COMPREHENSIVE RESEARCH ON RICE

ANNUAL REPORT
January 1, 1996 - December 31, 1996

PROJECT TITLE: Weed Control in Rice

PROJECT LEADERS AND PRINCIPAL UC INVESTIGATORS:

Project Leaders
D.E. Bayer, Professor, Weed Science Program, Department of Vegetable Crops, UCD
J.E. Hill, Extension Agronomist, Department of Agronomy and Range Science, UCD

Principal UC Investigators
E. Roncoroni, Staff Research Associate, Department of Vegetable Crops, UCD
D. Brandon, Research Assistant, Weed Science Program
D. Roush, Research Assistant, Weed Science Program
S. C. Scardaci, Farm Advisor, Colusa County
J. F. Williams, Farm Advisor, Sutter/Yuba County
R. G. Mutters, Farm Advisor, Butte County.

LEVEL OF 1996 FUNDING: $85,345

OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH OBJECTIVES:

I. To integrate new and existing herbicides and cultural practices for weed control in California rice.
II To study the biology and physiology of rice weeds in the field, greenhouse, and laboratory.
III. To study the phytotoxic effects of herbicide movement from rice fields.
IV. To study Londax-resistant weeds and develop a strategy for their management and control.

SUMMARY OF 1996 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVES:

OBJECTIVE I: ***To integrate new and existing herbicides and cultural practices for weed control in California rice.***

New Herbicides

Carfentrazone (F-8426). Experiments were established at four locations to evaluate carfentrazone (previously F-8426); at the RES, and in Colusa, Sutter and Yuba counties. At the RES, three rates of carfentrazone were applied at five growth stages of rice and rice weeds (Table 5a). The first was applied preflood surface (PFS) at rates of 0.06, 0.12 and 0.18 lb ai/A. All but the PFS treatment was compared to Londax as a standard. Rates of 0.05, 0.1 and 0.2 lb ai/A were applied into the flood water at the 3-leaf (*3l*) stage of rice. The third and fourth applications were to both flooded and

drained plots at the *4l* and *5l* growth stages. The fifth and last timing was applied to 1-tiller (*1t)*) rice with water lowered to two inches. A surfactant (L-77; 0.25% v/v) was added to all treatments at the third through fifth application timings. Carfentrazone gave satisfactory control of broadleaf and sedge weeds at all rates and timings in this experiment (Table 5ab). However, weeds were at low populations on the RES making the data difficult to interpret. PFS and into-the- water applications did not injure rice. However, applications directly to the rice foliage showed transient injury as small reddish-brown spots on the leaf surface.

In Colusa and Sutter counties carfentrazone was applied at 0.05, 0.10 and 0.15 lb ai/A at the *6 and 8l* stage respectively (early tillering) and in Yuba County at both the *5.2 and 6.5l* stages. The flood water was drained at all locations and L-77 surfactant (0.5% v/v) was used to ensure good coverage. A single aluminum ring set near the plot area was treated with Londax to determine if the weeds in the area were resistant. Smallflower umbrella sedge and possibly ricefield bulrush at the Yuba site showed resistance. The results of these tests are shown in tables 2, 3 and 4. Not all weed species were present at every site. In general, carfentrazone gave excellent control of California arrowhead, ricefield bulrush, redstem, and water plantain; very good control of smallflower umbrella sedge; and poor to no control of ducksalad. Rice injury was light to moderate as reddish brown spots to substantial necrosis, but was restricted to exposed leaves and not to new growth. Hence, rice recovery was complete in seven to ten days.

V-10029 rate and timing alone or in combination with Londax, Grandstand, Bolero, 2,4-D Amine or F-8426. V-10029 has been evaluated for several years at the RES and in UCD greenhouses as a mid-to-late postemergence foliar application for watergrass and barnyardgrass control. Previously we determined that applications should include a surfactant, therefore all V-10029 applications included the surfactant L-77 (0.25% v/v). In 1996, V-10029 was applied alone or in combination with Londax, Grandstand, Bolero, 2,4-D Amine or F-8426 at three growth stages; *5l to 1-t*, *1.5-t*, and *3-t*. The flood water was lowered to 2 inches for applications made at the *5l to 1t* and *1.5t* stages to expose 70 % of the weed foliage; the water was not lowered for the *3-t* application. V-10029 controlled watergrass at 16 g ai/A or above at all timings. The lowest rate (8 g ai/A) did not satisfactorily control watergrass at any timing (Table 5a). The next lowest rate (12 g ai/A) appeared to be at the break point, giving better control at the early timing but poorer control with the later applications as the weeds got larger. In contrast to watergrass, all rates of V-10029 gave excellent control of ricefield bulrush at the *5l to 1t* stage of rice but control decreased with later applications. The combinations of V-10029 + Londax at the *5l to 1t*, and *1.5t* timings controlled watergrass, ricefield bulrush, smallflower umbrella sedge and monochoria with little or no increase in rice injury. The combination of V-10029 + Grandstand also gave excellent broad-spectrum control at the earlier timings but control decreased with the later timing. The combinations of V-10029 + F-8426 or 2,4-D also increased control of ricefield bulrush, smallflower umbrella sedge and monochoria at the *1.5t* stage but control decreased with the later timing. The sequential treatments of Bolero 10G to V-10029 at 12 g ai/A did not have a major impact on watergrass or sprangletop control over V-10029 alone. All treatments made at the *5l to 1t* timing gave higher yields than treatments at the later timings (Table 5b).

Dithiopyr. Dithiopyr was applied PFS and at three postemergence stages of rice development. PFS application of dithiopyr prevented normal root development on germinating rice seedlings causing severe rice injury and stand reduction (Table 1a). The PFS applications controlled both watergrass and sprangletop but did not control ricefield bulrush. The postemergence applications were less phytotoxic to rice but did not control watergrass and sprangletop--especially at the later *2.5l* and *4l* growth stages. The combination of dithiopyr + Londax increased ricefield bulrush control but watergrass and sprangletop control was unsatisfactory.

Liberty (glufosinate). Glufosinate is a broad-spectrum herbicide previously used in non-crop and selected crop situations, but not in rice. Glufosinate is highly phytotoxic to most plants including rice, but through genetic engineering, resistance to the herbicide can be introduced to rice. This is a relatively new technology only now being commercialized in a few major crops. We were able to obtain seed for large scale testing from Louisiana State University using the variety koshihikari. Glufosinate was applied postemergence at 300, 600 and 900 g ai/A (0.27, 0.54 and 0.81 lb ai/A) at *6-7l* rice, midtillering (*mt*), at late tillering (*lt*) and as a split application at *6-7l* followed by a second application at *lt*. The field was drained for the *6-7l* treatment to assure adequate contact with the foliage. Ricefield bulrush (the principal species present) was not adequately controlled with single applications, although the two later treatments were generally better than the earliest treatment (Table 7). The split application provided very good control at the two higher rates. In this experiment ricefield bulrush was controlled at the *6-7l* treatment, but these plots were subsequently reinfested by newly germinated seed. Weeds were advanced in growth at the later treatment stages causing problems with spray coverage. The split applications controlled two cohorts of ricefield bulrush, all at small and early stages of growth thus providing the best treatment. All plots with herbicide-resistant rice showed some injury from the herbicide. Test plots of non-resistant koshihikari were severely injured. The ricefield bulrush was at extremely high populations (> 1000 plants/m^2) in these plots. Furthermore, low seeding rates of approximately 100 lb/A were planted because seed was limited. Koshihikari is a tall variety and lodged throughout the trial accounting for the low yields. Despite these shortcomings, the concept of glufosinate-resistant rice in a well-adapted California variety holds considerable promise.

Existing Herbicides and Combinations

2,4-D Formulations. Four formulations of 2,4-D Amine were evaluated in rice for control of ricefield bulrush, smallflower umbrella sedge and monochoria and for rice injury. The granular formulation of 2,4-D Amine was applied into the floodwater at rates of 0.5, 1.0 and 1.5 lb ai/A at the *4l* and *1t* rice stage. Ricefield bulrush was 6 to 7 inches tall at the first application. The granular formulation did not injure the rice but did not control the broadleaf or sedge weeds at either timing (Table 8a).

The Hi-Dep and Solutions formulations were compared with the liquid amine formulation of 2,4-D at *1t* and *2t* growth stages of rice. All 2,4-D treatments were applied in 10 gallons per acre (GPA) of spray solution at rates of 0.75, 1, and 1.5 lb ai/A. Prior to the application the floodwater was lowered to 2-3 inches to expose the rice weeds. At the *1t* stage, all formulations completely controlled ricefield bulrush and gave satisfactory control of smallflower umbrella sedge and monochoria (Table 8a). Some injury was observed on rice roots. The floodwater was raised to 6

inches 24 hours after the applications. At the time of the *2-t* treatments ricefield bulrush was well-tillered but had not started to flower. All rates of HI-Dep gave excellent control of ricefield bulrush and 90% or better control of smallflower umbrella sedge and monochoria.

Both the Solutions and standard amine formulations of 2,4-D controlled 100% ricefield bulrush at the 1.0 and 1.5 lb ai/A rates. Control of smallflower umbrellaplant and monochoria was less than for Hi-Dep.

The entire basin was treated with Ordram at 4 lb ai/A at the *2l* stage for watergrass control but a heavy population of late invading watergrass was not controlled and caused severe yield reductions in all treatments (Table 8).

