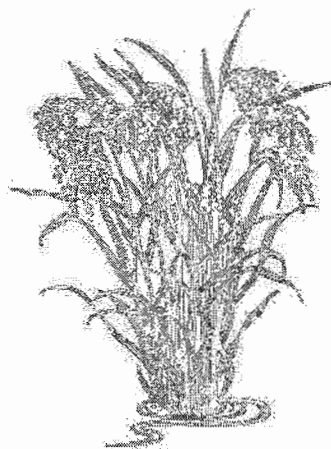


RICE FIELD DAY



Rice Weed Control

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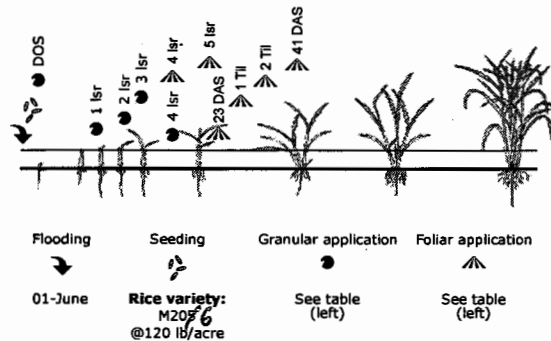
University of California

August 26, 2015

Evaluation of Herbicide Programs for Water-Seeded Rice (Continuous Flood)

COC = Crop oil concentrate; NIS = Non-ionic surfactant; UAN = Urea ammonium nitrate. Concentration of all these adjuvants was based on % v/v @ 20 gallons per acre spray volume.

#	Herbicide program	Rate (per acre)	Timing
1	Untreated control	—	—
2	Granite GR Abolish + Regiment + UAN + NIS	15 lb 1.5 qt + 0.53 oz + 2% + 0.2%	3 lsr 5 lsr
3	Cerano Granite GR Abolish + Regiment + UAN + NIS	12 lb 15 lb 1.5 qt + 0.53 oz + 2% + 0.2%	DOS 3 lsr 5 lsr
4	Cerano Butte Abolish + Regiment + UAN + NIS	12 lb 7.5 lb 1.5 qt + 0.53 oz + 2% + 0.2%	DOS 1 lsr 5 lsr
5	Bolero Regiment + UAN + NIS	23 lb 0.8 oz + 2% + 0.2%	1 lsr 4 lsr
6	Bolero Granite SC + SuperWham + COC	23 lb 2 oz + 6 qt + 1.25%	1 lsr 4 lsr
7	Shark Abolish + Regiment + UAN + NIS	7.5 oz 1.5 qt + 0.53 oz + 2% + 0.2%	1 lsr 5 lsr
8	Granite GR + Shark Abolish + Regiment + UAN + NIS	15 lb + 7.5 oz 1.5 qt + 0.53 oz + 2% + 0.2%	4 lsr 5 lsr
9	Cerano Shark Abolish + Regiment + UAN + NIS	12 lb 7.5 oz 1.5 qt + 0.53 oz + 2% + 0.2%	DOS 1 lsr 5 lsr
10	Untreated control	—	—
11	Bolero SuperWham + COC	23 lb 6 qt + 1.25%	1 lsr 1 Til
12	Cerano SuperWham + COC	12 lb 6 qt + 1.25%	DOS 1 Til
13	Granite GR SuperWham + COC	15 lb 6 qt + 1.25%	2 lsr 1 Til
14	RiceEdge	10 lb + 1.25%	23 DAS
15	RiceEdge	10 lb + 1.25%	41 DAS
16	Cerano Shark + Londax SuperWham + COC	12 lb 7.5 oz + 1.66 oz 6 qt + 1.25%	DOS 4 lsr 2 Til
17	Cerano Shark + Halomax SuperWham + COC	12 lb 7.5 oz + 1.33 oz 6 qt + 1.25%	DOS 4 lsr 2 Til
18	Granite GR + Shark Clincher Shark + SuperWham + COC	15 lb + 7.5 oz 13 oz 4 oz + 6 qt + 1.25%	4 lsr 1 Til 2 Til



Weed Control (% of untreated control; values for untreated control represent % cover by the respective weed species)																			
		20 DAS						40 DAS						60 DAS					
		Late watergrass (1)	Ricefield burinush (2)	Smallflower umbrella sedge (3)	Ducksalad (4)	Monochoria (5)	Redstem (6)	Late watergrass (1)	Ricefield burinush (2)	Smallflower umbrella sedge (3)	Ducksalad (4)	Monochoria (5)	Redstem (6)	Late watergrass (1)	Ricefield burinush (2)	Smallflower umbrella sedge (3)	Ducksalad (4)	Monochoria (5)	Redstem (6)
1	Untreated control	18	15	16	44	0	0	21	11	2	16	3	2	27	15	2	0	7	1
2	Granite GR Abolish + Regiment + UAN + NIS	90	77	74	66	—	—	100	100	100	100	—	89	100	100	100	—	100	100
3	Cerano Granite GR Abolish + Regiment + UAN + NIS	94	79	74	98	—	—	100	100	100	100	—	100	100	100	95	—	100	100
4	Cerano Butte Abolish + Regiment + UAN + NIS	97	100	100	100	—	—	100	100	100	100	—	100	100	100	100	—	95	100
5	Bolero Regiment + UAN + NIS	99	100	100	95	—	—	100	93	100	100	—	100	100	83	100	—	24	100
6	Bolero Granite SC + SuperWham + COC	99	100	100	99	—	—	100	100	100	100	—	100	100	100	100	—	100	100
7	Shark Abolish + Regiment + UAN + NIS	74	100	100	99	—	—	100	100	100	100	—	100	100	100	100	—	100	100
8	Granite GR + Shark Abolish + Regiment + UAN + NIS	97	100	100	96	—	—	100	100	100	100	—	100	100	100	100	—	100	100
9	Cerano Shark Abolish + Regiment + UAN + NIS	86	100	100	100	—	—	100	100	100	100	—	100	100	100	100	—	100	100
10	Untreated control	16	13	17	42	0	0	20	10	3	14	3	2	24	14	4	0	8	1
11	Bolero SuperWham + COC	100	93	100	95	—	—	100	90	100	100	—	100	100	82	100	—	85	100
12	Cerano SuperWham + COC	90	0	10	68	—	—	100	51	63	100	—	100	100	85	90	—	92	100
13	Granite GR SuperWham + COC	99	83	81	76	—	—	100	100	100	100	—	46	100	100	100	—	100	95
14	RiceEdge	—	—	—	—	—	—	96	100	100	—	—	100	96	100	100	—	92	90
15	RiceEdge	—	—	—	—	—	—	—	—	—	—	—	—	81	93	91	—	70	100
16	Cerano Shark + Londax SuperWham + COC	94	34	45	76	—	—	100	100	100	100	—	100	100	100	100	—	100	100
17	Cerano Shark + Halomax SuperWham + COC	93	69	74	88	—	—	100	100	100	100	—	100	100	100	100	—	100	100
18	Granite GR + Shark Clincher Shark + SuperWham + COC	96	100	68	78	—	—	100	100	100	100	—	100	100	100	100	—	100	100

