ℓ	83	78	0	100	100	100	7410	15.1
Ordram 15GR	64.0	2ℓ	86	78	17	100	100	100	8100	15.6
Ordram 15GR WF1153	64.0	4ℓ	68	77	7	100	60	90	7730	15.8
Ordram 15GR	64.0	4ℓ	62	58	0	83	37	95	7110	16.8
Untreated	—	—	17	10	0	27	43	3	4250	20.6
CV %			31.9	34.6	238.2	9.8	45.4	5.9	10.5	15.3
LSD (0.05)			35	37	NS	14	58	9	1230	NS

*SCPMU = ricefield bulrush, HETLI = ducksalad, LEFFA = sprangletop, CYPDI = smallflower umbrellaplant, ECHOR = watergrass

PPI = Preplant incorporated

ℓ = leaf stage rice

Table 7. Effects of preplant Ordram and Bolero in combination with Londax on rice and rice weed control, Biggs RES.

Treatment	Rate	Growth stage	Rice injury (6/8)	Weed control* SCPMU (6/8)	SCPMU (9/2)	HETLI (6/8)	ECHOR (9/2)	Yield	Moisture
	(oz ai/A)		(%)	(%)				(lb/A)	(%)
Bolero 8E	64.0	PFS	0	42	12	59	44	5870	19.4
Bolero 10G	64.0	PFS	0	42	10	46	38	6420	19.8
Bolero 8E + Londax	64.0 + 1.0	PFS + 2ℓ	9	100	100	100	99	10130	16.8
Bolero 10G + Londax	64.0 + 1.0	2ℓ + 2ℓ	0	100	100	100	100	9700	17.7
Ordram 10G	64.0	PPI	0	28	48	5	89	7460	18.8
Ordram 10G	64.0	2ℓ	9	88	85	52	100	9100	17.2
Ordram + Londax	64.0 + 1.0	PPI + 2ℓ	8	100	100	100	100	10050	17.6
Ordram + Londax	64.0 + 1.0	2ℓ + 2ℓ	14	100	100	100	100	10130	17.3
Londax	1.0	2ℓ	5	100	100	100	92	9740	17.4
Bolero 10G	64.0	2ℓ	2	81	62	86	79	9060	18.1
Untreated			0	2	8	0	2	5140	19.2
CV %			131.2	16.1	11.7	28.9	8.8	8.8	5.5
LSD (0.05)			8	17	11	28	10	1080	1.4

*SCPMU = ricefield bulrush, HETLI = ducksalad, ECHOR = watergrass

ℓ = leaf stage rice

PFS = pre-flood surface

PPI = Preplant incorporated

Table 8. Evaluation of Whip, Whip 360, KIH2023, and Poast in combination with Londax for weed control in rice, Biggs RES.