Grandstand (trichlopyr). Grandstand was evaluated at three locations at the RES to determine its efficacy as well as its potential for rice injury. Ordram was applied at the first location (Table 9a) at 4 lb ai/A at the 2- to 3-leaf growth stage of watergrass. Grandstand was applied when the rice was at *4l* and the *2t* growth stages. The second location (Table 9b) was treated with a combination of Ordram (4 lb ai/A) plus Londax (0.0625 lb ai/A) when the rice was *2-3l* growth stage to provide a weed free area. Grandstand or tank mixes of Grandstand plus 2,4-D amine were applied 30 days after seeding (DAS) when the rice was in the *1t* growth stage or 40 DAS when the rice was well-tillered. The weeds failed to germinate and grow in the third location, (Table 7c) so it was not necessary to use other herbicides to create a weed-free plot. Grandstand or tank mixes of Grandstand plus 2,4-D amine were applied when the rice was in the *1t* or *2.5-3t* growth stage. Floodwater was lowered for all treatments to expose at least 70% of the weed foliage. All applications were made using a volume of 20 GPA.

In the first location a heavy infestation of late watergrass invaded the plot area and significantly reduced rice yields. The best control was achieved when Grandstand was applied at the *4l* stage and weeds were small. Weed control was also better when COC or L-77 were added (Table 9a). In the weed-free area (second location) the addition of low rates of 2,4-D amine did not have an adverse affect on rice yields (Table 9b). At the third location where weed infestations were limited rice yields were reduced as applications were delayed from the *1t* stage to the *2.5- 3t* stage of rice, (Table 9d).

Abolish (thiobencarb) or Ordram (molinate) alone or in combination with Bolero (thiobencarb) or Ordram. PFS of Abolish at 2 or 4 lb ai/A or Ordram 8E at 3 lb ai/A were applied alone or in sequential combinations with Bolero or Ordram at the *2l* stage of rice. The combination of Abolish at 2 lb ai/A + Ordram at 2lb ai/A or Abolish at 4 lb ai/A and Ordram at 4 lb ai/A provided satisfactory watergrass control. Abolish applied to the soil PFS showed slight injury but the rice recovered. The combination of Ordram applied PFS followed by Ordram postflood at the *2l* stage of rice increased watergrass control over the Ordram followed by Bolero combinations. Sprangletop was not a significant weed problem in this experiment.

Whip (fenoxaprop) alone or with adjuvants (Kenetic, X-77 or Crop Oil Concentrate). Whip and Whip + additives were applied to *1t* and *3t* growth stages of rice. The entire plot area was treated with Londax at 0.0625 lb ai/A (1 oz ai/A) at the *2l* stage to control broadleaf and sedge weeds. When

the rice was in the *5l* stage and starting to tiller the floodwater was lowered to 2-3 inches to expose at least 70% of the watergrass and sprangletop foliage. Whip was applied at the rate of 0.075 lb ai/A alone or in combination with Kenetic, X-77, or crop oil concentrate (COC). The floodwater was returned to a depth of 5-6 inches 48 hours after the treatments. At the *3t* timing it was not necessary to lower the floodwater because the grass weeds had 70% of the foliage exposed above the water.

The early application of Whip at 0.075 lb ai/A did not control watergrass and the addition of Kenetic or X-77 did not increase control (Table 11). The addition of COC caused a slight reduction in both watergrass and sprangletop control over Whip alone. At the *3t* timing the 0.15 lb ai/A rate of Whip alone did not provide satisfactory control of watergrass or sprangletop. The addition of Kenetic to Whip at 0.15 lb ai/A increased watergrass and sprangletop control, especially at 0.25% v/v. Grass control was enhanced by both X-77 and COC but control was generally slightly less than the best Kenetic treatment. Combinations of Whip at 0.2 lb ai/A plus Kenetic gave similar control at the different surfactant concentrations. As the concentration of X-77 increased the watergrass control increased. The level of watergrass control decreased slightly as the concentration of COC increased. All Treatments applied to *3t* rice caused leaf tip burn but the rice soon recovered.

Pinpoint Flood

Postemergence applications of Abolish alone or in combinations with F-8426, V-10029, Whip, Londax (bensulfuron), Mon-1200, Grandstand, 2,4-D, or MCPA. Rice was water-seeded and drained to simulate the pin-point flood production practice. Floodwater was removed at the *½-1l* stage of rice and the field was allowed to drain completely. Abolish alone, or tank mixes of Abolish and F-8426, V-10029, or Whip, were applied to *2l* rice. The field was reflooded 48 hr after the Abolish treatment and Londax or Mon- 1200 was applied to plots previously treated with Abolish. Once the rice had reached the *1t* stage and the ricefield bulrush was 8 inches tall the floodwater was lowered to expose 70% of the weed foliage and sequential foliar treatments of F-8426, Grandstand, V-10029, 2,4-D amine , Grandstand + 2,4-D amine or MCPA +2,4-D amine were applied.

Late spring rains just prior to flooding and seeding allowed the watergrass, sprangletop and some barnyardgrass to become established and was too large for the Abolish treatment to be effective, Table 12a. The tank mix applications of V-10029 + L-77 gave satisfactory watergrass control. The combination of Abolish + Whip controlled sprangletop, but not watergrass. The combinations including Londax or F-8426 controlled all the broadleaf and sedge weeds except the combination including F-8426 did not control ducksalad. The combination of MCPA + 2,4-D amine applied at the *1t* growth stage gave complete control of the broadleaf and sedge weeds. Other combinations including 2,4-D amine or Grandstand gave satisfactory control of the broadleaf and sedge weeds.

Combinations of Abolish plus V-10029 were among the treatments that provided the highest rice yields, Table 12b.

A comparison of postflood treatments of Abolish and/or other combinations in the pinpoint flood system. At the *½-1l* leaf stage of water-seeded rice the floodwater was drained and the field was allowed to dry. The herbicides were applied at *3l* rice and the water was returned 24 hr following the applications. V- 10029 + Abolish, V-10029 + Londax, V-10029 + Prowl and V-10029

+ F-8426 provided satisfactory watergrass and barnyardgrass control and good to excellent broad-spectrum sedge and broadleaf control (Table 13a). V-10029 provided excellent control of established watergrass and barnyardgrass present at the time of application and the soil residual herbicides prevented the invasion of late emerging watergrass. Combinations with F-8426 provided nearly equivalent control of ricefield bulrush, smallflower umbrella sedge and monochoria as did the combination with Londax. All treatments with Prowl gave 27-30% rice injury from which the rice was unable to recover.

OBJECTIVE II: To study the biology and physiology of rice weeds in the field, greenhouse and laboratory.

Dithiopyr. Dithiopyr was evaluated in the greenhouse for the control of watergrass, Londax-resistant smallflower umbrella sedge, and for its effect on rice. When applied early to very small weeds ¼ inch to ½ inch tall, the Londax-resistant smallflower umbrella sedge showed some dithiopyr symptoms at the higher rates of 0.25 and 0.5 lb ai/A but were not controlled. The susceptible smallflower umbrella sedge was controlled at these higher rates. Germination of the watergrass was poor but control was incomplete. Rice appeared to grow normally. We concluded that dithiopyr did not satisfactorily control Londax-resistant smallflower umbrella sedge although the susceptible biotype was controlled. The control of watergrass was questionable. Subsequent field experiments proved this to be true (see above).

Pursuit. Pursuit was evaluated at 0.015, 0.03 and 0.06 lb ai/A on Londax-resistant and susceptible smallflower umbrella sedge, early watergrass and rice in the greenhouse. Applications were made postemergence when the smallflower umbrella sedge was approximately 1 inch tall, early watergrass approximately 2 inches tall and rice approximately 2 inches tall. Susceptible smallflower umbrella sedge was severely stunted and dying in the 0.015 lb ai/A treatments and were completely killed in all other treatments. The Londax-resistant smallflower umbrella sedge showed some stunting at the 0.03 lb ai/A rate but were not killed. However, at the 0.06 lb ai/A rate all smallflower umbrella sedge plants were dead. Both early watergrass and rice showed only mild herbicide symptoms at the maximum rate used. The conclusion from this study was that Pursuit shows promise for selective smallflower umbrella sedge control in rice but application needs to be made early when the weeds are very small.

Herbicide-resistant Watergrass. Seed was collected from a field in Glenn County where proper field applications of Whip failed to control watergrass. In the greenhouse, Whip at 0.05, 0.07, 0.1 and 0.2 lb ai/A and V-10029 + L-77 at 12 grams ai/A + 0.25% were compared on non-resistant early watergrass and the 'resistant watergrass' (RW) collection. Early watergrass showed approximately 50% reduction in growth when treated with Whip at 0.05 lb ai/A and was completely killed by Whip at or above 0.07 lb ai/A and with V-10029 at 12 grams ai/A. The RW was completely tolerant of Whip at all rates showing no symptoms. The RW showed some symptoms from the V-10029 treatments but was not controlled. We concluded that this biotype of watergrass is tolerant of foliar applications of Whip even at the highest use rates. This same biotype appears to be tolerant of V-10029.