Crop Response (0 to 100 scale; evaluated two weeks after application)													
		1 st application			2 nd application			3 rd application					
		Bleaching	Stunting	Stand reduction	Other injury	Bleaching	Stunting	Stand reduction	Other injury	Bleaching	Stunting	Stand reduction	Other injury
1	Untreated control	0	0	0	0	0	0	0	0	0	0	0	0
2	Granite GR Abolish + Regiment + UAN + NIS	0	0	0	0	0	8	3	0	—	—	—	—
3	Cerano Granite GR Abolish + Regiment + UAN + NIS	24	9	9	0	0	1	0	7	0	14	5	0
4	Cerano Butte Abolish + Regiment + UAN + NIS	28	30	23	0	0	4	3	4	0	4	3	0
5	Bolero Regiment + UAN + NIS	0	55	24	3	0	4	26	3	—	—	—	—
6	Bolero Granite SC + SuperWham + COC	0	66	46	3	0	1	29	7	—	—	—	—
7	Shark Abolish + Regiment + UAN + NIS	0	10	15	0	0	0	1	0	—	—	—	—
8	Granite GR + Shark Abolish + Regiment + UAN + NIS	0	0	0	0	0	11	1	1	—	—	—	—
9	Cerano Shark Abolish + Regiment + UAN + NIS	25	10	16	0	0	0	5	2	0	2	1	0
10	Untreated control	0	0	0	0	0	0	0	0	0	0	0	0
11	Bolero SuperWham + COC	0	73	58	4	0	4	21	3	—	—	—	—
12	Cerano SuperWham + COC	24	9	5	0	0	0	0	1	—	—	—	—
13	Granite GR SuperWham + COC	0	0	0	0	0	0	0	1	—	—	—	—
14	RiceEdge	0	1	0	2	—	—	—	—	—	—	—	—
15	RiceEdge	0	1	0	1	—	—	—	—	—	—	—	—
16	Cerano Shark + Londax SuperWham + COC	30	11	6	0	0	0	0	4	0	3	0	0
17	Cerano Shark + Halomax SuperWham + COC	25	10	11	0	0	0	0	3	0	0	0	0
18	Granite GR + Shark Clincher Shark + SuperWham + COC	0	0	0	0	0	6	0	2	0	6	1	5

Timing	Date	Weed stage/size						Temperature (°F)		Wind speed (mph)	RH (%)	Water depth (inches)
		1	2	3	4	5	6	Water surface	Air			
Seeding	03-June	x	x	x	x	x	x	—	—	—	—	—
DOS	04-June	x	x	x	x	x	x	86	90	—	—	4
1 lsr	10-June	—	1-2 l	g	2 l	x	x	83	87	—	—	4
2 lsr	14-June	2.5-3 l	4-5 l	1"	3-4 l	—	x	69	76	—	—	4
3 lsr	16-June	3 l	2-3 l	1-2"	3-4 l	—	—	81	82	—	—	4
4 lsr	19-June	4 l	3-5 l	2-3 l	>3 l	2 l	g	77	82	<1	44	2-3
5 lsr	25-June	5 l	5-7 l	2-4"	f	>2 l	2-4 l	79	90	4	52	2-3
23 DAS	26-June	5-6 l	5 l	3-4 l	f	2-3 l	3-4 l	87	95	3.8	39	2-3
1 Til	01-July	1-2 Til	2-3 Til	>5"	f	>2-4 l	5-6 l	80	81	<2	37	2-3
2 Til	06-July	2-3 Til	3 Til	>10"	f	>6 l	6-8 l	76	85	3.5	51	3-4
41 DAS	14-July	20-25"	f	>18"	f	>8 l	>8 l	75	79	3.1	48	3-4

Abbreviations: DOS = day of seeding rice; DAS, days after seeding rice; lsr = leaf stage of rice, Til = tiller of rice
*1 = leaf stage; f = flowering; g = germinating; x = not present; — = not recorded

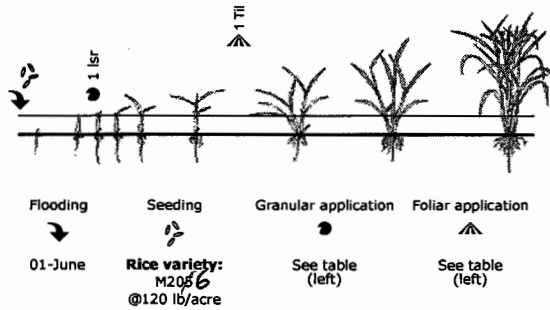
Evaluation of A New Rice Herbicide (Butte®) [Continuous Flood]

#	Herbicide program	Rate (per acre)	Timing
1	Untreated control	---	---
4	Butte	7.5 lb	1 lsr
5	Butte	9 lb	1 lsr
6	Butte Grandstand + SuperWham + COC	7.5 lb 6 oz + 6 qt + 1.25%	1 lsr 1 Ttl
7	Butte Granite SC + COC	7.5 lb 2.8 oz + 1.25%	1 lsr 1 Ttl
9	Untreated control	---	---
10	GWN-9796 + Sandea	57 oz + 1 oz	1 lsr

COC = Crop oil concentrate. Concentration of COC was based on % v/v @20 gallons per acre spray volume.

