Weed Management Update

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California Rice Herbicides

Common name	Trade name	MOA
Bensulfuron	Londax®	ALS inhibitor
Bispyribac-sodium	Regiment®	ALS inhibitor
Halosulfuron	Sandea®	ALS inhibitor
Imazosulfuron	League	AL inhibitor
Orthosulfamuron	Strada	ALS inhibitor
Penoxsulam	Granite®	ALS inhibitor
Benzobicyclon + Halosulfuron	Butte	HPPD inhibitor + ALS inhibitor
Benzobicyclon Carfentrazone	Cliffhanger Shark H2O®	HPPD inhibitor PROTOX inhibitor
Clomazone	Cerano®	Carotenoid biosynthesis inhibitor
Cyhalofop-butyl	Clincher®	ACCase inhibitor
Pendimethalin	Prowl H2O®	Tubulin inhibitor
Propanil	Stam®, SuperWham®	Photosystem II inhibitor
Thiobencarb	Abolish®, Bolero®	VLCFA (Very long chain fatty acids)
Triclopyr Florpyrauxifen-benzyl Pyraclonil	Grandstand® Loyant Zembu	Synthetic auxin Synthetic auxin Protox inhibitor

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Drill-Seeded Rice

- No benzobicyclon + Halosulfuron (Butte), clomazone (Cerano), pyraclonil (Zembu)
- Preflooding, preemergence herbicides
  - Pendimethalin (Prowl)
    - Prowl will not control emerged weeds
    - Apply after drill- or dry-seeded
    - Dry-seeded need light incorporation
    - Water should be flushed across the field after application
    - Soil type, do not use it on sandy soil

Drill-Seeded Rice

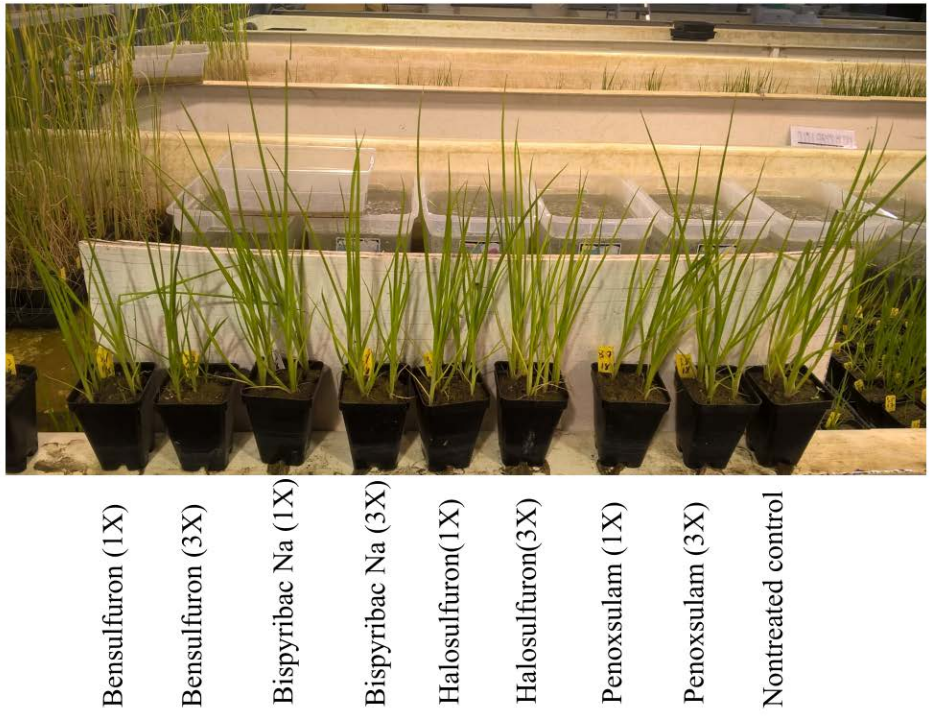
- 2-4 leaf stage (prior to permanent flood)
  - Prowl H2O(pendimethalin)
  - Abolish (thiobencarb)
  - Loyant (florpyrauxifen)
  - Granite SC (penoxsulam
  - Propanil
  - Clincher (cyhalofop)
  - Regiment (bispyribac)
  - Shark H2O (carfentrazone)
  - Londax (bensulfuron)
  - Sandea (halosulfuron)