RW was treated with Abolish at 4 and 16 lb ai/A (PFS) and Ordram at 4 and 16 lb ai/A (PPI). RW treated with either Abolish or Ordram at 4 lb ai/A showed some stunting and yellowing but was not controlled. Both Abolish and Ordram controlled RW only when applied at 16 lb ai/A. When these herbicides were applied at the 2-leaf stage, RW was unaffected by 4 lb ai/A and showed only moderate symptoms at 16 lb ai/A with none of the plants killed. We concluded that this biotype of watergrass is tolerant to both

Londax-resistant smallflower umbrella sedge. Greenhouse and laboratory studies have shown that several biotypes of smallflower umbrella sedge are resistant to Londax. Each biotype has slightly different germination requirements and grow differently at given temperatures. We have been able to quantify the analytical procedure used to determine ALS (acetolactate synthase) activity and using this technique have shown that there are at least 3 different levels of resistance to Londax. This has also been verified by growth studies in the greenhouse. The one biotype shown to be the most resistant to Londax appears to be more vigorous than the Londax susceptible biotype.

OBJECTIVE III: To study the phytotoxic effects of herbicide movement from rice fields.

Propanil drift. Two trials were conducted to measure the off-target movement of propanil during application and for a 3 day period following treatment. In both studies cotton plants were used to detect off-target movement and in one study high volume air samplers were also used to detect off-target movement. Cotton plants placed in the field at time of application were completely defoliated and died. Cotton plants placed within 150 feet down wind of the treated area showed 50% leaf with propanil symptoms. Some of the severely mottled leaves turned necrotic but most remained attached to the plant and the plant continued to grow. New leaves did not show propanil symptoms. Cotton plants located beyond 150 feet downwind from the treated area had fewer propanil symptoms shown as small discrete yellowish spots. The concentration of propanil in the air was rapidly dissipated as the distance from the point of application increased shown by fewer spots on the cotton leaves and by the area of the leaf affected.

Lift-off or movement of the propanil following application was monitored starting 30 minutes after the application and continued for 3 days. Small amounts of propanil were dislodged from the treated rice plants following the application and transported in the air. The concentration in the air decreased both as distance from the treated area increased and with time after the application. The conclusion from these studies suggested that a large majority of the off-target movement of propanil occurred during the application and that far less moved off-target as lift-off. The concentration in the air decreased as distance from the treated field increased and as time after application increased.

2,4-D drift. A trial was conducted to measure the off-target movement of 2,4-D amine during application and for a three day period following treatment. Cotton plants and high volume air samplers were used to detect off-target movement. Three types of aircraft were used to apply the 2,4-D amine; an AgCat fixed wing airplane, a Bell Jet Ranger helicopter, and a HU-1B helicopter. The AgCat was equipped with 6520 fan-type nozzles and flew one plot at 110 mi/hr and a second plot at 90 mi/hr. The Bell Jet Ranger was equipped with D-8 jet nozzles directed straight back and flew at 60 mi/hr. The HU-1B was equipped with Acu-Flo 2832 nozzles and flew at 50 mi/hr. The off-

target movement of 2,4-D amine was nearly identical for the two plots flown with the AgCat fixed wing airplane as measured by either the air samplers or the cotton plants. There was significantly less off-target movement of 2,4-D amine from the application with the Bell Jet Ranger and HU-1B helicopters when compared with the AgCat fixed wing airplane. The large difference in off-target movement during application between the AgCat fixed wing airplane and the helicopters can be related to the type of nozzles used and the higher air- sheer due to the forward velocity of the fixed wing aircraft.

Lift-off or movement of 2,4-D amine was monitored beginning 30 minutes following the end of the application and continued for three days. A small amount of 2,4-D amine moved from the treated field following application and was transported in the air. The concentration in the air decreased both as distance from the treated field increased and with time after application. We concluded that application of 2,4-D amine is critical and that the majority of off-target movement of 2,4-D amine occurs at this time and that a lesser component is subject to off-target lift- off. The concentration in the air decreased as distance from the treated field increased and as time after application increased.

OBJECTIVE IV: To study Londax-resistant weeds and develop a strategy for their management and control.

We proposed to study combinations and rates of Londax in two field studies in 1996. However, relatively heavy rainfall in the middle of the planting season made fields unsuitable for these studies. Hence, this objective could not be accomplished.

PUBLICATIONS OR REPORTS:

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CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

With rapidly increasing resistance of rice weeds to Londax, this year's research focused on accelerating our knowledge of possible replacement herbicides. Carfentrazone, formerly F-8426,

was tested on the Rice Experiment Station and at three on-farm sites in Colusa, Sutter and Yuba counties. This FMC product, slated for full registration in 1999, controlled all four weed species currently showing resistance to Londax. Control was excellent on ricefield bulrush, California arrowhead and redstem, and very good on smallflower umbrella sedge, but did not control ducksalad. At the Sutter County site, water plantain was also controlled. Carfentrazone was active as a foliar spray requiring that the water be lowered for good coverage. Granular formulations are in the early stages of testing. Rice showed some initial injury as reddish brown spotting, but quickly recovered. Additional studies were carried out with V-10029 (Valent), a promising watergrass/barnyardgrass herbicide. Several "old" herbicides were tested to support re-registration or add needed performance information. These included MCPA, 2,4-D, trichlopyr (Grandstand) and Whip. Project leaders cooperated in three drift studies, two with new formulations of propanil to assist in the expansion of the propanil use zones, and one with 2,4-D to assess differences in drift potential from fixed-wing and helicopters applications. Drift was considerably higher with fixed-wing than with helicopter applications. Collections of Londax-resistant weeds were tested in the greenhouse and showed a variable response to Londax indicating that more than one mechanism may be confer resistance. Greenhouse studies were also conducted to evaluate possible herbicides for Londax-resistant weeds with Pursuit showing some initial promise. Finally, suspected watergrass resistance was tested on late watergrass populations collected from Glenn County. These tests indicated that some populations of watergrass may have developed at least partial resistance to Whip, Ordram and Abolish/Bolero.

Table 1a. Evaluations for F-8426 rate and timing for weed control and rice injury.

				Weed Control [2]					Rice Injury	
				ECHOR	LEFFA	SCPMU	CYPDI	HETLI		
Treatment	Water Depth	Rate	Timing [1]	(8/22)	(8/22)	(8/22)	(8/22)	(8/22)	(7/20)	(8/22)
	(inches)	(lb ai/A)		(%)	(%)	(%)	(%)	(%)	(%)	(%)
F-8426	preflood	0.06	*PFS*	63	93	80	87	93	3	0
F-8426	preflood	0.12	*PFS*	87	100	80	80	97	0	0
F-8426	preflood	0.18	*PFS*	83	97	87	90	100	3	0
F-8426	4 inch water	0.05	3 *l*	50	93	83	97	93	0	0
F-8426	4 inch water	0.1	3 *l*	43	97	80	90	80	0	0
F-8426	4 inch water	0.2	3 *l*	40	100	80	90	80	0	0
Londax	4 inch water	0.06	3 *l*	67	100	93	93	83	0	0
F-8426 + L-77	4 inch water	0.05 + .25 %	4 *l*	40	97	93	100	77	0	0
F-8426 + L-77	4 inch water	0.1 + .25%	4 *l*	40	97	100	100	90	3	0
F-8426 + L-77	4 inch water	0.2 + .25%	4 *l*	37	100	97	100	97	0	0
F-8426 + L-77	Drained	0.05 + .25 %	4 *l*	30	77	83	83	83	3	0
F-8426 + L-77	Drained	0.1 + .25%	4 *l*	40	87	97	100	93	10	0
F-8426 + L-77	Drained	0.2 + .25%	4 *l*	47	100	100	97	100	10	0
Londax + L-77	Drained	0.06 + .25%	4 *l*	37	93	97	100	93	0	0
F-8426 + L-77	4 inch water	0.05 + .25 %	5 *l*	40	93	97	87	87	0	0
F-8426 + L-77	4 inch water	0.1 + .25%	5 *l*	40	93	90	83	80	0	0
F-8426 + L-77	4 inch water	0.2 + .25%	5 *l*	43	87	100	100	87	0	0
F-8426 + L-77	Drained	0.05 + .25 %	5 *l*	43	97	97	96	93	0	0
F-8426 + L-77	Drained	0.1 + .25%	5 *l*	47	93	100	97	90	0	0
F-8426 + L-77	Drained	0.2 + .25%	5 *l*	50	93	100	90	90	0	0
Londax + L-77	Drained	0.06 + .25%	5 *l*	70	97	100	87	80	0	0
F-8426 + L-77	2 inch water	0.05 + .25 %	1 *t*	43	97	93	93	90	0	0
F-8426 + L-77	2 inch water	0.1 + .25%	1 *t*	63	93	100	97	90	0	0
F-8426 + L-77	2 inch water	0.2 + .25%	1 *t*	50	90	93	83	83	0	0
Londax + L-77	2 inch water	0.06 + .25%	1 *t*	40	100	97	100	87	0	0
Untreated	-	-	-	30	100	93	90	87	0	0

[1] *PFS* = preflood surface, *l* = leaf stage rice, *t* = rice tillers

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

Table 1b. Height, % lodged, and yield of rice for F-8426 rate and timing study.