Weed Control																	
(% of untreated control; values for untreated control represent % cover by the respective weed species)																	
Late watergrass (1)	Ricefield burrush (2)	Smallflower umbrellasedge (3)	Ducksalad (4)	Monochoria (5)	Redstem (6)	Late watergrass (1)	Ricefield burrush (2)	Smallflower umbrellasedge (3)	Ducksalad (4)	Monochoria (5)	Redstem (6)	Late watergrass (1)	Ricefield burrush (2)	Smallflower umbrellasedge (3)	Ducksalad (4)	Monochoria (5)	Redstem (6)
16	10	19	35	0	0	10	10	3	2	8	>1	29	10	2	0	10	1
100	100	100	100	---	---	98	100	100	97	99	---	97	100	100	---	100	76
100	100	100	100	---	---	99	100	100	97	100	---	99	100	100	---	100	78
100	100	100	100	---	---	100	100	100	100	100	---	98	100	100	---	100	100
100	100	100	100	---	---	100	100	100	100	100	---	99	100	100	---	100	84
19	7	20	41	0	0	23	7	5	5	6	>1	33	8	3	0	3	1
100	100	100	100	---	---	98	100	100	100	99	---	96	100	100	---	100	73

Crop Response							
(0 to 100 scale; two weeks after application)							
Bleaching	Stunting	Stand reduction	Other injury	Bleaching	Stunting	Stand reduction	Other injury
0	0	0	0	0	0	0	0
4	0	0	3	---	---	---	---
3	0	0	2	---	---	---	---
4	0	0	1	0	1	1	0
4	0	0	2	0	2	1	0
0	0	0	0	0	0	0	0
2	0	0	1	0	0	0	0



Timing	Date	Weed stage/size						Temperature (°F)		Wind speed (mph)	RH (%)	Water depth (inches)
		1	2	3	4	5	6	Water surface	Air			
Seeding	03-June	x	x	x	x	x	x	---	---	---	---	4
1 lsr	10-June	---	1-2 l	g	2 l	x	x	83	87	---	---	4
1 Ttl	01-July	1-2 Ttl	1-3 Ttl	5-6 l	f	>6 l	3-6 l	82	89	1	35	2-3

Abbreviations: lsr = leaf stage of rice, Ttl = tiller of rice
*l = leaf stage; f = flowering; g = germinating; x = not present; --- = not recorded

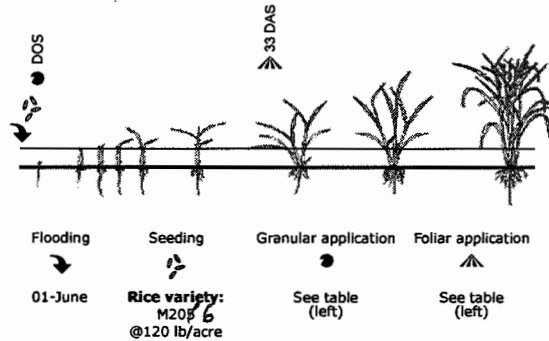
Evaluation of A New Rice Herbicide (Strada®) [Continuous Flood]

#	Herbicide program	Rate (per acre)	Timing
1	Untreated control	—	—
2	Cerano SuperWham + COC	10 lb 6 qt + 1.25%	DOS 33 DAS
3	Cerano SuperWham + Strada + COC	10 lb 6 qt + 2.1 oz + 1.25%	DOS 33 DAS
4	Cerano Shark + Strada + NIS	10 lb 4 oz + 2.1 oz + 0.25%	DOS 33 DAS

COC = Crop oil concentrate; NIS = Non-ionic surfactant. Concentration of COC and NIS was based on % v/v @20 gallons per acre spray volume.

Weed Control (% of untreated control; values for untreated control represent % cover by the respective weed species)																			
Late watergrass (1)	Ricefield bulrush (2)	Smallflower umbrellassegde (3)	Ducksalad (4)	Monochona (5)	Late watergrass (1)	Ricefield bulrush (2)	Smallflower umbrellassegde (3)	Ducksalad (4)	Monochona (5)										
										20 DAS					60 DAS				
										17	11	14	42	0	22	12	3	0	19
90	0	0	71	—	98	98	100	—	75										
92	0	0	74	—	100	98	100	—	92										
90	0	0	77	—	100	95	85	—	90										

Crop Response (0 to 100 scale; two weeks after application)															
Bleaching	Stunting	Stand reduction	Other injury	Bleaching	Stunting	Stand reduction	Other injury								
								1 st application				2 nd application			
								0	0	0	0	0	0	0	0
14	18	5	0	0	0	0	2								
15	11	1	0	0	2	0	9								
12	13	3	0	0	3	0	6								



Timing	Date	Weed stage/size					Temperature (°F)		Wind speed (mph)	RH (%)	Water depth (inches)
		1	2	3	4	5	Water surface	Air			
Seeding	03-June	x	x	x	x	x	—	—	—	—	4
DOS	04-June	x	x	x	x	x	86	90	—	—	4
33 DAS	06-July	2 Tll	1-3 Tll	2-3 Tll	2-3 Tll	>8 l	75	80	3.5	63	3-4

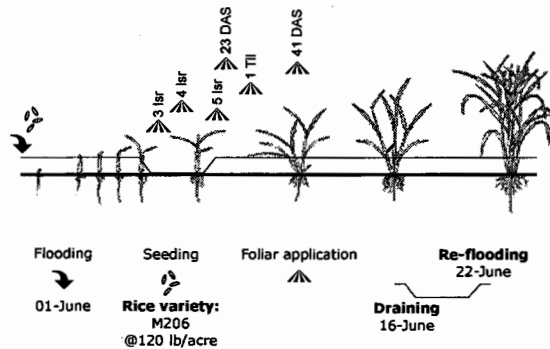
Abbreviations: DOS = day of seeding rice; DAS, days after seeding rice; Tll = tiller of rice
* l = leaf stage; f = flowering; g = germinating, x = not present