Drill-Seeded Rice

- Post-flooding (tillering stage)
  - Loyant (florpyrauxifen)
  - Granite SC (penoxsulam
  - Propanil
  - Clincher (cyhalofop)
  - Regiment (bispyribac)
  - Shark H2O (carfentrazone)

Herbicide resistant weeds

- The inherited ability of a plant to survive and reproduce after being exposed to a dose of herbicide that is normally lethal to the wild type of that plant.
- Resistance
- Cross-resistance
- Multiple resistance



Suspected Resistant Weed Samples of each Herbicide Tested Across Weed Species in the Field Survey

Herbicides	Number of sample tested	% Suspected herbicide resistant
Bensulfuron-methyl	104	99
Halosulfuron-methyl	77	96
Propanil	475	88
Bispyribac-sodium	407	85
Penoxsulam	382	82
Cyhalofop-butyl	411	59
Thiobencarb	490	43
Benzobicyclon + halosulfuron	525	12
Carfentrazone	216	7
Clomazone	362	6
Triclopyr	73	1

Becerra-Alvarez, A. et al. Outlooks Pest Management 2023

Suspected Resistant Samples to One or More Herbicide Modes of Action for Screened Rice Weed Species in the Field Survey

% Suspected Herbicide-resistant to Given Number of Modes of Action

Weed Species	Samples	One	Two	Three	Four	Five
Barnyardgrass	173	7	23	34	24	1
Early watergrass	49	20	59	6	2	-
Late watergrass	107	9	12	19	53	3
Smallflower umbrella sedge	189	8	64	25	-	-
Bearded sprangletop	110	39	4	-	-	-
Ricefield bulrush	18	33	6	-	-	-
Redstem	15	66	7	-	-	-

A dash indicates no population with the given amount of multiple resistance was recorded for the given weed species

Becerra-Alvarez, A. et al. Outlooks Pest Management 2023

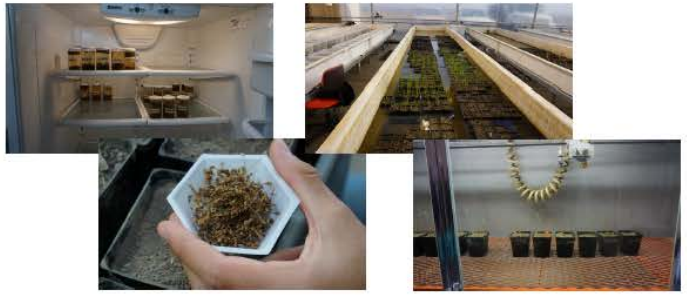
Managing Herbicide Resistance Research

- Tracking herbicide-resistant weeds in California rice fields
- Understand weed biology and mode of herbicide resistance
- Developed alternative cropping system to mange resistance
- Search for new herbicides for to control resistant weeds

Tracking herbicide-resistant weeds in California

- Free service: funded by the California Rice Research Board
- Growers or Pest Control Advisers can submit weed seed samples
- Collection of samples is by growers and PCAs
- Proves or disproves herbicide resistance in weed samples submitted