Treatment	Water Depth	Rate	Timing [1]	Height	Lodging	Yield
	(inches)	(lb ai/A)		(cm)	(%)	(lb/A at 14% moisture)
F-8426	preflood	0.06	*PFS*	91	42	5370
F-8426	preflood	0.12	*PFS*	88	33	4870
F-8426	preflood	0.18	*PFS*	88	42	5300
F-8426	4 inch water	0.05	3 *l*	82	33	5770
F-8426	4 inch water	0.1	3 *l*	84	50	5330
F-8426	4 inch water	0.2	3 *l*	80	67	5570
Londax	4 inch water	0.06	3 *l*	78	33	6010
F-8426+ L-77	4 inch water	0.05 + .25 %	4 *l*	74	0	4420
F-8426+ L-77	4 inch water	0.1 + .25%	4 *l*	75	33	4560
F-8426+ L-77	4 inch water	0.2 + .25%	4 *l*	72	0	4310
F-8426+ L-77	Drained	0.05 + .25 %	4 *l*	80	67	4840
F-8426+ L-77	Drained	0.1 + .25%	4 *l*	82	67	5500
F-8426+ L-77	Drained	0.2 + .25%	4 *l*	85	100	6690
Londax +L-77	Drained	0.06 + .25%	4 *l*	83	67	6200
F-8426 + L-77	4 inch water	0.05 + .25 %	5 *l*	78	0	5340
F-8426 + L-77	4 inch water	0.1 + .25%	5 *l*	80	28	4640
F-8426 + L-77	4 inch water	0.2 + .25%	5 *l*	79	25	4860
F-8426 + L-77	Drained	0.05 + .25 %	5 *l*	88	100	6100
F-8426 + L-77	Drained	0.1 + .25%	5 *l*	85	67	5700
F-8426 + L-77	Drained	0.2 + .25%	5 *l*	84	67	5820
Londax +L-77	Drained	0.06 + .25%	5 *l*	81	0	5560
F-8426 + L-77	2 inch water	0.05 + .25 %	1 *t*	87	67	5550
F-8426 + L-77	2 inch water	0.1 + .25%	1 *t*	86	67	6080
F-8426 + L-77	2 inch water	0.2 + .25%	1 *t*	82	0	4490
Londax +L-77	2 inch water	0.06 + .25%	1 *t*	95	100	6090
Untreated	-	-	-	86	50	6070

[1] *PFS* = preflood surface, *l* = leaf stage rice, *t* = rice tillers

Table 2. 1996 Weed Control Evaluations for F-8426 in Colusa county trial.

				Weed Control[2]								
				SAGMO	CYPDI		AMMCO		HETLI	Rice	Lodging	Yield @ 14%
Treatment	Water Depth	Rate	Timing[1]	7/18	7/18	8/22	7/18	8/22	7/18	Injury	(%)	Moisture (lb/a)
1	1-2inch	control	8 l	0.3	0.0	0.5	0.0	0.0	0.0	0.0	89	5940
2	1-2inch	60 g/ha	8 l	8.8	7.1	8.0	7.3	10.0	0.8	1.1	73	5890
3	1-2inch	120 g/ha	8 l	9.2	8.0	8.5	8.3	10.0	1.0	1.5	86	5950
4	1-2inch	180 g/ha	8 l	9.8	8.6	8.4	8.0	10.0	1.3	1.8	85	6200

[1] l = leaf stage
[2] SAGMO = arrowhead, CYPDI = smallflower umbrella sedge, AMMCO = red stem, HETLI = ducksalad

Table 3. 1996 Weed Control Evaluations for F-8426 in Sutter county trial.

				Weed Control[2]									
				SAGMO		CYPDI	AMMCO	SCPMU		HETLI	ALISMA	Lodging	Yield @ 14%
Treatment	Water Depth	Rate	Timing[1]	7/18	8/22	8/22	8/22	7/18	8/22	7/18	8/22	(%)	Moisture (lb/a)
1	1-2inch	control	6 l	0.0	0.0	0.8	0.0	0.8	0.0	0.3	2.5	88	5350
2	1-2inch	60 g/ha	6 l	10.0	10.0	8.9	10.0	10.0	10.0	3.8	7.5	73	7080
3	1-2inch	120 g/ha	6 l	10.0	10.0	9.7	10.0	10.0	10.0	4.1	8.8	90	6790
4	1-2inch	180 g/ha	6 l	10.0	10.0	9.6	10.0	10.0	9.9	4.0	8.8	85	6750

[1] l = leaf stage
[2] SAGMO = arrowhead, CYPDI = smallflower umbrella sedge, AMMCO = red stem, SCPMU = ricefield bulrush, HETLI = ducksalad, ALISMA = water plantain

Table 4. 1996 Weed Control Evaluations for F-8426 in Yuba county trial.

				Weed Control[2]						
				SAGMO	CYPDI	AMMCO	SCPMU	HETLI	Lodging	Yield @ 14%
Treatment	Water Depth	Rate	Timing[1]	7/18	7/18	7/18	7/18	7/18	(%)	Moisture (lb/a)
1	0.5-1.5 inch	control	5.2 l	0.0	0.5	2.5	0.0	0.0	26	4880
2	0.5-1.5 inch	60 g/ha	5.2 l	5.8	7.4	10.0	8.6	0.0	21	5400
3	0.5-1.5 inch	120 g/ha	5.2 l	9.0	8.6	8.8	10.0	0.0	3	5550
4	0.5-1.5 inch	180 g/ha	5.2 l	9.6	8.9	8.5	10.0	0.0	26	5450
5	1.5-3 inch	60 g/ha	6.5 l	9.8	5.3	7.5	9.6	0.0	20	5240
6	1.5-3 inch	120 g/ha	6.5 l	10.0	7.3	9.8	10.0	0.0	8	5160
7	1.5-3 inch	180 g/ha	6.5 l	9.8	6.8	6.5	10.0	0.0	22	6050

[1] l = leaf stage
[2] SAGMO = arrowhead, CYPDI = smallflower umbrella sedge, AMMCO = red stem, SCPMU = ricefield bulrush, HETLI = ducksalad

Table 5a. Evaluation of V-10029 + L-77 alone and in combination with Londax, Grandstand, Bolero, 2,4-D amine or F-8426.

Treatment	Rate	Timing [1]	Weed Control [2]					Rice injury	
			ECHOR (8/21)	LEFFA (8/21)	SCPMU (8/21)	CYPDI (8/21)	MOOVA (8/21)	(7/19)	(8/21)
	(ai/A)		(%)	(%)	(%)	(%)	(%)	(%)	(%)
V-10029 + L-77	8 g + .25%	5*l*-1*t*	60	70	87	83	53	0	0
V-10029 + L-77	12 g + .25%	5*l*-1*t*	77	70	87	90	47	7	0
V-10029 + L-77	16g + .25%	5*l*-1*t*	87	60	87	90	67	13	3
V-10029 + L-77	20g + .25%	5*l*-1*t*	87	57	90	90	87	20	0
V-10029 + L-77	24g + .25%	5*l*-1*t*	83	47	100	87	50	20	3
Ordram + Londax	4 lb + .0625 lb	5*l*-1*t*	47	53	97	97	100	0	0
V-10029 + Grandstand + L-77	12 g +.375 lb + .25%	5*l*-1*t*	67	87	100	100	90	23	7
V-10029 + Londax + L-77	12g + 0.625lb + .25%	5*l*-1*t*	80	63	100	100	97	10	0
V-10029 + L-77	8 g + .25%	1.5 *t*	47	80	67	77	40	0	0
V-10029 + L-77	12 g + .25%	1.5 *t*	67	70	67	67	60	7	0
V-10029 + L-77	16g + .25%	1.5 *t*	70	83	67	70	63	7	0
V-10029 + L-77	20g + .25%	1.5 *t*	73	70	63	73	83	10	0
V-10029 + L-77	24g + .25%	1.5 *t*	87	73	77	77	73	10	0
V-10029 + Londax + L-77	12g + .0625 lb +.25%	1.5 *t*	73	77	97	100	90	10	3
V-10029 + Bolero + L-77	12 g + 4 lb + .25%	1.5 *t*	73	43	80	93	80	7	0
V-10029 + F-8426 + L-77	12g + .05 lb + .25%	1.5 *t*	60	70	87	83	80	17	7
V-10029 + 2,4-D + L-77	12g + .5 lb + .25%	1.5 *t*	53	87	93	90	87	13	3
V-10029 + Grandstand + L-77	12 g +.375 lb + .25%	1.5 *t*	50	87	87	87	90	10	3
V-10029 + L-77	8 g + .25%	3 *t*	3	57	53	63	40	-	0
V-10029 + L-77	12 g + .25%	3 *t*	43	90	77	77	47	-	0
V-10029 + L-77	16g + .25%	3 *t*	77	83	43	73	80	-	0
V-10029 + L-77	20g + .25%	3 *t*	73	77	40	53	93	-	3
V-10029 + L-77	24g + .25%	3 *t*	80	83	33	63	100	-	3
V-10029 + Bolero + Grandstand +L-77	12g +4 lb + .375 lb +.25%	3 *t*	50	90	57	73	63	-	7
V-10029 + Bolero + 2,4-D + L-77	12 g + 4 lb + .5 lb +.25%	3 *t*	53	70	60	63	83	-	3
V-10029 + Bolero + F-8426 + L-77	12g +4 lb + .05 lb + .25%	3 *t*	43	67	60	63	40	-	3
Untreated	-	-	0	67	23	53	57	-	0

[1] *l* = leaf stage rice, *t* = rice tillers

[2] ECHOR = watergrass, LEFFA = sprangletop, SCPMU = ricefield bulrush,CYPDI = smallflower umbrella sedge, MOOVA = monochoria

Table 5b. Height, % lodged and yield of rice for V-10029 + L-77 alone or in combination with Londax, Grandstand, Bolero, 2,4-D amine or F-8426 treatments.