Evaluation of Herbicide Programs for Water-Seeded Rice

[Pinpoint Flood]

#	Herbicide program	Rate (per acre)	Timing
1	Untreated control	---	---
2	RiceEdge	10 lb	23 DAS
3	RiceEdge	10 lb	41 DAS
4	Clincher + Granite GR Shark Abolish + Regiment + UAN + NIS	13 oz + 2 oz 4 oz 1.5 qt + 0.53 oz + 2% + 0.2%	3 lsr 4 lsr 5 lsr
6	SuperWham + COC	6 qt + 1.25%	1 Tll
7	Clincher + SuperWham + COC	13 oz + 6 qt + 1.25%	4 lsr
8	Regiment + UAN + NIS Clincher + SuperWham + COC	0.67 oz + 2% + 0.2% 13 oz + 6 qt + 1.25%	4 lsr 1 Tll
9	Untreated control	---	---
11	Granite SC Clincher + SuperWham + COC	2 oz 13 oz + 6 qt + 1.25%	3 lsr 1 Tll
12	Abolish + SuperWham + COC Granite SC + COC	1.5 qt + 4 qt + 1.25% 2.8 oz + 2.5%	4 lsr 1 Tll

COC = Crop oil concentrate; **NIS** = Non-ionic surfactant; **UAN** = Urea ammonium nitrate. Concentration of all these adjuvants was based on % v/v @20 gallons per acre spray volume.



Weed Control (% of untreated control) (values for untreated control represent % cover by the respective weed species)													
Late watergrass (1)		Spangletop (2)		Ricefield bulrush (3)		Smallflower umbrella sedge (4)		Ducksalad (5)		Monochoria (6)		Redstem (7)	
40 DAS							60 DAS						
1	22	21	10	0	0	2	7	2	15	26	0	2	8
95	94	100	---	---	---	---	94	0	100	80	---	0	80
---	---	---	---	---	---	---	64	40	98	92	---	0	97
100	---	100	100	100	---	---	100	100	100	99	---	62	100
98	---	99	100	80	---	---	97	0	100	100	---	0	100
100	---	98	100	55	---	---	100	90	100	96	---	0	97
99	---	93	100	100	---	---	100	90	100	78	---	0	77
1	1	18	20	13	0	2	10	3	14	17	0	1	9
100	---	99	99	100	---	---	100	88	96	79	---	0	77
100	---	100	100	80	---	---	95	90	98	99	---	0	97

Crop Response (0 to 100 scale, evaluated two weeks after application)											
Bleaching		Stunting		Stand reduction		Other injury		Bleaching		Stunting	
1 st application				2 nd application				3 rd application			
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	2	---	---	---	---	---	---	---	---
0	0	0	2	---	---	---	---	---	---	---	---
0	0	0	5	0	0	0	6	0	5	0	0
0	1	1	4	---	---	---	---	---	---	---	---
0	1	2	5	---	---	---	---	---	---	---	---
0	5	0	2	0	2	2	4	---	---	---	---
0	0	0	0	0	0	0	0	0	0	0	0
0	4	0	4	0	0	0	4	---	---	---	---
0	0	0	0	0	0	1	2	---	---	---	---

Timing	Date	Weed stage/size							Temperature (°F)		Wind speed (mph)	RH (%)	Water depth (inches)
		1	2	3	4	5	6	7	Water surface	Air			
Seeding	03-June	x	x	x	x	x	x	x	---	---	---	---	4
3 lsr	18-June	2-2.5 l	---	3-4 l	1-2"	2-3 l	x	---	74	4	51	0	
4 lsr	20-June	3-4 l	---	4-5 l	2-3"	4-5 l	2-3 l	---	85	3	44	0	
5 lsr	24-June	4 l	2-3 l	5 l	3-4"	4-6 l	2-4 l	g	79	80	1	49	3
23 DAS	26-June	5-6 l	3-4 l	5-6 l	4-6"	f	4-5 l	g	87	95	3.8	39	3.5
1 Tll	01-July	1-2 Tll	1-2 Tll	1-2 Tll	5-6 l	f	>6 l	4-5 l	82	89	1	35	3
41 DAS	14-July	20"	3-4 Tll	f	18"	f	>8 l	8-10 l	75	79	3.1	48	3

Abbreviations: DAS, days after seeding rice; lsr = leaf stage of rice, Tll = tiller of rice
* l = leaf stage; f = flowering; g = germinating; x = not present; --- = not recorded

Evaluation of Herbicide Programs for Dry-Seeded Rice (Drill-Seeded)

COC = Crop oil concentrate; **NIS** = Non-ionic surfactant; **UAN** = Urea ammonium nitrate.
 Concentration of all these adjvants was based on % v/v @20 gallons per acre spray volume.