Treatment	Rate	Growth stage	Rice injury (7/7)	Rice injury (7/28)	Weed control* ECHOR (7/28)	Weed control* LEFFA (7/28)	Weed control* SCPMU (7/28)	Plant height	Lodging	Yield
	(oz ai/A)		---- (%) ----		---- (%) ----			(in)	(%)	(lb/A)
Londax+Whip	1.0+2.0	2ℓ+2-3t	2	0	96	91	93	34	58	7250
Londax+Whip 360	1.0+0.85	2ℓ+2-3t	5	0	98	100	94	33	38	7920
Londax+Whip+Whip	1.0+1.3+1.6	2ℓ+2.3t+4-5t	5	0	98	93	100	33	53	7500
Londax+Whip 360	1.0+1.1	2ℓ+4-5t	0	5	95	95	100	35	20	8660
Londax+Whip 360	1.0+1.3	2ℓ+4-5t	0	5	100	90	95	33	10	7710
Londax+Whip 360 +Whip 360	1.0+0.6+0.8	2ℓ+2-3t+4-5t	5	0	98	99	90	34	40	7770
Londax+Ordram	1.0+64.0	2ℓ+2ℓ	0	0	100	100	100	35	40	8740
Londax+Bolero	1.0+64.0	2ℓ+2ℓ	0	0	76	100	100	35	37	8970
Londax+Whip	1.0+2.4	2ℓ+2-3t	0	0	99	96	94	34	52	7400
Londax+Whip	1.0+1.6	2ℓ+2-3tr	2	0	94	90	100	35	60	7230
Londax+Whip 360	1.0+1.1	2ℓ+2-3t	10	2	94	98	87	35	42	7710
Londax+Whip 360	1.0+0.8	2ℓ+2-3t	5	0	94	98	97	35	47	7720
Londax+KIH2023	1.0+0.6	2ℓ+2-3t	2	0	100	70	100	34	50	7120
Londax+KIH2023	1.0+0.85	2ℓ+2-3t	2	0	99	71	100	34	67	7070
Londax+Poast	1.0+1.2	2ℓ+2-3t	5	0	85	68	85	36	22	8520
Londax+Poast	1.0+2.4	2ℓ+2-3t	10	2	100	83	80	35	25	7190
Londax+KIH2023	1.0+0.6	2ℓ+4-5t	0	0	90	68	100	35	45	7500
Londax+KIH2023	1.0+0.85	2ℓ+4-5t	0	2	94	65	100	35	37	7000
Londax+Poast	1.0+1.2	2ℓ+4-5t	0	6	87	93	85	34	24	6710
Londax+Poast	1.0+2.4	2ℓ+4-5t	0	13	99	93	98	33	48	7440
Londax+Whip	1.0+2.4	2ℓ+4-5t	0	2	98	80	100	35	35	8310
Londax+Whip	1.0+3.2	2ℓ+4-5t	0	5	100	95	93	34	37	7090
Untreated	—	—	0	0	28	63	45	35	25	6380
CV %			—	356.8	12.9	10.4	13.9	3.9	61.3	12.5
LSD (0.05)			—	NS	17	13	18	2	NS	1340

*ECHOR = watergrass, LEFFA = sprangletop, SCPMU = ricefield bulrush
ℓ = leaf stage rice
t = tillers

Table 9. Timing of flood incorporation following different rates of PFS Bolero 8E.

Treatment	Rate	Flood timing	ECHOR[1] control	Yield
	(lb ai/A)	*(DAT)*[1]	*(%)*	*(lb/A)*
Bolero	4	0	55	5450
	6		73	5990
Bolero	4	3	43	6040
	6		62	5930
Bolero	4	6	25	5150
	6		48	5200
Bolero	4	9	20	4730
	6		48	5200
Bolero	4	12	27	4790
	6		48	4400

[1]DAT = days after treatment
[2]ECHOR = watergrass

Table 10. Weed control and movement of Facet under different water management[1]

Treatment	Rate	Weed control[2]			Yield
		ECHOR	LEFFA	SCPMU	
	(oz ai/A)	(%)			*(lb/A)*
1. Facet	4	55	40	30	5400
2. Facet	4	50	45	35	5170
3. Facet	4	70	70	0	5400
4. Untreated		10	40	0	4280

[1]Water management treatment corresponding toherbicide treatments:
1. 6" continuous flooding
2. soil surface wet
3. soil surface dry
4. 6" continuous flooding

[2]ECHOR = watergrass, LEFFA = sprangletop, SCPMU = ricefield bulrush

Table 11a. Facet found in adjacent plots to treated plots applied into the water.

Sample interval week	Depth in the soil		
	Surface	3 inch	6 inch
	——— ppb quinchlorac ———		
1	14	30	16
2	20	40	32
3	23	35	26
4	19	42	38
5	18	37	34
6	14	29	27
7	12	19	21

Table 11b. Facet found in adjacent plots to treated plots applied on the soil surface and then flooded.

Sample interval week	Depth in the soil		
	Surface	3 inch	6 inch
	——— ppb quinchlorac ———		
1	18	15	10
2	33	39	32
3	36	47	41
4	27	40	20
5	13	19	18
6	10	15	19
7	10	15	21