Weed seed collection and submission



Whole-plant assay method

Reporting and archiving results

Weed Seed Collection and Submission

Name and contact

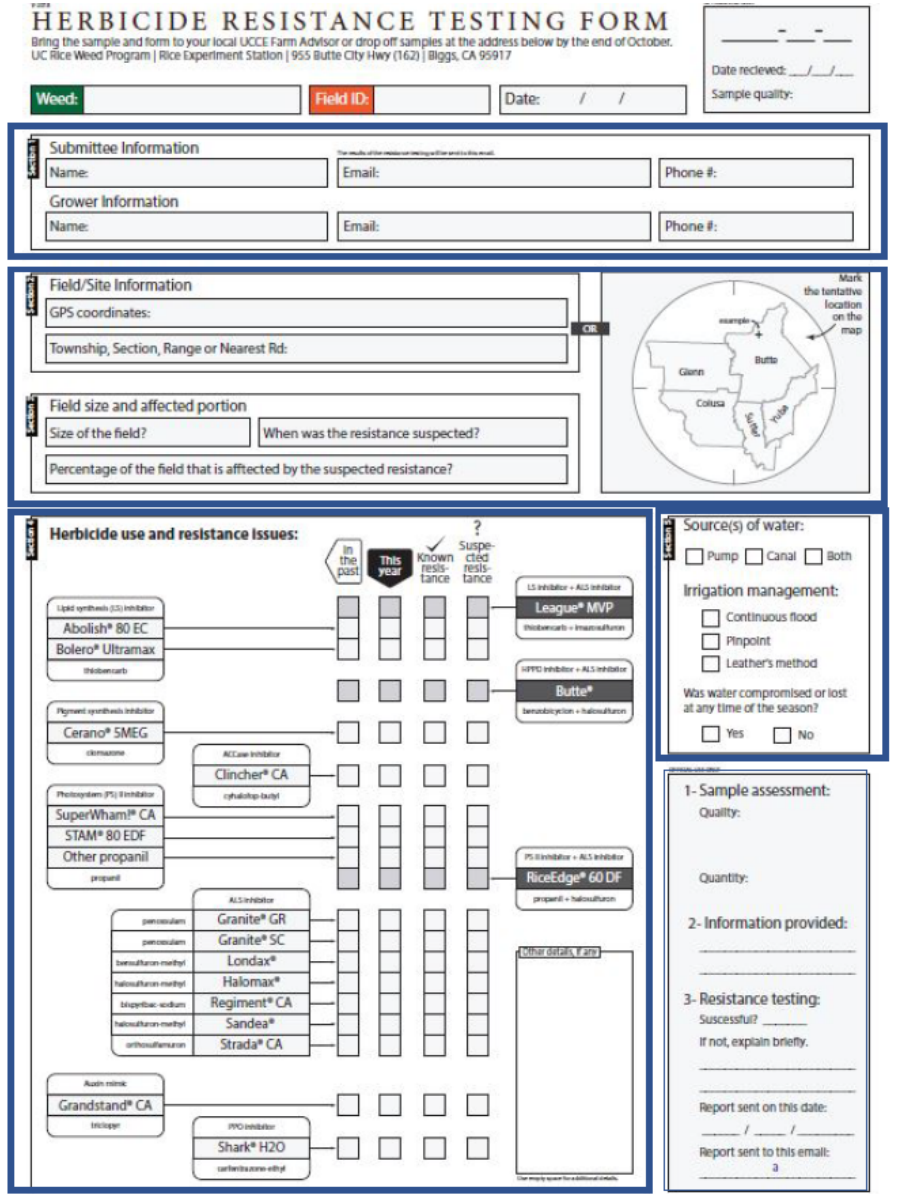
Location

Amount affected

Herbicide use

Irrigation information

Feedback on seed quality



HERBICIDE RESISTANCE TESTING FORM

Bring the sample and form to your local UCCE Farm Advisor or drop off samples at the address below by the end of October.
UC Rice Weed Program | Rice Experiment Station | 955 Butte City Hwy (162) | Biggs, CA 95917

Weed: | Field ID: | Date: / /

Date recieved: ___/___/___
Sample quality:

Submittee Information
Name: | Email: | Phone #:

Grower Information
Name: | Email: | Phone #:

Field/Site Information
GPS coordinates:
OR
Township, Section, Range or Nearest Rd:

Mark the tentative location on the map

Field size and affected portion
Size of the field? | When was the resistance suspected?
Percentage of the field that is afftected by the suspected resistance?

Herbicide use and resistance issues:

	In the past	This year	✓ Known resistance	? Suspected resistance
Lipid synthesis (LS) inhibitor: Abolish® 80 EC				
Bolero® Ultramax (thiobencarb)				
LS inhibitor + ALS inhibitor: League® MVP (thiobencarb + imazosulfuron)				
HPPD inhibitor + ALS inhibitor: Butte® (benzobicyclon + halosulfuron)				
Pigment synthesis inhibitor: Cerano® SMEG (clomazone)				
ACCase inhibitor: Clincher® CA (cyhalofop-butyl)				
Photosystem (PS) II inhibitor: SuperWham!® CA				
STAM® 80 EDF				
Other propanil (propanil)				
PS II inhibitor + ALS inhibitor: RiceEdge® 60 DF (propanil + halosulfuron)				
ALS inhibitor: Granite® GR (penoxsulam)				
Granite® SC (penoxsulam)				
Londax® (bensulfuron-methyl)				
Halomax® (halosulfuron-methyl)				
Regiment® CA (bispyribac-sodium)				
Sandea® (halosulfuron-methyl)				
Strada® CA (orthosulfamuron)				
Auxin mimic: Grandstand® CA (triclopyr)				
PPO inhibitor: Shark® H2O (carfentrazone-ethyl)				