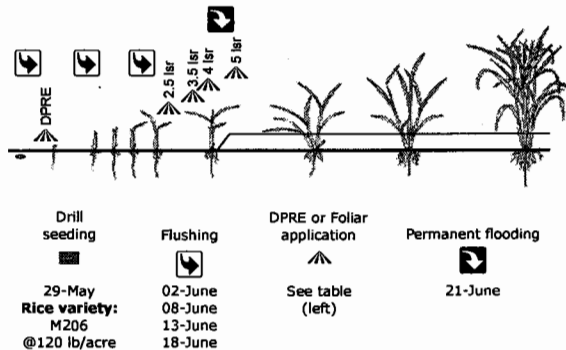
#	Herbicide program	Rate (per acre)	Timing
1	Untreated control	—	—
2	Prowl	2 pt	DPRE
3	Abolish	1.5 qt	DPRE
4	Prowl SuperWham + COC	2 pt 6 qt + 1.25%	DPRE 3.5 lsr
5	Abolish SuperWham + COC	1.5 qt 6 qt + 1.25%	DPRE 3.5 lsr
6	Prowl Basagran + SuperWham + COC	2 pt 2 pt + 4 qt + 1.25%	DPRE 3.5 lsr
7	Halomax + Prowl	1.33 oz + 2 pt	DPRE
8	Untreated control	—	—
9	Prowl Abolish + Regiment + UAN + NIS	2 pt 1.5 qt + 0.53 oz + 2% + 0.2%	DPRE 5 lsr
10	Abolish Abolish + Regiment + UAN + NIS	1.5 qt 1.5 qt + 0.53 oz + 2% + 0.2%	DPRE 5 lsr
11	Abolish Clincher + Granite SC + Prowl + COC Shark	1.5 qt 15 oz + 2 oz + 2 pt + 2.5% 4 oz	DPRE 2.5 lsr 4 lsr
12	Prowl Clincher + Granite SC + Prowl + COC Shark	2 pt 15 oz + 2 oz + 2 pt + 2.5% 4 oz	DPRE 2.5 lsr 4 lsr
13	Abolish Clincher + Prowl + SuperWham + COC Shark	1.5 qt 13 oz + 2 pt + 4 qt + 2.5% 4 oz	DPRE 3.5 lsr 4 lsr
14	Prowl Clincher + Prowl + SuperWham + COC Shark	2 pt 13 oz + 2 pt + 4 qt + 2.5% 4 oz	DPRE 3.5 lsr 4 lsr
15	Abolish Basagran + SuperWham + COC	1.5 qt 2 pt + 4 qt + 1.25%	DPRE 4 lsr
16	Untreated control	—	—

Weed Control (% of untreated control) (values for untreated control represent % cover by the respective weed species)					
Echinochloa (1) Smallflower umbrella sedge (2)		Echinochloa (1) Smallflower umbrella sedge (2)		Echinochloa (1) Smallflower umbrella sedge (2)	
20 DAS		40 DAS		60 DAS	
36	3	40	5	37	3
59	29	62	31	53	11
42	91	44	100	43	100
84	89	88	100	94	100
88	98	85	100	92	100
79	94	86	100	89	100
74	94	74	100	78	97
32	2	38	4	31	2
51	19	95	98	98	100
43	90	96	100	100	100
78	93	88	100	96	100
81	83	87	100	92	98
90	96	99	100	100	100
85	88	98	100	100	98
61	97	92	100	91	100
33	2	31	3	28	2

Crop Response (0 to 100 scale; evaluated two weeks after application)											
1 st application				2 nd application				3 rd application			
Bleaching	Stunting	Stand reduction	Other injury	Bleaching	Stunting	Stand reduction	Other injury	Bleaching	Stunting	Stand reduction	Other injury
0	0	0	0	0	0	0	0	0	0	0	0
0	2	0	0	—	—	—	—	—	—	—	—
0	2	0	0	—	—	—	—	—	—	—	—
0	1	0	0	0	2	2	2	—	—	—	—
0	2	0	0	0	1	0	1	—	—	—	—
0	1	0	0	0	1	1	2	—	—	—	—
0	2	0	0	—	—	—	—	—	—	—	—
0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	1	0	2	—	—	—	—
0	2	0	0	0	2	0	3	—	—	—	—
0	2	0	0	0	8	0	12	0	10	0	9
0	2	0	0	0	9	0	14	0	8	0	11
0	1	0	0	0	8	1	11	0	10	0	8
0	2	0	0	0	8	1	12	0	11	0	8
0	2	0	0	0	1	1	1	—	—	—	—
0	0	0	0	0	0	0	0	0	0	0	0

Echinochloa species

- 1- Barnyardgrass
- 2- Early watergrass
- 3- Late watergrass

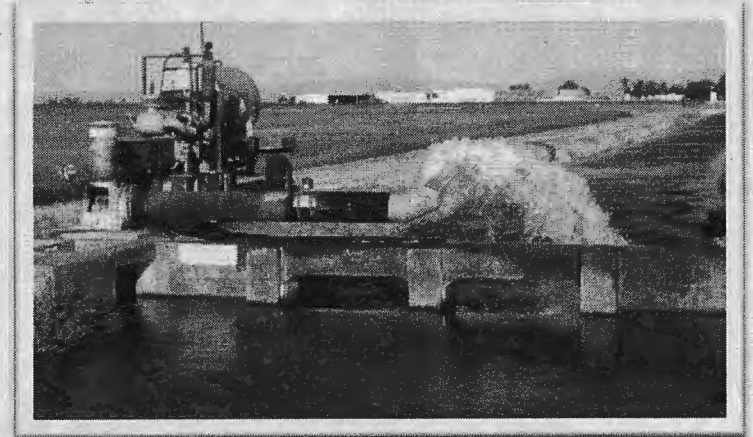
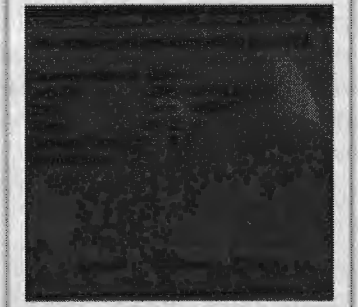


Timing	Date	Weed stage/size		Temperature (°F)		Wind speed (mph)	RH (%)	Water depth
		1	2	Soil surface	Air			
Seeding	29-May	x	x	—	—	—	—	dry
DPRE	03-June	x	x	76	85	3.2	34	moist
2.5 lsr	14-June	2.5-3 l	1"	67	68	3.3	59	moist
3.5 lsr	17-June	3-3.5 l	1-1.5"	75	74	1.8	61	moist
4 lsr	19-June	4-5 l	1-2"	74	76	4	49	moist
5 lsr	22-June	4-6 l	4-6 l	66	68	3.1	57	3-4"

* l = leaf stage; f = flowering; g = germinating; x = not present; — = not recorded

RICE FIELD DAY

Wednesday, August 26, 2015



Dealing with the Drought

California Cooperative Rice Research Foundation, Inc.

