

Weed Management in Rice

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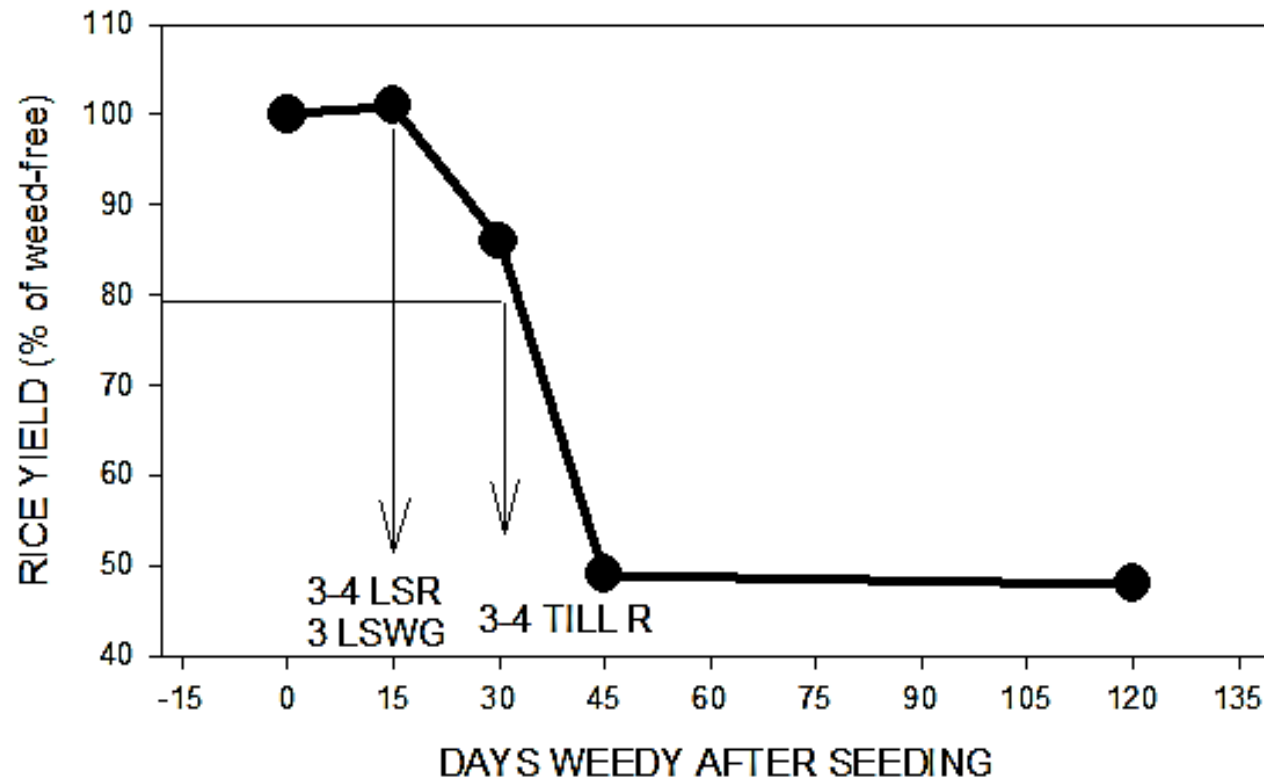
What Rice Farmers Say About Weeds

- Weeds is rank as 1st or 2nd problem in rice.
- Weed management in rice is challenging, complex, expensive, and regulated.
- Herbicide is the preferred method of controlling weed and it is the first and probably the last line of defense.
- Farmers are not quit sure if herbicides are now working well – resistant weeds
- Herbicide program vary between fields, no base program
- Less water means more weeds and more herbicides

Rice Yield Loss from Heavy, Season-long Weed Intereference

Weed Species	Potential Yield Loss (%)
Barnyardgrass	82
Bearded sprangletop	36
Ducksalad	21
Eclipta	10