Other details, if any

Source(s) of water:
☐ Pump ☐ Canal ☐ Both

Irrigation management:
☐ Continuous flood
☐ Pinpoint
☐ Leather's method

Was water compromised or lost at any time of the season?
☐ Yes ☐ No

1- Sample assessment:
Quality:

Quantity:

2- Information provided:

3- Resistance testing:
Sucessful? _____
If not, explain briefly.

Report sent on this date:
___ / ___ / ___
Report sent to this email:

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Weed Seed Collection and Submission

Bearded Sprangletop (ST) - [*Leptochloa fusca* (L.) Kunth ssp. *fascicularis* (Lam.) N Snow]

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Watergrass Seed Identification

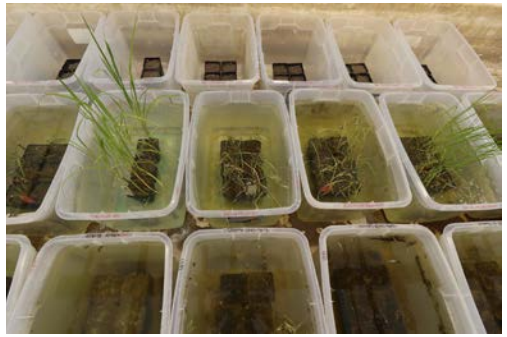
Breaking Seed Dormancy

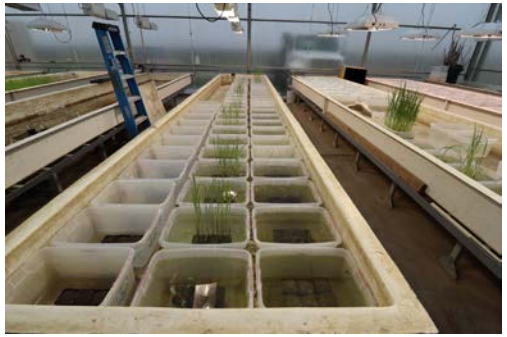
- Seeds placed in water-filled containers and dark stored at 4 C for 3 to 4 weeks to break dormancy
  - Replace water occasionally
  - All grass species and ricefield bulrush only

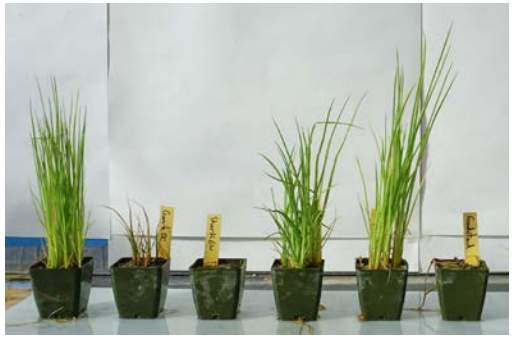
- Simulate cold wet winter conditions

Whole-Plant Assay Method

- Seeds sown in field soil
- Thinned as needed (transplanting)
- Grown out in flooded basins until 3-4 leaf stage for postemergence applications
- Preemergence herbicides applied day of seeding
- Test all MOAs registered for the species
- Rate 1X and/or 2X rate
- Pots as replicates (4 to 6) and sometimes study repeated