Treatment	Rate (ai/Acre)	Timing [1]	Height (cm)	Lodging (%)	Yield (lb/A at 14% moisture)
V-10029 + L-77	8 g + .25%	5*l*-1*t*	86	0	5730
V-10029 + L-77	12 g + .25%	5*l*-1*t*	90	0	5450
V-10029 + L-77	16g + .25%	5*l*-1*t*	82	0	5630
V-10029 + L-77	20g + .25%	5*l*-1*t*	86	0	5530
V-10029 + L-77	24g + .25%	5*l*-1*t*	84	0	5240
Ordram + Londax	4 lb + .0625 lb +.25%	5*l*-1*t*	89	0	5670
V-10029 + Grandstand + L-77	12 g +.375 lb + .25%	5*l*-1*t*	89	0	5570
V-10029 + Londax + L-77	12g + 0.625lb + .25%	5*l*-1*t*	81	0	5760
V-10029 + L-77	8 g + .25%	1.5 *t*	85	0	3800
V-10029 + L-77	12 g + .25%	1.5 *t*	88	0	4650
V-10029 + L-77	16g + .25%	1.5 *t*	92	0	4730
V-10029 + L-77	20g + .25%	1.5 *t*	89	0	4050
V-10029 + L-77	24g + .25%	1.5 *t*	91	0	4020
V-10029 + Londax + L-77	12g + .0625 lb +.25%	1.5 *t*	85	0	4720
V-10029 + Bolero + L-77	12 g + 4 lb + .25%	1.5 *t*	87	0	4330
V-10029 + F-8426 + L-77	12g + .05 lb + .25%	1.5 *t*	90	0	4700
V-10029 + 2,4-D + L-77	12g + .5 lb + .25%	1.5 *t*	87	0	4230
V-10029 + Grandstand + L-77	12 g +.375 lb + .25%	1.5 *t*	86	0	4740
V-10029 + L-77	8 g + .25%	3 *t*	91	0	3520
V-10029 + L-77	12 g + .25%	3 *t*	95	0	4240
V-10029 + L-77	16g + .25%	3 *t*	92	0	3470
V-10029 + L-77	20g + .25%	3 *t*	87	0	4710
V-10029 + L-77	24g + .25%	3 *t*	90	0	3980
V-10029 + Bolero + Grandstand +L-77	2g +4 lb + .0625 lb +.25	3 *t*	93	0	3660
V-10029 + Bolero + 2,4-D + L-77	12 g + 4 lb + .5 lb +.25%	3 *t*	91	0	3510
V-10029 + Bolero + F-8426 + L-77	12g +4 lb + .05 lb + .25%	3 *t*	90	0	3530
Untreated	-	-	90	3	3200

[1] *l* = leaf stage rice, *t* = rice tillers

Table 6a. Evaluation of dithiopyr alone or in combination with Londax.

			Weed Control [2]					Rice injury	
			ECHO	LEFFA	CPM	CYPDI	MOOVA		
Treatment	Rate	Timing [1]	(8/15)	(8/15)	(8/15)	(8/15)	(8/15)	(6-19)	(8-15)
	(lb ai/A)		(%)	(%)	(%)	(%)	(%)	(%)	(%)
Dithiopyr	0.25	*PFS*	87	100	0	100	90	70	27
Dithiopyr	0.5	*PFS*	97	100	0	100	90	100	33
Dithiopyr	0.75	*PFS*	97	100	0	100	100	100	97
Dithiopyr	0.12	1-1.5 *l*	67	63	3	90	37	-	13
Dithiopyr	0.25	1-1.5 *l*	73	70	0	83	50	-	30
Dithiopyr	0.5	1-1.5 *l*	63	70	7	73	43	-	33
Dithiopyr + Londax	0.25+0.0625	1-1.5 *l*	57	67	87	97	70	-	43
Dithiopyr	0.12	2.5 *l*	37	53	0	93	57	-	0
Dithiopyr	0.25	2.5 *l*	50	80	30	97	50	-	0
Dithiopyr	0.5	2.5 *l*	67	100	0	100	43	-	17
Dithiopyr + Londax	0.25+0.0625	2.5 *l*	27	77	80	90	50	-	0
Dithiopyr	0.12	4 *l*	43	77	13	97	50	-	0
Dithiopyr	0.25	4 *l*	60	93	0	100	40	-	0
Dithiopyr	0.5	4 *l*	50	90	3	93	40	-	0
Dithiopyr + Londax	0.25+0.0625	4 *l*	37	40	97	97	83	-	0
Control	-	-	13	90	7	93	37	-	0

[1] *PPS* = preflood surface, *l* = leaf stage rice,

[2] ECHOR = watergrass, LEFFA = sprangletop, SCPMU = ricefield bulrush,CYPDI = smallflower umbrella sedge, MOOVA = monochoria

Table 6b. Height, % lodged and yield of rice for dithiopyr rate and timing study

Treatment	Rate	Timing [1]	Height	Lodging	Yield
	(lb ai/A)		(cm)	(%)	(lb/A at 14 % moisture)
Dithiopyr	0.25	*PPS*	70.7	70	750
Dithiopyr	0.5	*PPS*	73.7	92	300
Dithiopyr	0.75	*PPS*	73.0	58	400
Dithiopyr	0.12	1-1.5 *l*	90.3	83	2710
Dithiopyr	0.25	1-1.5 *l*	81.3	93	1910
Dithiopyr	0.5	1-1.5 *l*	89.7	83	3020
Dithiopyr + Londax	0.25+0.0625	1-1.5 *l*	89.7	75	3390
Dithiopyr	0.12	2.5 *l*	84.0	33	2170
Dithiopyr	0.25	2.5 *l*	83.0	100	2430
Dithiopyr	0.5	2.5 *l*	85.7	100	1720
Dithiopyr + Londax	0.25+0.0625	2.5 *l*	89.7	100	3140
Dithiopyr	0.12	4 *l*	84.0	90	2610
Dithiopyr	0.25	4 *l*	86.3	93	2400
Dithiopyr	0.5	4 *l*	80.3	67	1950
Dithiopyr + Londax	0.25+0.0625	4 *l*	91.3	93	3840
Control	-	-	75.3	75	1230

[1] *PPS* = preflood surface, *l* = leaf stage rice

Table 7. 1996 Weed Control Evaluations of Glufosinate Resistant Koshihikari Rice at Biggs (RES).

			Weed Control[2]			Rice Injury		
			HETLI	SCPMU				
Treatment	Rate	Timing[1]	7/16	7/16	8/25	7/16	8/25	Yield
	(g/ha)							(lb/A @ 14% moisture)
untreated	0	-	0.0	0.0	0.8	0.0	0.0	1390
Londax	300	6-7 l	5.8	6.5	2.8	0.3	0.0	960
Liberty	600	6-7 l	6.4	7.3	4.5	0.3	0.0	1150
Liberty	900	6-7 l	9.1	9.0	6.5	0.0	0.0	1810
Liberty	300+600	6-7 l+lt	2.5	2.8	8.5	0.0	0.0	1210
Liberty	600+600	6-7 l+lt	5.9	7.6	10.0	0.1	0.0	1640
Liberty	900+600	6-7 l+lt	9.2	9.5	1.0	0.3	0.0	1980
Liberty	300	mt	8.1	6.3	2.9	0.0	0.0	1230
Liberty	600	mt	10.0	8.1	7.1	0.4	0.0	1420
Liberty	900	mt	6.8	7.5	8.4	0.6	0.0	1950
Liberty	300	lt	0.0	0.0	5.9	0.0	0.0	890
Liberty	600	lt	0.0	0.0	8.1	0.0	0.0	720
Liberty	900	lt	0.0	0.0	7.6	0.0	0.0	1070
Liberty	Koshihikari	-	2.8	4.0	3.5	2.3	3.4	600
Liberty	open	-	0.0	0.0	0.0	0.0	0.0	280

[1] l = leaf stage rice, mt = mid tiller, lt = late tiller

[2] SCPMU = ricefield bulrush, HETLI = ducksalad

Table 8a. Evaluation of rates and timings of four formulations of 2,4-D amine

Treatment	Rate	Timing [1]	Weed Control [2]			Rice Injury
			SCPMU	CYPDI	MOOVA	
			(8/20)	(8/20)	(8/20)	(8/20)
	(lb ai/A)		(%)	(%)	(%)	(%)
2,4-D 12G	0.5	4 *l*	13	67	47	0
2,4-D 12G	1	4 *l*	7	53	43	0
2,4-D 12G	1.5	4 *l*	0	53	57	0
2,4-D 12G	0.5	1 *t*	3	53	50	0
2,4-D 12G	1	1 *t*	10	67	43	0
2,4-D 12G	1.5	1 *t*	0	57	40	0
Hi-Dep (2,4-D amine)	0.75	1 *t*	100	87	100	7
Hi-Dep (2,4-D amine)	1	1 *t*	100	100	93	3
Hi-Dep (2,4-D amine)	1.5	1 *t*	100	93	100	17
Solutions (2,4-D amine)	0.75	1 *t*	100	93	93	3
Solutions (2,4-D amine)	1	1 *t*	100	93	93	10
Solutions (2,4-D amine)	1.5	1 *t*	100	97	100	3
2,4-D Amine	0.75	1 *t*	100	97	100	3
2,4-D Amine	1	1 *t*	100	97	97	3
2,4-D Amine	1.5	1 *t*	100	97	100	17
Hi-Dep (2,4-D amine)	0.75	2 *t*	100	97	93	20
Hi-Dep (2,4-D amine)	1	2 *t*	100	93	90	3
Hi-Dep (2,4-D amine)	1.5	2 *t*	100	90	90	17
Solutions (2,4-D amine)	0.75	2 *t*	67	77	77	0
Solutions (2,4-D amine)	1	2 *t*	100	87	97	33
Solutions (2,4-D amine)	1.5	2 *t*	100	57	53	0
2,4-D Amine	0.75	2 *t*	80	57	57	0
2,4-D Amine	1	2 *t*	100	60	33	0
2,4-D Amine	1.5	2 *t*	100	47	50	0
Untreated	-	-	13	53	57	0

[1] *l* = leaf stage rice, *t* = rice tillers

[2] SCPMU = ricefield bulrush,CYPDI = smallflower umbrella sedge, MOOVA = monochoria

Table 8b. Height, % lodged and yield of rice for 2,4-D amine formulation rate and timing study.