Effect of Late Watergrass Competition on Rice Yields



Chemical Weed Management

Challenging, Complex, Expensive, and Regulated



California Rice Weeds - Grasses



Barnyardgrass
Echinochloa crus-galli



Early Watergrass
E. oryzoides



Late Watergrass
E. Phyllopogon



Bearded Sprangletop
Leptochloa fascicularis



Junglerice, *Echinochloa colona*

California Rice Weeds - Sedges



Ricefield Bulrush
Schoenoplectus mucronatus



Smallflower Umbrella Sedge
Cyperus difformis

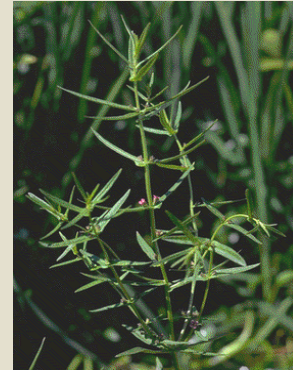
California Rice Weeds -Broadleaves



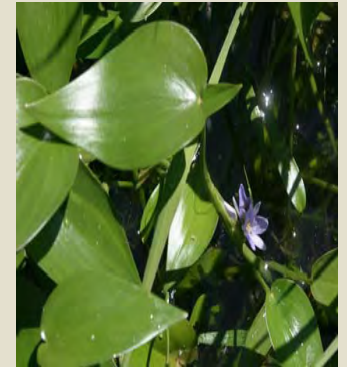
California Arrowhead
Sagittaria montevidensis



Gregg's Arrowhead
Sagittaria longiloba



Redstem
Ammannia species



Monochoria
Monochoria vaginalis



Ducksalad
Heteranthera limosa



Waterhyssop
Bacopa rotundifolia



Common Waterplantain
Monochoria vaginalis

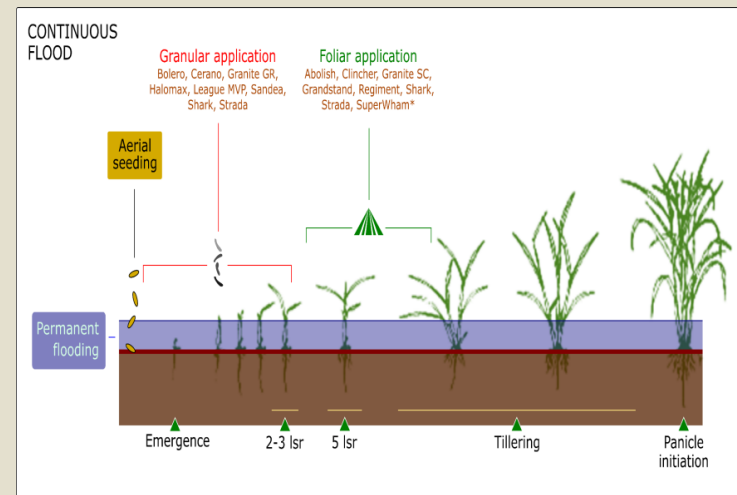
Rice Herbicide

Common name	Trade name	MOA
Bensulfuron	Londax®	ALS inhibitor
Bispyribac-sodium	Regiment®	ALS inhibitor
Halosulfuron	Sandea®, Semptra	ALS inhibitor
Penoxsulam	Granite®	ALS inhibitor
Imazasulfuron	League MVP	ALS inhibitor
Orthosulfamuron	Strada	ALS inhibitor
Carfentrazone	Shark H2O®	PROTOX inhibitor
Clomazone	Cerano®, Bombard®	Carotenoid biosynthesis inhibitor
Cyhalofop-butyl	Clincher®	ACCase inhibitor
Pendimethalin	Prowl H2O®	Tublin inhibitor
Propanil	Stam®, SuperWham®	Photosystem II inhibitor
Thiobencarb	Abolish®, Bolero®	VLCFA (Very long chain fatty acids)
Triclopyr	Grandstand®	Synthetic auxin