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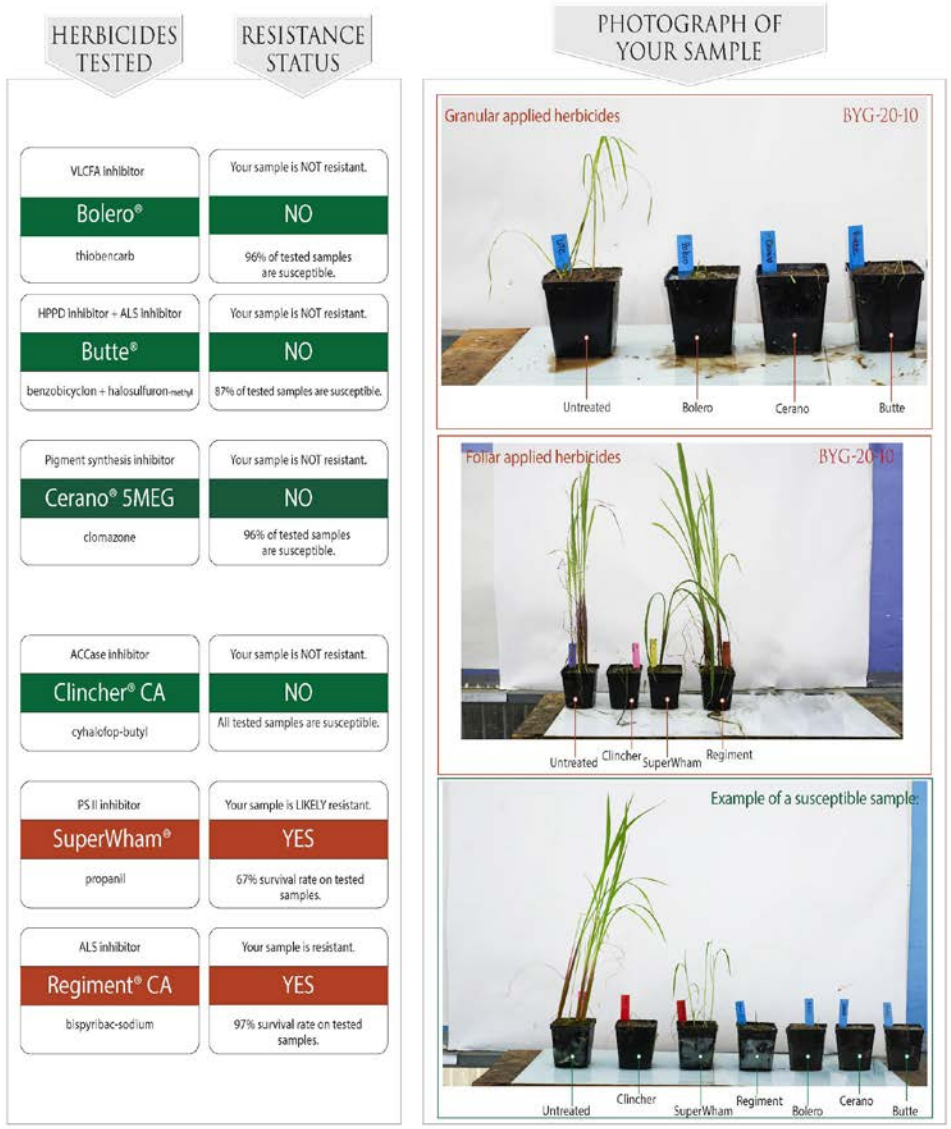
Reporting Results

- Report sent before the next growing season
- A representative picture of the sample and the picture of a susceptible sample for comparison