Treatment	Rate	Timing [1]	Height	Lodging	Yield
	(lb ai/A)		(cm)	(%)	(lb/A at 14 % moisture)
2,4-D 12G	0.5	4 *l*	85	63.3	1410
2,4-D 12G	1	4 *l*	78	33.3	1540
2,4-D 12G	1.5	4 *l*	78	66.7	1220
2,4-D 12G	0.5	1 *t*	78	91.7	1790
2,4-D 12G	1	1 *t*	82	33.3	1720
2,4-D 12G	1.5	1 *t*	75	66.7	1120
Hi-Dep (2,4-D amine)	0.75	1 *t*	83	25.0	2210
Hi-Dep (2,4-D amine)	1	1 *t*	88	0.0	3110
Hi-Dep (2,4-D amine)	1.5	1 *t*	79	58.3	1990
Solutions (2,4-D amine)	0.75	1 *t*	87	8.3	2820
Solutions (2,4-D amine)	1	1 *t*	88	0.0	3320
Solutions (2,4-D amine)	1.5	1 *t*	82	0.0	2640
2,4-D Amine	0.75	1 *t*	83	0.0	2330
2,4-D Amine	1	1 *t*	81	0.0	2340
2,4-D Amine	1.5	1 *t*	80	25.0	1270
Hi-Dep (2,4-D amine)	0.75	2 *t*	82	33.3	2120
Hi-Dep (2,4-D amine)	1	2 *t*	85	16.7	3150
Hi-Dep (2,4-D amine)	1.5	2 *t*	79	0.0	2350
Solutions (2,4-D amine)	0.75	2 *t*	85	58.3	1830
Solutions (2,4-D amine)	1	2 *t*	84	0.0	2360
Solutions (2,4-D amine)	1.5	2 *t*	79	100.0	1110
2,4-D Amine	0.75	2 *t*	80	100.0	1250
2,4-D Amine	1	2 *t*	84	33.3	1500
2,4-D Amine	1.5	2 *t*	88	66.7	2540
Untreated	-	-	76	50.0	1390

[1] *l* = leaf stage rice, *t* = rice tillers

Table 9a. Evaluation of rates and timing of Grandstand alone or in combination with COC, L-77, X-77 or Londax for weed control, rice injury and yield of rice.

Treatment	Rate	Timing [1]	Weed Control [2]			Rice Injury	Height	Lodging	Yield
			SCPMU	CYPDI	MOOVA				
			(8/23)	(8/23)	(8/23)	(8/23)			
	(lb ai/A)		(%)	(%)	(%)	(%)	(cm)	(%)	(lb/A at 14% moisture)
Grandstand	0.25	4 *l*	83	77	3	0	82	33.3	2190
Grandstand	0.375	4 *l*	93	93	4	0	76	33.3	2200
Grandstand + COC	0.375 + .5%	4 *l*	80	83	4	3	74	50.0	1870
Grandstand + L-77	0.25 + .25%	4 *l*	80	83	3	0	82	50.0	2120
Grandstand + L-77	0.375 + .25%	4 *l*	97	97	6	0	82	50.0	1640
Grandstand + X-77	0.25 + .25%	4 *l*	43	60	4	3	77	33.3	1680
Grandstand +X-77	0.375 + .25%	4 *l*	80	87	5	0	85	33.3	2030
Londax + 2,4-D	0.625 + 0.5	4 *l*	93	100	9	0	85	75.0	2190
Londax + COC	0.625 + .5%	4 *l*	77	93	7	0	85	33.3	3320
Londax + Grandstand + COC	0.625 +.375 + .5%	4 *l*	93	93	7	0	85	25.0	2620
Londax + MCPA	0.625 + 0.5	4 *l*	90	97	10	0	92	25.0	2220
Grandstand	0.25	2 *t*	13	50	5	0	78	33.3	1490
Grandstand	0.375	2 *t*	13	47	6	0	79	66.7	1240
Grandstand + X-77	0.25 + .25%	2 *t*	27	33	6	0	86	0	1750
Grandstand + X-77	0.375 + .25%	2 *t*	17	47	5	10	82	30	1270
Grandstand + L-77	0.25 + .25%	2 *t*	27	37	6	3	81	66.7	1300
Grandstand + L-77	0.375 + .25%	2 *t*	40	37	4	0	87	66.7	2450
Londax +COC	0.625 + .5%	2 *t*	57	67	3	0	86	100	1870
Londax +Grandstand +COC	0.625 + .375 + .25%	2 *t*	60	77	4	0	77	33.3	2010
Londax + MCPA	0.625 + 0.5	2 *t*	70	60	5	3	79	66.7	1930
Grandstand + COC	0.375 + .5%	2 *t*	40	90	4	0	88	66.7	2070
Untreated	-	-	5	60	4	0	77	41.3	1160

[1] *l* = leaf stage rice, *t* = rice tillers

[2] SCPMU = ricefield bulrush, CYPDI = smallflower umbrella sedge, MOOVA = monochoria

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Table 9b. Evaluation of Grandstand + L-77 alone or in tank-mix combinations with 2,4-D applied at 30 or 40 days after seeding in a weed free area.

Treatment	Rate	Timing [1]	Weed Control [2] SCPMU (8/23)	Weed Control [2] CYPDI (8/23)	Weed Control [2] MOOVA (8/23)	Rice Injury (8/23)	Lodging	Height	Yield
	(lb ai/A)		(%)	(%)	(%)	(%)	(%)	(cm)	(lb/A at 14% moisture)
Grandstand + X-77	0.375 +.25%	30 *DAS*	100	100	93	20	0.0	86	4080
Grandstand + 2,4-D	0.25 + 0.25	30 *DAS*	100	100	97	3	3.3	84	3180
Grandstand + 2,4-D	0.25 + 0.5	30 *DAS*	100	97	90	0	0.0	88	4730
Grandstand + 2,4-D	0.375 + 0.25	30 *DAS*	100	100	93	0	0.0	94	4230
Grandstand + 2,4-D	0.375 + 0.5	30 *DAS*	100	100	100	3	0.0	85	5430
Grandstand + 2,4-D	0.5 + 0.5	30 *DAS*	100	100	100	10	3.3	91	4450
Grandstand + X-77	0.375 +.25%	40 *DAS*	100	100	80	10	0.0	89	4750
Grandstand + 2,4-D	0.25 + 0.25	40 *DAS*	100	100	97	3	33.3	92	4780
Grandstand + 2,4-D	0.25 + 0.5	40 *DAS*	100	100	83	0	3.3	90	5420
Grandstand + 2,4-D	0.375 + 0.25	40 *DAS*	100	100	87	3	35.0	92	3780
Grandstand + 2,4-D	0.375 + 0.5	40 *DAS*	100	100	67	3	23.3	94	3600
Grandstand + 2,4-D	0.5 + 0.5	40 *DAS*	100	100	97	17	0.0	89	4420
Untreated	-	-	100	100	85	0	0.0	91	2630

[1] *DAS* = days after seeding

[2] SCPMU = ricefield bulrush, CYPDI = smallflower umbrella sedge, MOOVA = monochoria

Table 9c. Evaluation of Grandstand + L-77 applied alone or in combination with 2,4-D for weed control and rice injury.

Treatment	Rate	Timing [1]	Weed Control [2]					Rice Injury
			ECHOR	LEFFA	SCPMU	CYPDI	HETLI	
			(8/23)	(8/23)	(8/23)	(8/23)	(8/23)	(8/23)
	(lb ai/A)		(%)	(%)	(%)	(%)	(%)	(%)
Grandstand + L-77	.375 + .25%	1 *t*	43.3	100.0	96.7	93.3	100.0	0.0
Grandstand + 2,4-D amine + L-77	.25 + .25 + .25%	1 *t*	26.7	93.3	100.0	100.0	100.0	3.3
Grandstand + 2,4-D amine + L-77	.25 + .5 + .25%	1 *t*	20.0	100.0	100.0	96.7	100.0	3.3
Grandstand + 2,4-D amine + L-77	.375 + .25 + .25%	1 *t*	16.7	86.7	66.7	93.3	100.0	0.0
Grandstand + 2,4-D amine + L-77	.375 + .5 + .25%	1 *t*	30.0	100.0	100.0	100.0	100.0	10.0
MCPA + 2,4-D amine	.5 + .5	1 *t*	50.0	100.0	96.7	90.0	100.0	3.3
Grandstand + L-77	.375 + .25%	2.5- 3 *t*	36.7	90.0	83.3	60.0	100.0	0.0
Grandstand + 2,4-D amine + L-77	.25 + .25 + .25%	2.5- 3 *t*	30.0	83.3	83.3	63.3	96.7	0.0
Grandstand + 2,4-D amine + L-77	.25 + .5 + .25%	2.5- 3 *t*	30.0	93.3	90.0	73.3	93.3	0.0
Grandstand + 2,4-D amine + L-77	.375 + .25 + .25%	2.5- 3 *t*	43.3	90.0	90.0	76.7	100.0	3.3
Grandstand + 2,4-D amine + L-77	.375 + .5 + .25%	2.5- 3 *t*	56.7	93.3	93.3	83.3	93.3	0.0
MCPA + 2,4-D amine	.5 + .5	2.5- 3 *t*	43.3	80.0	100.0	80.0	96.7	0.0
Untreated	-	-	30.0	100.0	93.3	90.0	86.7	0.0

[1] *t* = rice tillers

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

Table 9d. Height, % lodged and yield of rice for treatments of Grandstand + L-77 applied alone or in combination with 2,4-D.