Rice Herbicide

Herbicide	Applied to Foliage	Applied in Water	Timing
Abolish (Thiobencarb)	Yes	Yes	1-2 lsr
Bolero (Thiobencarb)	No	Yes	1-2 lsr
Cerano (Clomazone)	No	Yes	0-1 lsr
Clincher (Cyhalofop-butyl)	Yes	No	2 lsr - mt
Regiment (Bispyribac-sodium)	Yes	No	5 lsr - mt
SuperWham (Propanil)	Yes	No	3 lsr - mt
Stam (Propanil)	Yes	No	3 lsr - mt
Londax (Bensulfuron)	Yes	Yes	0-5 lsr
Sempre (Halosulfuron)	Yes	Yes	0-5 lsr
Granite (Penoxsulam)	Yes	Yes	2 lsr - mt
Grandstand (Triclopyr)	Yes	No	5 lsr - mt
Shark (carfentrazone)	Yes	Yes	2 lsr - mt
Prowl (Pendimethalin)	No	No	premergence

1	Untreated control	-----	-----
2	Granite GR Abolish + Regiment + UAN + NIS	15 lb 1.5 qt + 0.53 oz + 2% + 0.2%	3 Isr 5 Isr
3	Cerano Granite GR Abolish + Regiment + UAN + NIS	12 lb 15 lb 1.5 qt + 0.53 oz + 2% + 0.2%	DOS 3 Isr 5 Isr
4	Cerano Butte Abolish + Regiment + UAN + NIS	12 lb 7.5 lb 1.5 qt + 0.53 oz + 2% + 0.2%	DOS 1 Isr 5 Isr
5	Bolero Regiment + UAN + NIS	23 lb 0.8 oz + 2% + 0.2%	1 Isr 4 Isr
6	Bolero Granite SC + SuperWham + COC	23 lb 2 oz + 6 qt + 1.25%	1 Isr 4 Isr
7	Shark Abolish + Regiment + UAN + NIS	7.5 oz 1.5 qt + 0.53 oz + 2% + 0.2%	1 Isr 5 Isr
8	Granite GR + Shark Abolish + Regiment + UAN + NIS	15 lb + 7.5 oz 1.5 qt + 0.53 oz + 2% + 0.2%	4 Isr 5 Isr
9	Cerano Shark Abolish + Regiment + UAN + NIS	12 lb 7.5 oz 1.5 qt + 0.53 oz + 2% + 0.2%	DOS 1 Isr 5 Isr
10	Untreated control	-----	-----
11	Bolero SuperWham + COC	23 lb 6 qt + 1.25%	1 Isr 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 Isr 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 Isr 2 Til
17	Cerano Shark + Halomax SuperWham + COC	12 lb 7.5 oz + 1.33 oz 6 qt + 1.25%	DOS 4 Isr 2 Til
18	Granite GR + Shark Clincher Shark + SuperWham + COC	15 lb + 7.5 oz 13 oz 4 oz + 6 qt + 1.25%	4 Isr 1 Til 2 Til



	Late watergrass (1)	Ricefield bulrush (2)	Smallflower umbrellae sedge (3)	Ducksalad (4)	Monochoria (5)	Redstem (6)
Granite GR Abolish + Regiment + UAN + NIS	100	100	100	--	100	100
Cerano Granite GR Abolish + Regiment + UAN + NIS	100	100	95	--	100	100
Cerano Butte Abolish + Regiment + UAN + NIS	100	100	100	--	95	100
Bolero Regiment + UAN + NIS	100	83	100	--	24	100
Bolero Granite SC + SuperWham + COC	100	100	100	--	100	100
Shark Abolish + Regiment + UAN + NIS	100	100	100	--	100	100
Granite GR + Shark Abolish + Regiment + UAN + NIS	100	100	100	--	100	100
Cerano Shark Abolish + Regiment + UAN + NIS	100	100	100	--	100	100
Bolero SuperWham + COC	100	82	100	--	85	100
Cerano SuperWham + COC	100	85	90	--	92	100
Granite GR SuperWham + COC	100	100	100	--	100	95
RiceEdge	96	100	100	--	92	90
RiceEdge	81	93	91	--	70	100
Cerano Shark + Londax SuperWham + COC	100	100	100	--	100	100
Cerano Shark + Halomax SuperWham + COC	100	100	100	--	100	100
Granite GR + Shark Clincher Shark + SuperWham + COC	100	100	100	--	100	100