University of California

United States Department of Agriculture

Cooperating

Rice Experiment Station

P.O. Box 306, Biggs, CA 95917-0306

Rice Weed Control: Herbicide Programs, New Chemicals, and Weed Management
(K. Al-Khatib, A.S. Godar, W. Brim-DeForest, J.R. Stogsdill, R. Pedroso, M.F. Galla, B.A. Linqvist, L. Espino and R.G. Mutters, UCD and UCCE)

The UC Rice Weed Research Program at the Hamilton road site at the Rice Experiment Station, Biggs, CA includes the performance testing of herbicides, and their mixtures and sequential combinations for the common rice growing systems in California (continuous flood, pinpoint flood, and drill-seeded rice systems). We have also continued testing new products primarily aimed at assisting the rice industry in the registration of new herbicides as options become available. Our efforts seek to assist California rice growers in achieving economic and timely broad-spectrum weed control, preventing and managing issues of evolved herbicide-resistant weeds, and complying with personal and environmental safety requirements.

Here we highlight results from our 2015 field operation for the major rice growing systems used in California. Herbicide program efficacy comments presented here primarily reflect the average visual ratings of four replicates for major weed species approximately 40 days after seeding (DAS) of rice which covers the critical period of competition (30 days). Crop response (stand reduction, stunting and other injury to rice) has also been highlighted wherever relevant.

Continuously-Flooded Rice

This system promotes suppression of certain weeds such as barnyardgrass and sprangletop. These two weeds would otherwise be dominant in dry-seeded systems. After seeding rice into a flooded field, a water depth of 4 inches is maintained throughout the season. When late post-emergence foliar applications are needed, water depth is lowered to expose about two-thirds of weed foliage to the herbicide spray, but fields are never completely drained. This year, watergrass (early and late) were the predominant weeds, followed by ducksalad, ricefield bulrush, smallflower umbrella sedge, redstem and sprangletop. All weeds evaluated in our program are susceptible to rice herbicides registered in California, but we discuss and give weed management options for fields with population(s) of resistant weed species.

For this system, several granular into-the-water herbicide products are available for controlling weeds in rice including Bolero, Cerano, Granite, Halomax, Londax, and Shark H₂O. These herbicides can be

applied early to provide good to excellent control of labelled (target) weeds. As they vary in their target weeds (spectrum of weed control), it is useful to combine two of these herbicides in a program to offer broad spectrum weed control.

POST-applied (foliar) herbicides are often necessary to achieve excellent weed control in rice. The follow-up POST application of herbicides not only extend spectrum of weed control, but also may help delay and/or manage herbicide-resistant weeds through overlapping activity on the same target weed species. Thus, the choice of POST-applied herbicides is primarily dictated by composition of weed species and the presence or absence of resistant weeds. The rice herbicide options for the foliar application include Abolish, Clincher, Granite SC, Regiment, RiceEdge, Shark H₂O, SuperWham or Stam, Halomax and Londax.

All Bolero-based programs, with Bolero applied at the 1 leaf stage of rice (1sr) offered excellent control (100%) of watergrass, sprangletop and smallflower umbrella sedge. Inclusion of SuperWham at 6 qt/A + 1.25% v/v Crop Oil Concentrate (COC) at 1-tiller stage or Regiment (0.8 oz/A + 2% v/v UAN + 0.2% v/v NIS at 4 lsr) in this program improved (>90%) control of ducksalad; however, neither of these two programs provided more than 85% control of ricefield bulrush. A tank-mix of Granite SC (2 oz/A) and SuperWham (6 qt/A + 1.25% v/v COC) applied at 4 lsr maximized (100% control) the control of ricefield bulrush. Although Bolero-based programs offer excellent control of grasses and ALS- and propanil-resistant smallflower umbrella sedge, a substantial level of stand reduction of rice is observed.

Cerano applied at the day of seeding (DOS) provided good control of watergrass and sprangletop (>90% control) 20 days after seeding (DAS). A foliar application of SuperWham (6 qt/A + 1.25% v/v COC) at 1-tiller stage following Cerano was exceptionally effective in controlling watergrass (100% control), however, the control of ricefield bulrush and smallflower umbrella sedge was poor (<75% control) 40 DAS. Cerano supplemented with a granular application of Shark H₂O (7.5 oz/A) with Londax (1.66 oz/A) or Halomax (1.33 oz/A) at 3 lsr and followed by a foliar application of SuperWham (6 qt/A + 1.25% v/v COC) at 2-tiller stage provided complete control of all the weed species. An alternative to this program with similar efficacy was Cerano followed by Granite GR (15 lb/A) at 3 lsr followed by a tank-mix foliar application of Abolish (1.5 qt/A) + Regiment (0.53 oz/A) with 2% v/v UAN and 0.2% v/v NIS at 5 lsr.

Granite GR (15 lb/A at 2-3 lsr) offers a broader spectrum of weed control (including ducksalad and ricefield bulrush) compared to Bolero and Cerano; however, it lacks efficacy on sprangletop and redstem control. While a follow-up foliar application of SuperWham (6 qt/A + 1.25% v/v COC at 1-tiller stage) alone offers overlapping control of some weed species and help controlling certain ALS-resistant weeds, it does not control sprangletop and redstem. Granite followed by a tank-mix application of Abolish (1.5 qt/A) + Regiment (0.53 oz/A) + UAN (2% v/v) + NIS (0.2 % v/v) at 5 lsr provided 100% control of sprangletop. An addition of Shark H₂O (0.53 oz//A at 2.5 lsr) on top of this program maximized the overall weed control (100% control of all the weed species including redstem).

The Shark H₂O- based programs offer control of ALS- and propanil-resistant sedges (ricefield bulrush and smallflower umbrella sedge) and the Bolero-based programs offer control of ALS- and propanil resistant smallflower umbrella sedge. Programs with a follow-up application of a tank mix of Abolish (1.5 qt/A) + Regiment (0.53 oz/A) + 2% v/v UAN + 0.2% v/v NIS at 5 lsr offer control of multiple-resistant watergrass escapes. Another option is to use Regiment at the highest label rate (0.8 oz/A) with 2% v/v UAN + 0.2% v/v NIS at the 4 lsr. For Clincher-resistant sprangletop, a program with granular application of Cerano (DOS) or Bolero (1 lsr), followed by a foliar application of Abolish at 5 lsr is recommended. For Cerano-resistant sprangletop, Bolero applied at the 1 lsr, followed by a foliar application of Clincher (at the 3-4 lsr) is recommended.