Treatment	Rate (lb ai/A)	Timing [1]	Height (cm)	Lodging (%)	Yield (lb/A at 14% moisture)
Grandstand + L-77	.375 + .25%	1 *t*	85.0	30.0	5520
Grandstand + 2,4-D amine + L-77	.25 + .25 + .25%	1 *t*	83.7	25.0	4870
Grandstand + 2,4-D amine + L-77	.25 + .5 + .25%	1 *t*	87.7	25.0	4630
Grandstand + 2,4-D amine + L-77	.375 + .25 + .25%	1 *t*	83.3	23.3	5300
Grandstand + 2,4-D amine + L-77	.375 + .5 + .25%	1 *t*	85.0	50.0	5400
MCPA + 2,4-D amine	.5 + .5	1 *t*	84.3	28.3	6760
Grandstand + L-77	.375 + .25%	2.5- 3 *t*	89.7	3.3	4060
Grandstand + 2,4-D amine + L-77	.25 + .25 + .25%	2.5- 3 *t*	90.3	36.7	3810
Grandstand + 2,4-D amine + L-77	.25 + .5 + .25%	2.5- 3 *t*	90.3	28.3	4120
Grandstand + 2,4-D amine + L-77	.375 + .25 + .25%	2.5- 3 *t*	84.7	8.3	3250
Grandstand + 2,4-D amine + L-77	.375 + .5 + .25%	2.5- 3 *t*	95.7	50.0	4880
MCPA + 2,4-D amine	.5 + .5	2.5- 3 *t*	89.3	25.0	3900
Untreated	-	-	86.0	50.0	6060

[1] *t* = rice tillers

Table 10a. Evaluation of Abolish and Ordram alone or in combination with Bolero or Ordram for weed control and rice injury.

Treatment	Rate	Timing [1]	Weed Control [2]					Rice injury	
			ECHOR	LEFFA	SCPMU	CYPDI	MOOVA		
			(8/15)	(8/15)	(8/15)	(8/15)	(8/15)	(6-19)	(8-15)
	(lb ai/A)		(%)	(%)	(%)	(%)	(%)	(%)	(%)
Abolish +Bolero	2.0 + 2.0	*PPS* + 2*l*	40	100	0	100	70	10	0
Abolish +Ordram	2.0 + 2.0	*PPS* + 2*l*	77	100	0	100	70	20	27
Abolish	2	*PPS*	47	100	0	97	77	13	0
Abolish +Ordram	4.0 + 4.0	*PPS* + 2*l*	90	100	3	100	53	20	0
Ordram	3	*PPS*	43	97	3	90	27	0	0
Ordram + Bolero	3.0 + 2.0	*PPS* + 2*l*	63	100	7	13	37	0	0
Ordram + Bolero	3.0 + 4.0	*PPS* + 2*l*	60	100	10	97	27	0	0
Ordram + Ordram	3.0 + 4.0	*PPS* + 2*l*	83	100	7	100	57	0	0
Control	-	-	43	93	0.0	93	63	0	0

[1] *PPS* = preplant surface, *l* = leaf stage rice

[2] ECHOR = watergrass, LEFFA = sprangletop, SCPMU = ricefield bulrush, CYPDI = smallflower umbrella sedge, MOOVA = monochoria

Table 10b. Height, % lodged and yield of rice for Abolish and Ordram alone or in combination with Ordram or Bolero.

Treatment	Rate (lb ai/A)	Timing [1]	Height (cm)	Lodging (%)	Yield (lb/A at 14 % moisture)
Abolish +Bolero	2.0 + 2.0	*PPS* + 2*l*	80.0	75	990
Abolish +Ordram	2.0 + 2.0	*PPS* + 2*l*	78.3	67	1110
Abolish	2	*PPS*	79.3	58	770
Abolish +Ordram	4.0 + 4.0	*PPS* + 2*l*	92.0	80	4260
Ordram	3	*PPS*	84.7	85	1720
Ordram + Bolero	3.0 + 2.0	*PPS* + 2*l*	84.3	62	2770
Ordram + Bolero	3.0 + 4.0	*PPS* + 2*l*	87.3	80	3620
Ordram + Ordram	3.0 + 4.0	*PPS* + 2*l*	86.0	80	3390
Control	-	-	78.7	80	1120

[1] *PPS* = preflood surface, *l* = leaf stage rice

Table 11. Evaluation of Whip alone or in combination with Kenetic, X-77 or Crop Oil Concentrate

Treatment	Rate	timing	Weed Control [2] ECHOR (8/21)	Weed Control [2] LEFFA (8/21)	Rice Injury (7/19)	Rice Injury (8/2)	Rice Injury (8/21)	Height	Lodging	Yield
	(lb ai/A)		(%)	(%)	(%)	(%)	(%)	(cm)	(%)	(Lb/A @ 14% moisture)
Whip	0.075	1 *t*	20	60	0	0	0	93	17	5450
Whip + Kenetic	0.075 + .25%	1 *t*	23	70	7	0	0	92	7	4600
Whip + X-77	0.075 + .25%	1 *t*	20	57	3	0	0	93	3	5660
Whip + COC	0.075 + .5%	1 *t*	3	37	3	0	0	92	20	4260
Whip	0.15	3 *t*	37	67	-	0	0	95	0	5460
Whip + Kenetic	0.15 + .04%	3 *t*	33	57	-	0	0	87	8	5260
Whip + Kenetic	0.15 + .0625%	3 *t*	53	60	-	7	3	86	3	5440
Whip + Kenetic	0.15 + .125%	3 *t*	53	93	-	10	0	91	17	5490
Whip + Kenetic	0.15 + .25%	3 *t*	73	100	-	17	0	89	17	5690
Whip + Kenetic	0.2 + .04%	3 *t*	83	90	-	3	3	86	0	5710
Whip + Kenetic	0.2 + .0625%	3 *t*	80	67	-	7	0	90	8	5230
Whip + Kenetic	0.2 + .125%	3 *t*	77	100	-	13	3	87	0	5620
Whip + Kenetic	0.2 + .25%	3 *t*	80	83	-	20	3	81	47	4900
Whip + X-77	0.15 + .0625%	3 *t*	60	80	-	3	0	90	0	5020
Whip + X-77	0.15 + .125%	3 *t*	57	63	-	7	0	89	0	5470
Whip + X-77	0.15 + .25%	3 *t*	40	70	-	10	0	91	0	5690
Whip + X-77	0.2 + .0625%	3 *t*	70	93	-	7	0	89	33	5450
Whip + X-77	0.2 + .125%	3 *t*	73	83	-	10	0	90	33	5950
Whip + X-77	0.2 + .25%	3 *t*	80	83	-	17	0	89	0	6310
Whip + COC	0.15 + .25%	3 *t*	47	93	-	0	0	89	25	4580
Whip + COC	0.15 + .5%	3 *t*	57	80	-	7	0	86	20	5640
Whip + COC	0.2 + .25%	3 *t*	73	87	-	10	0	92	12	6090
Whip + COC	0.2 + .5%	3 *t*	67	100	-	17	0	88	25	5490
Untreated	-	-	17	57	-	3	0	94	8	5220

[1] *t* = rice tillers

[2] ECHOR = watergrass, LEFFA = sprangletop

Table 12a. Postemergence applications of Abolish alone or in combination with F-8426, V-10029, Whip, Londax, Mon-1200, Grandstand, 2,4-D amine or MCPA for weed control.