2016 CALIFORNIA RICE WEED HERBICIDE SUSCEPTIBILITY CHART

Active ingredient	Product name	Mode of action	Grasses				Sedges		Broadleaf weeds					
			Banyardgrass	Early watergrass	Late watergrass	Sprangletop	Ricefield bulrush	Smallflower umbrella sedge	Ducksalad	Monochoria	Redstem	California arrowheads		
ACCase inhibitor	Clincher® CA (cyhalofop)		R	R	R	R								
Pigment inhibitor	Cerano® 5 MEG (clomazone)		R	R	R	R								
Lipid inhibitors	Abolish® Bolero® Ultramax **League® MVP (thiobencarb)		R	R	R			R						
PSII inhibitors	RiceShot® 48 SF Stam® 80 EDF CA SuperWHAM!® CA (propanil)		R	R	R		R	R						
ALS inhibitors			Three classes of ALS inhibitors											
Protox inhibitor	Shark® H ₂ O (carfentrazone)													
Auxin mimic	Grandstand® CA (triclopyr)													
Cell division inhibitor	Prowl® H ₂ O (pendimethalin) Drill-seeded rice only													
SU	Londax® (bensulfuron)								R	R			R	R
SU	Halomax® Sandeia® (halosulfuron)								R	R			R	R
SU	**League® MVP (imazasulfuron)		R	R	R			R	R			R	R	
SU	Strada® CA (orthosulfamuron)		R	R	R			R	R			R	R	
POB	Regiment® CA (bispyribac)		R	R	R			R	R			R	R	
SA	Granite® GR Granite® SC (penoxulam)		R	R	R			R	R			R	R	

SU = sulfonylurea
POB = pyrimidinyl oxybenzoate
SA = sulfonamide

Control Partial control / suppression No control

R No control of resistant plants. The resistance is already widespread.

R No control of resistant plants. The resistance is spreading.

** This product is a premix of two herbicide chemistries. Weed control spectrum shown is for the herbicide component mentioned along with the mode of action. The other herbicide component of the product and its weed control spectrum are given in the corresponding mode of action.

2011 Resistance Testing

Weed species	# Samples	Stam	Londax	Cerano	Clincher	Granite	Regiment
Bulrush	8	3	3	-	-	1	-
Smallflower	8	4	3	-	-	-	-
Watergrass	6	0	-	-	-	-	-
Sprangletop	9	-	-	3	1	-	-
Total	31						

2012 Resistance Testing

Weed species	# Samples	Stam	Londax	Cerano	Clincher	Granite	Regiment
Bulrush	-	-	-	-	-	-	-
Smallflower	12	5	7	-	-	-	-
Watergrass	11	0	-	-	-	-	-
Sprangletop	8	-	-	2	2	-	-
Total	31						

2013 Resistance Testing

Weed species	# Samples	Stam	Londax	Cerano	Clincher	Granite	Regiment	Multiple
Bulrush	2	1	0	-	-	-	-	-
Smallflower	26	21	21	-	-	14	14	21
Watergrass	11	8	-	0	7	8	-	8
Sprangletop	4	-	-	1	3	-	-	0
Total	43							

2014 Resistance Testing

Weed species	# Samples	Stam	Londax	Cerano	Clincher	Granite	Bolero	Multiple
Bulrush	9	5	8	-	-	5	-	6
Smallflower	22	13	21	-	-	18	0	21
E. Watergrass	6	0	-	-	-	-	6	0
L. Watergrass	8	5	-	-	-	-	6	0
Sprangletop	11	-	-	1	4	-	-	4
Total	56							

Herbicide Survey

2015 Resistance Testing

Weed	Herbicide to be tested
Echinochloa species	Thiobencarb, clomazone, cyhalofop, propanil, bensulfuron, bispyribac, and penoxulam
Smallflower umbrella sedge	Thiobencarb, propanil, bensulfuron, bispyribac, penoxsulam, and carfentrazone
Ricefield Bulrush	Propanil, bensulfuron, bispyribac, penoxsulam, carfentrazone, and triclopyr
Redstem	Bensulfuron, penoxsulam, triclopyr
Sprangletop	Thiobencarb, clomazone, cyhalofop

2015 Resistance Testing

Under testing

Preliminary results (2 WAT)

Weed species	# Samples
Bulrush	4
Smallflower	30
E. Watergrass	2
L. Watergrass	6
Barnyardgrass	8
Sprangletop	11
Total	61

- Majority of *Echinochloa* grasses are resistant to Abolish
- Both early watergrasses are likely resistant to propanil
- Abolish-resistant late watergrasses are also resistant to Regiment and Clincher. Surprisingly, they appear to be susceptible to Granite SC.
- All early watergrass and barnyardgrass are susceptible to clincher.
- Propanil resistance in late watergrass and barnyardgrass is not clear yet.