Pinpoint Flood

In this system the field is completely drained during the period of foliar application of herbicide (at about the 2-4 leaf stage of rice). The complete drainage of the field is intended to expose weed foliage to herbicide applications, thus allowing the opportunity to achieve the best efficacy of POST herbicides. Weeds present in this system were (in order of relative density) ricefield bulrush, ducksalad, watergrass (early and late), smallflower umbrella sedge, redstem, and sprangletop.

The SuperWham-only (6 qt/A + 1.25% v/v COC at 4 lsr to 1-tiller stage) application was excellent in controlling (97% or more) watergrass, ricefield bulrush and smallflower umbrella sedge. SuperWham when tank-mixed with Clincher (6 qt/A + 13 oz/A + 2.5% v/v COC at 4 lsr) was effective in controlling both watergrass and sprangletop.

A tank-mix application of Clincher (13 oz/A) and Granite SC (2 oz/A) with 2% v/v COC at 3 lsr provided excellent (>99%) control of all

weeds including ducksalad within a week after treatment. With two follow-up applications of Shark H₂O (4 oz/A) at 4 lsr and Abolish + Regiment (1.5 qt/A + 0.53 oz/A + 2 % v/v UAN + 0.2% v/v NIS) at 5 lsr the overall efficacy of this program was excellent (100% control of all weeds). Addition of Shark H₂O to the weed management program offers improved efficacy including control of ALS-inhibitor- and/or propanil-resistant sedges; whereas the tank- mix application of Regiment + Abolish provokes synergism on watergrass control and also helps in controlling multiple herbicide-resistant watergrass. This program offers an excellent 'reactive' as well as 'preventive' herbicide-resistant weed management in rice.

A single application of three-way tank-mix of Clincher (13 oz/A), Granite SC, (2 oz/A), Abolish, (1.5 qt/A) with 2.5% v/v COC applied at 2-3 lsr provided 100% control of watergrass and sprangletop, and an excellent control of ducksalad, ricefield bulrush, smallflower umbrella sedge. This program will not control certain ALS-inhibitor-resistant ricefield bulrush and thiobencarb-resistant watergrass populations; however, it is a good alternative for fields with ACCase-resistant (Clincher-resistant) sprangletop populations. Similar results were obtained when Regiment (0.67oz/A + 2% v/v UAN + 0.2% v/v NIS) or Granite SC (2 oz/A + 2.5% v/v COC) were applied at 3-4 lsr followed by tank mix of SuperWham + Clincher (6 qt/A + 13 oz /A + 2.5% v/v COC) at 1-tiller stage.

An excellent control of watergrass, sprangletop and ricefield bulrush, and smallflower umbrella sedge (>98%) were achieved by Clincher (13 oz/A + 2.5% v/v COC) alone at 3-4 lsr followed by a tank mix of SuperWham + Grandstand (6 qt/A + 8 oz/A + 1.25% v/v COC) at 1 t-tiller stage or Abolish + SuperWham (1.5 qt/A + 6 qt/A 1.25% v/v COC) at 3-4 lsr followed by Granite SC (2.8 oz/A + 2.5% v/v COC) alone at 1-tiller stage. Grandstand effectively controls ricefield bulrush and redstem, and it is particularly useful when the field has herbicide-resistant populations of these weeds. Abolish is a better choice than Grandstand when ducksalad is predominant in the field.

Drill-Seeded Rice

Typically a period of three to four weeks elapses between the first flush and permanent flooding in drill-seeded rice system. This period offers flexibility for herbicide use when proximity to sensitive crops imposes restrictions to aerial applications. During this period weeds adapted to dryland seedbeds such as barnyardgrass, sprangletop, watergrass and smallflower umbrella sedge become established, whereas aquatic weeds such as ricefield bulrush, ducksalad, and redstem are less favored or eliminated. Thus, this system when alternated with the water-seeded system may be useful for reducing

aquatic weed pressure in water-seeded system, and *vice versa*. Weeds present in this system were the *Echinochloa* complex (early and late watergrass, and barnyardgrass), and smallflower umbrella sedge and sprangletop.

Abolish and Prowl are valuable residual herbicides which provide early weed control up to the start of permanent flood. Both herbicides suppress watergrass and barnyardgrass; however Abolish is more active on smallflower umbrella sedge than Prowl. Regular flushing before permanent flood activates these herbicides and also helps in the establishment of rice. For a delayed pre-emergence application (DPRE) of these herbicides, the rice seed is first drilled into dry soil, the field is then flushed once and then an herbicide is applied onto a moist soil surface. As these pre-emergent herbicides do not provide complete control of weeds, one or two foliar applications of herbicides/herbicide mixtures on emerged weeds are necessary.

The DPRE application of Prowl (2 pt/A) provided 62% control of *Echinochloa* species and 31% control of smallflower umbrella sedge. Abolish (1.5 qt/A) was less effective on *Echinochloa* species (43% control) than Prowl; however it was exceptionally effective in controlling smallflower umbrella sedge (99 to 100% control).

All the foliar applications (described later) that followed DPRE application of Prowl provided excellent control of smallflower umbrella sedge (98 to 100% control), thus, providing flexibility in the herbicide program for controlling herbicide-resistant biotypes of this weed.

A foliar application of SuperWham (6 qt/A 2% v/v COC) alone following the DPRE Abolish or Prowl application improved control of *Echinochloa* species (85 to 90%) compared to its control by DPRE applications alone; however, the control was still not adequate. The DPRE application followed by a tank-mix of Abolish + Regiment (1.5 qt/A + 0.53 oz/A + 2.0% v/v UAN + 0.2% v/v NIS) at 5 lsr greatly improved *Echinochloa* control (>97 %). Two foliar applications of Prowl + SuperWham + Clincher (2 pt/A + 4 qt/A + 13 oz/A + 2.5% v/v COC) at 3 lsr and Shark H₂O (4 oz/A) at 4 lsr following the DPRE application provided excellent control (98 to 100%) of *Echinochloa* species. In this program, the second application of Prowl suppresses *Echinochloa* emergence for extended period whereas the tank-mix application of SuperWham and Clincher provide overlapping efficacy on emerged barnyardgrass and watergrass. Shark H₂O supplements SuperWham for controlling smallflower umbrella sedge (including propanil-resistant biotypes). This is an intensive program for controlling *Echinochloa* and sedges, thus, it is particularly suitable

for controlling herbicide-resistant populations of grasses and sedges. Similar levels of weed control may be achieved without Shark H₂O when Abolish is used as a DPRE application, and *Echinochloa* and smallflower umbrella sedge are susceptible. Use of Abolish and Prowl in alternate years will add to delaying evolution of resistant *Echinochloa* species.