Treatment	Rate	Timing [1]	Weed Control [2]						
			ECHOR	LEFFA	SCPMU	CYPDI	HETLI	MOOVA	SAGMO
			(8/6)	(8/6)	(8/6)	(8/6)	(8/6)	(8/6)	(8/6)
	(lb ai/A)		(%)	(%)	(%)	(%)	(%)	(%)	(%)
Abolish	4	2 *l*	40	67	50	57	53	100	100
Abolish + F-8426 + L-77	4 + .06 + .25%	2 *l*	20	53	87	87	53	93	100
Abolish + F-8426 + L-77	4 + .12 + .25%	2 *l*	30	67	87	90	27	97	100
Abolish + V-10029 + L-77	4 + 12g + .25%	2 *l*	97	63	80	80	70	83	100
Abolish + V-10029 + L-77	4 + 18 g + .25	2 *l*	80	50	93	93	83	97	100
Abolish + Whip	4 + .07	2 *l*	27	67	3	7	20	67	87
Abolish + Whip	4 + .1	2 *l*	23	100	33	33	30	77	80
Abolish + Londax + L-77	4 + .06 + .25%	2 *l*	30	50	100	100	87	100	100
Abolish + Londax	4 + 0.0625	2 *l* + 2.5 *l*	47	60	100	100	77	100	100
Abolish + Mon 1200	4 + 0.06	2 *l* + 2.5 *l*	7	57	73	80	63	100	100
Abolish + V-10029 + L-77	4 + 12g + .25 %	2 *l* + 1 *t*	67	50	97	83	83	97	100
Abolish + V-10029+Grandstand + L-77	4 + .375 + .25%	2 *l* + 1 *t*	67	50	93	90	90	100	100
Abolish + 2,4-D amine	4 + 1	2 *l* + 1 *t*	27	40	90	70	93	100	100
Abolish + F-8426 + L-77	4 + .03 + .25 %	2 *l* + 1 *t*	43	50	100	100	50	93	100
Abolish + F-8426 + L-77	4 + .06 + .25 %	2 *l* + 1 *t*	23	60	77	77	73	97	100
Abolish + F-8426 + L-77	4 + .12 + .25 %	2 *l* + 1 *t*	13	47	93	80	57	97	100
Abolish + Grandstand + L-77	4 + .375 + .25 %	2 *l* + 1 *t*	50	63	100	90	77	100	100
Abolish + Grandstand + 2,4-D Amine	4+ .5 + .375	2 *l* + 1 *t*	33	67	90	70	83	100	100
Abolish + MCPA + 2,4-D Amine	4 + .5 +.5	2 *l* + 1 *t*	27	47	100	100	100	100	100
Untreated	-	-	33	50	23	30	23	100	100

[1] *l* = leaf stage rice, *t* = rice tillers

[2] ECHOR = watergrass, LEFFA = sprangletop, SCPMU = ricefield bulrush, CYPDI = smallflower umbrella sedge, HETLI = ducksalad, MOOVA = monochoria, SAGMO = California arrowhead

Table 12b. The effect of Abolish alone or Abolish combinations on rice injury, height and yield.

reatment	Timing [1]	Rate (lb ai/A)	Rice Injury (8/6) (%)	Height (cm)	Yield (lb/A at 14% moisture)
Abolish	2 *l*	4	10	84	4430
Abolish + F-8426 + L-77	2 *l*	4 + .06 + .25%	17	83	3690
Abolish + F-8426 + L-77	2 *l*	4 + .12 + .25%	20	82	4340
Abolish + V-10029 + L-77	2 *l*	4 + 12g + .25%	17	85	6250
Abolish + V-10029 + L-77	2 *l*	4 + 18 g + .25%	10	84	4270
Abolish + Whip	2 *l*	4 + .07	27	82	2960
Abolish + Whip	2 *l*	4 + .1	40	80	1590
Abolish + Londax + L-77	2 *l*	4 + .06 + .25%	17	87	5320
Abolish + Londax + L-77	2 *l* + 2.5 *l*	4 + .06 + .25%	17	80	4250
Abolish + Mon 1200	2 *l* + 2.5 *l*	4 + 0.06	20	87	3570
Abolish + V-10029 + L-77	2 *l* + 1 *t*	4 + 12g + .25 %	13	81	5240
Abolish + V-10029+Grandstand + L-77	2 *l* + 1 *t*	4 + .375 + .25%	20	84	4530
Abolish + 2,4-D amine	2 *l* + 1 *t*	4 + 1	17	83	4250
Abolish + F-8426 + L-77	2 *l* + 1 *t*	4 + .03 + .25 %	20	83	4170
Abolish + F-8426 + L-77	2 *l* + 1 *t*	4 + .06 + .25 %	13	85	3750
Abolish + F-8426 + L-77	2 *l* + 1 *t*	4 + .12 + .25 %	13	85	4050
Abolish + Grandstand + L-77	2 *l* + 1 *t*	4 + .375 + .25 %	17	81	4640
Abolish + Grandstand + 2,4-D Amine	2 *l* + 1 *t*	4+ .5 + .375	23	85	4350
Abolish + MCPA + 2,4-D Amine	2 *l* + 1 *t*	4 + .5 +.5	13	84	3860
Untreated	-	-	20	84	3540

[1] *l* = leaf stage rice, *t* = rice tillers

Table 13a. Evaluation of several herbicides applied to 3-leaf rice at pin-point flood for weed control and rice injury.

Treatment	Rate	Weed Control [1]					Rice Injury	
		ECHOR	LEFFA	SCPMU	CYPDI	MOOVA		
		(8/23)	(8/23)	(8/23)	(8/23)	(8/23)	(7/24)	(8/23)
	(lb ai/A)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Abolish	4	0	73	13	30	77	7	0
Abolish + F-8426 + L-77	4 + .03 + .25%	0	87	70	40	80	10	0
Abolish + F-8426 + L-77	4 + .06 + .25%	0	73	97	83	93	17	3
Abolish + F-8426 + L-77	4 + .12 + .25%	0	93	100	97	100	20	10
Abolish + V-10029 + L-77	4 + 12g + .25%	73	10	93	83	90	13	7
Abolish + V-10029 + L-77	4 + 18g + .25%	63	30	83	100	97	17	10
Abolish + Whip	4 + .07	0	90	47	63	83	13	7
Abolish + Whip	4 + .1	0	87	17	27	80	20	7
Whip + Londax	.1 + .06	0	33	77	100	90	3	0
Whip + F-8426 + L-77	.1 + .06 + .25%	0	77	97	90	87	17	7
V-10029 + Londax + L-77	18g + .06 + .25%	73	27	100	100	100	7	0
V-10029 +F-8426 + L-77	18g + .06 + .25%	70	3	100	100	97	13	7
Abolish + V-10029 + F-8426 + L-77	4 + 18g + .06 + .25%	80	43	90	73	90	20	7
Abolish + Whip+ F-8426 + L-77	4 + .1 + .06 + .25%	0	90	97	63	97	20	13
V10029 + Prowl +L-77	18 g + .25 + .25%	67	10	97	57	100	27	20
V10029 + Prowl +L-77	18g + .5 + .25%	70	3	87	90	97	30	20
Whip + Prowl	.07 + .25	33	87	20	27	80	27	17
Control	-	0	67	97	27	100	3	0

[1] ECHOR = watergrass, LEFFA = sprangletop, SCPMU = ricefield bulrush,CYPDI = smallflower umbrella sedge, MOOVA = monochoria

Table 13b. Height, % lodged and yield of rice for herbicide combinations applied to 3-leaf rice.

Treatment	Rate (lb al/A)	Height (cm)	Lodging (%)	Yield (lb /A at 14% moisture)
Abolish	4	93	17	1160
Abolish + F-8426 + L-77	4 + .03 + .25%	84	20	1800
Abolish + F-8426 + L-77	4 + .06 + .25%	83	50	840
Abolish + F-8426 + L-77	4 + .12 + .25%	77	43	1100
Abolish + V-10029 + L-77	4 + 12g + .25%	88	0	4310
Abolish + V-10029 + L-77	4 + 18g + .25%	86	0	3850
Abolish + Whip	4 + .07	85	17	1480
Abolish + Whip	4 + .1	78	67	1020
Whip + Londax	.1 + .06	87	27	1550
Whip + F-8426 + L-77	.1 + .06 + .25%	88	23	1920
V-10029 + Londax + L-77	18g + .06 + .25%	87	0	3090
V-10029 +F-8426 + L-77	18g + .06 + .25%	89	0	2240
Abolish + V-10029+ F-8426 + L-77	4 + 18g + .06 + .25%	87	0	3910
Abolish + Whip+ F-8426 + L-77	4 + .1 + .06 + .25%	84	10	1170
V10029 + Prowl +L-77	18 g + .25 + .25%	88	3	1330
V10029 + Prowl +L-77	18g + .5 + .25%	84	0	1150
Whip + Prowl	.07 + .25	90	63	760
Control	-	73	27	320

Appendix A

Trade Names and Common Names And Manufacturers of Herbicides

Trade Name	Common Name	Manufacturer
Abolish	thiobencarb	United Agri Products
Bolero	thiobencarb	Valent
Dimension	dithiopyr	Rohm and Haas
F-8426	carfenthrazone	FMC
Grandstand	triclopyr	DowElanco
Liberty	glufosinate	AgrEvo
Londax	bensulfuron	DuPont
Mon-1200		Monsanto
Ordram	molinate	Zeneca
Prowl	pendimethalin	American Cyanamid
Pursuit	imazethapyr	American Cyanamid
Rhomene	MCPA	Rhone-Poulenc
Super Wham	propanil	Cedar
V-10029		Valent
Whip	fenoxoprop	AgrEvo
2,4-D amine 12G	2,4-D amine	Riverdale
Amine 4 2,4-D	2,4-D amine	Clean Crop
Hi-Dep	2,4-D amine	PBI/Gordon
Solutions	2,4-D amine	Riverdale
Weedar 64	2,4-D amine	Rhone-Poulenc

Appendix B

Additives used with Herbicides

Trade Name	Type	Manufacturer
Kenetic	organo silicone surfactant	Helena
Silwet L-77	organo silicone surfactant	Loveland
X-77	non-ionic surfactant	Valent
Agri-Dex	crop oil concentrate	Helena
Herbimax	crop oil concentrate	Loveland