Early watergrass

Susceptible



Untreated

Clincher

Abolish

Granite SC

Regiment

Resistant
2015



Untreated

Clincher

Abolish

Granite SC

Regiment

Late watergrass

Susceptible



Untreated

Clincher

Abolish

Granite SC

Regiment

Resistant 2015



Untreated

Clincher

Abolish

Granite SC

Regiment

Barnyardgrass

Susceptible



Untreated
Clincher
Abolish
Granite SC
Regiment

Resistant 2015



Untreated
Clincher
Abolish
Granite SC
Regiment

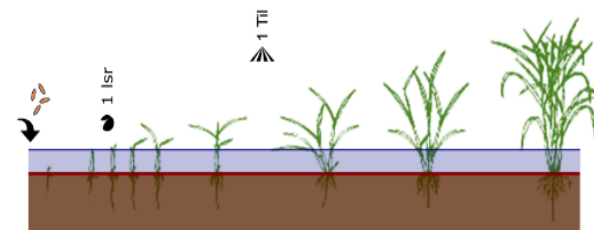
What to do about resistance

- Use integrated weed management practices as much as possible
- Be aggressive , reduce herbicide rate is not an option
- Apply herbicide to young actively growing weeds
- Use Multiple MOA
- Do not get locked into a standard herbicide program
- Consider rotational crop when it is make sense
- Find new herbicide with different mode of action

Butte efficacy in continuous flood system

Untreated control		
Butte	7.5 lb	1 lsr
Butte	9 lb	1 lsr
Butte Grandstand + SuperWham + COC	7.5 lb 6 oz + 6 qt + 1.25%	1 lsr 1 Til
Butte Granite SC + COC	7.5 lb 2.8 oz + 1.25%	1 lsr 1 Til
Untreated control		
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.



	20 DAS						40 DAS						60 DAS					
	Late watergrass (1)	Ricefiled bulrush (2)	Smallflower umbrellasedge (3)	Ducksalad (4)	Monochoria (5)	Redstem (6)	Late watergrass (1)	Ricefiled bulrush (2)	Smallflower umbrellasedge (3)	Ducksalad (4)	Monochoria (5)	Redstem (6)	Late watergrass (1)	Ricefiled bulrush (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
Untreated control	16	10	19	35	0	0	10	10	3	2	8	>1	29	10	2	0	10	1
Butte	100	100	100	100	—	—	98	100	100	97	99	—	97	100	100	—	100	76
Butte	100	100	100	100	—	—	99	100	100	97	100	—	99	100	100	—	100	78
Butte Grandstand + SuperWham + COC	100	100	100	100	—	—	100	100	100	100	100	—	98	100	100	—	100	100
Butte Granite SC + COC	100	100	100	100	—	—	100	100	100	100	100	—	99	100	100	—	100	84
Untreated control	19	7	20	41	0	0	23	7	5	5	6	>1	33	8	3	0	8	1
GWN-9796 + Sandea	100	100	100	100	—	—	98	100	100	100	99	—	96	100	100	—	100	73