New Weed Management Products

RiceEdge®

RiceEdge® is a dry flowable mixture of propanil and halosulfuron product delivered by RiceCo, LLC, CA. The herbicide was tested under a continuous flood and a pinpoint flood (drained for one week at the 3-4 lsr). In both trials, it was applied at the highest label rate of 10 lb/A with 1.25% v/v COC at 20 DAS. RiceEdge® provided excellent control (>95%) of watergrass, ricefield bulrush, and smallflower umbrella sedge in both systems. Ducksalad control was often poor (<50%) with this herbicide product.

Butte®

Butte® is a granular mixture of benzobicyclon and halosulfuron product developed by Gowan. The benzobicyclon component of Butte® adds a new mode of action (HPPD-inhibitor) to the herbicide programs in water-seeded rice.

Butte® was tested under a continuous flood system with two rates of application, both alone and in a program. An early POST application of Butte® at 7.5 lb/A rate or a slightly higher rate (9 lb/A) at 1 lsr (7 days after seeding) provided excellent control (>98%) of all weeds including watergrass, ricefield bulrush, smallflower umbrella sedge, ducksalad, and monochoria. These applications provided a broad spectrum of weed control and offered an exceptional level of crop safety. A follow-up application (at 1-tiller stage) of SuperWham + Grandstand (6 pt/A + 6 oz/A + 1.25% v/v COC), Granite SC (2.8 oz/A + 1.25% v/v COC), or Regiment (0.67 oz/A + 2.0% v/v UAN + 0.2% v/v NIS) provided exceptional control (100% control of all weeds including redstem 40 DAS). While stand-alone application of Butte® offers excellent weed control in water-seeded rice, a follow-up application or an inclusion of a partner granular herbicide (for example Cerano) will maximize the spectrum of weed control.

Strada®

Strada® is a granular formulation of orthosulfamuron (an ALS-inhibiting herbicide) developed by Nichino America. Efficacy of Strada® was tested under a continuous flood in a Cerano-based program in a tank mix with SuperWham or Shark H₂O applied at 35

days after seeding (approximately at 2-tiller stage of rice). Cerano (10 lb/A at DOS) followed by a tank mix of Strada (2.1 oz/A) with SuperWham (6 qt/A + 1% v/v COC) or Shark H₂O (4 oz/A + 0.25% v/v NIS) provided a very good control of watergrass (>95%) and a fair control of ricefield bulrush (>80%). Smallflower umbrella sedge control was much better (>95%) with the program containing SuperWham than that containing Shark H₂O (<50%).

Weed Management

The evolution of herbicide resistance in major weed species of California rice, including *Cyperus difformis* L. (smallflower umbrella sedge) and *Echinochloa phyllopogon* (Stapf) Koss (late watergrass), has necessitated the search for alternative management options, including alternate herbicide modes of action and tillage practices in conjunction with the use of a stale seedbed. In addition to the prevailing water seeding and continuous flooding in rice, reduced irrigation schemes are being explored for water conservation, which is expected to alter the usual weed recruitment patterns.

Weed Germination, Emergence and Growth Models:

To establish appropriate timing of weed control interventions under variable field conditions, it is necessary to be able to predict the dynamics of weed germination and emergence under those conditions. The population-based threshold models (PBTM) combine information about irrigation method and soil temperature to provide species-specific emergence and growth curves, allowing growers to better time application of herbicides and manage weeds using cultural controls. Our updated model and validation work for *C. difformis* and *E. phyllopogon* are in their final stages, and publications on the field-validated models are expected within the next year.

Weed Population Dynamics in Alternative Irrigation Systems

Due to looming water resource issues in California, we have also been evaluating the dynamics of weed emergence in alternative irrigation systems. Since 2013, we have been evaluating three systems: i) Water-Seeded Alternate Wet and Dry (WS-AWD): flooded for initial seeding by air, and until canopy closure of the rice, subsequently allowed to drain and then flushed again when Volumetric Water Content (VWC) reached 35%; ii) Drill-Seeded Alternate Wet and Dry (DS-AWD): drill-seeded, then flushed again when VWC reached 35%; and iii) Water-Seeded Conventional (WS-Control): permanent flood of 10-15 cm, which was maintained until the field was drained approximately one month prior to harvest. Evaluations of weed dynamics in these systems are in their final stages, and publications are expected in the near future.

Herbicides used and their active ingredient

<u>Herbicide</u>	<u>% ai</u>	<u>lb ai/gal</u>
Abolish 8EC (thiobencarb)	84	8.0
Bolero Ultramax (thiobencarb)	15	NA
Butte (benzobicyclon + halosulfuron)	3 + 0.64	NA
Cerano 5 MEG (clomazone)	5	NA
Clincher CA (cyhalofop-butyl)	29.6	2.4
Grandstand (triclopyr)	44.4	3.0
Granite GR (penoxsulam)	0.24	NA
Granite SC (penoxsulam)	24	2.0
Halomax 75 (halosulfuron)	75	NA
Londax (bensulfuron-methyl)	60	NA
Prowl H ₂ O (pendimethalin)	42.6	3.8
Regiment (bispyribac-sodium)	80	NA
RiceEdge (propanil + halosulfuron)	60 + 0.64	NA
Sandea (halosulfuron)	75	NA
Shark H ₂ O (carfentrazone)	40	NA
Strada CA (orthosulfamuron)	50	NA
SuperWham! CA (propanil)	41.2	4.0

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