Untreated



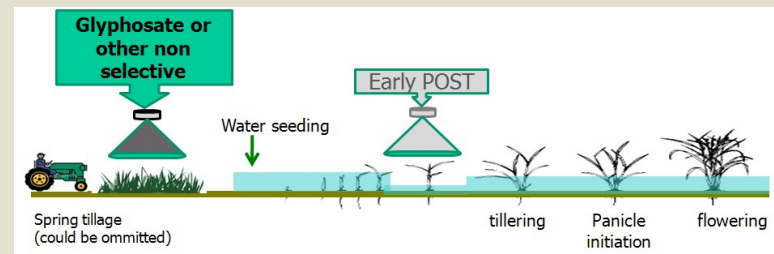
Butte @7.5 lb/A at 1 lsr



Systems to Consider

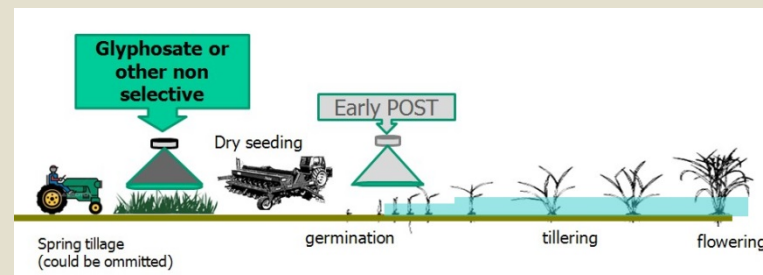
- Pre-planting weed control

- Stale seeded
- Minimum tillage



- Dry seeding

- Drill
- Broadcast



Untreated control		
Prowl	2 pt	DPRE
Abolish	1.5 qt	DPRE
Prowl SuperWham + COC	2 pt 6 qt + 1.25%	DPRE 3.5 lsr
Abolish SuperWham + COC	1.5 qt 6 qt + 1.25%	DPRE 3.5 lsr
Untreated control		
Prowl Abolish + Regiment + UAN + NIS	2 pt 1.5 qt + 0.53 oz + 2% + 0.2%	DPRE 5 lsr
Abolish Abolish + Regiment + UAN + NIS	1.5 qt 1.5 qt + 0.53 oz + 2% + 0.2%	DPRE 5 lsr
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
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
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
Prowl Clincher + Prowl + SuperWham + COC Shark	2 pt 13 oz + 2 pt + 4 qt + 2.5% 4 oz	DPRE 3.5 lsr 4 lsr

Drill-Seeded Rice

	Echinochloa (1) Smallflower umbrell: sedge (2)		Echinochloa (1) Smallflower umbrell: sedge (2)		Echinochloa (1) Smallflower umbrell: sedge (2)	
	20 DAS		40 DAS		60 DAS	
Untreated control	36	3	40	5	37	3
Prowl	59	29	62	31	53	11
Abolish	42	91	44	100	43	100
Prowl SuperWham + COC	84	89	88	100	94	100
Abolish SuperWham + COC	88	98	85	100	92	100
Halomax + Prowl	74	94	74	100	78	97
Untreated control	32	2	38	4	31	2
Prowl Abolish + Regiment + UAN + NIS	51	19	95	98	96	100
Abolish Abolish + Regiment + UAN + NIS	43	90	96	100	100	100
Abolish Clincher + Granite SC + Prowl + COC Shark	78	93	86	100	96	100
Prowl Clincher + Granite SC + Prowl + COC Shark	81	83	87	100	92	98
Abolish Clincher + Prowl + SuperWham + COC Shark	90	96	99	100	100	100
Prowl Clincher + Prowl + SuperWham + COC Shark	85	88	98	100	100	98

Knowledge for Good Weed Management

- Knowledge of the weed species present
- Knowledge of rice herbicide, their efficacy and behavior
- Knowledge of mixture and sequential treatments
- Knowledge of herbicide weed species resistance
- knowledge of herbicide mode of action
- Interactions with water management
- Good water management capability

Knowledge for Good Weed Management

- Compatibility to tank mix herbicide
- Avoid antagonism that may result in loss of control of injury to rice
- Proper adjuvants
- Knowledge of application requirement
- Environmental conditions

An aerial photograph of a vast agricultural landscape. The foreground and middle ground are dominated by large, rectangular plots of vibrant green crops, likely rice, arranged in a grid-like pattern separated by narrow dirt roads or irrigation channels. To the left, there are several large, dark, rectangular areas that appear to be flooded or recently tilled. In the upper center, a cluster of white industrial buildings, possibly a processing plant or warehouse, is visible, surrounded by several large white storage silos. A small canal or river flows along the right side of the image. The overall scene depicts a highly organized and productive agricultural operation.

Thanks!