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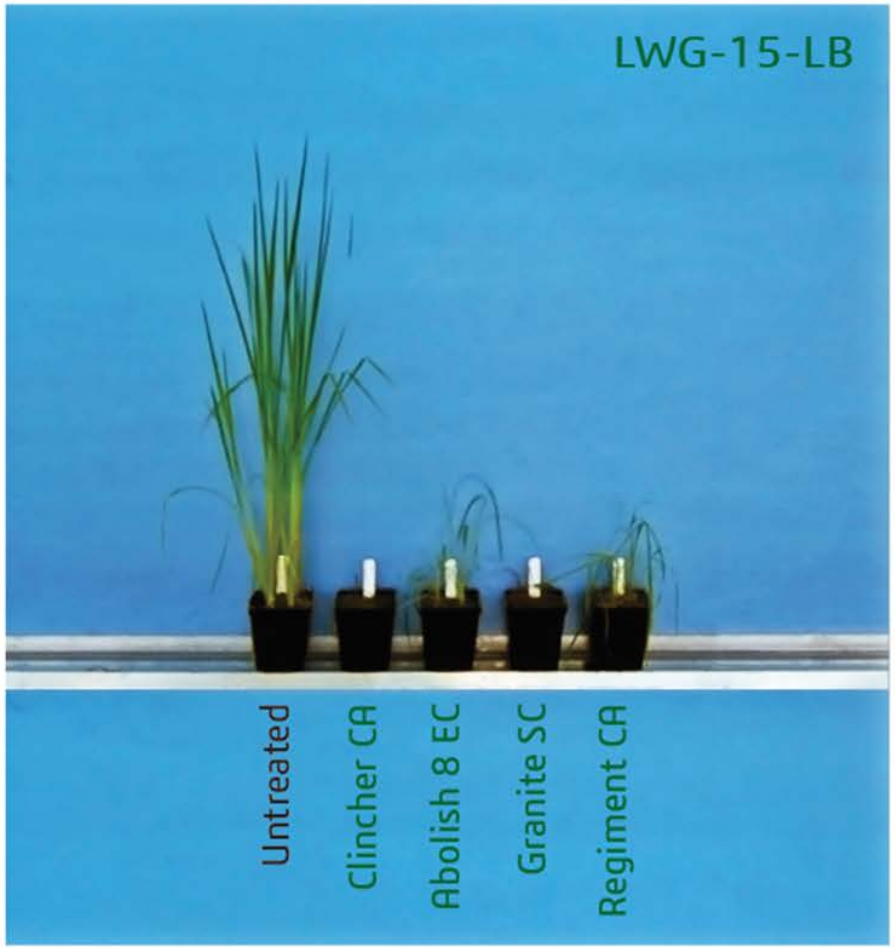
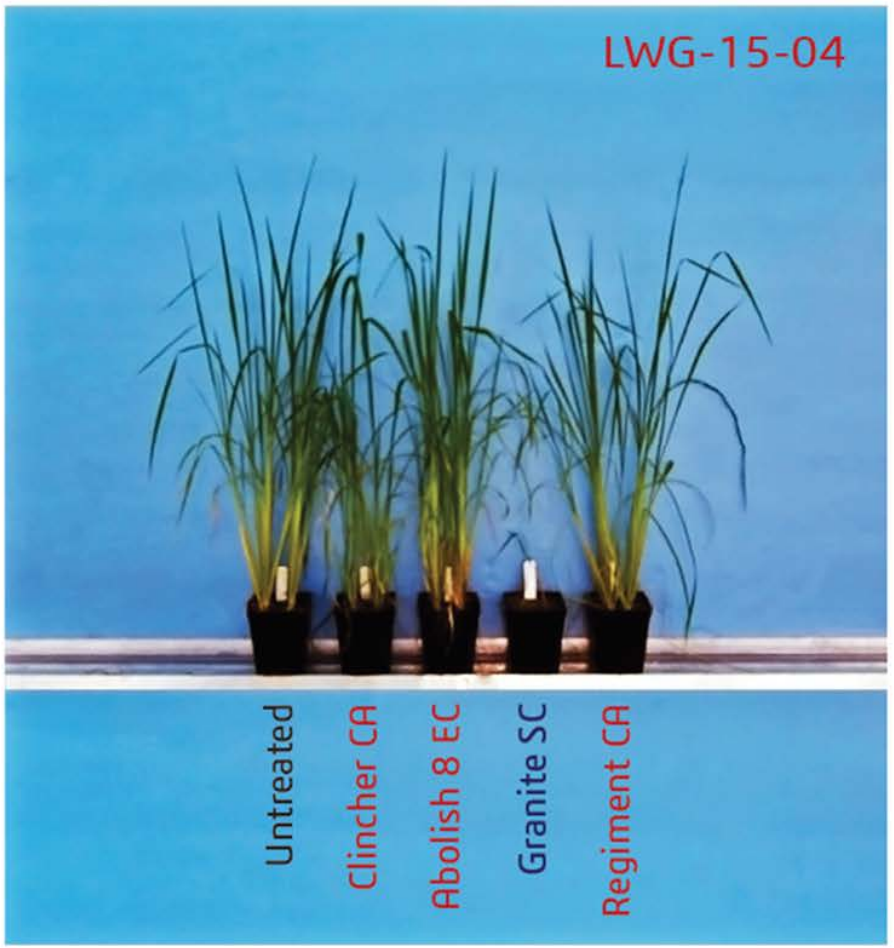
Susceptible Population



Your Sample



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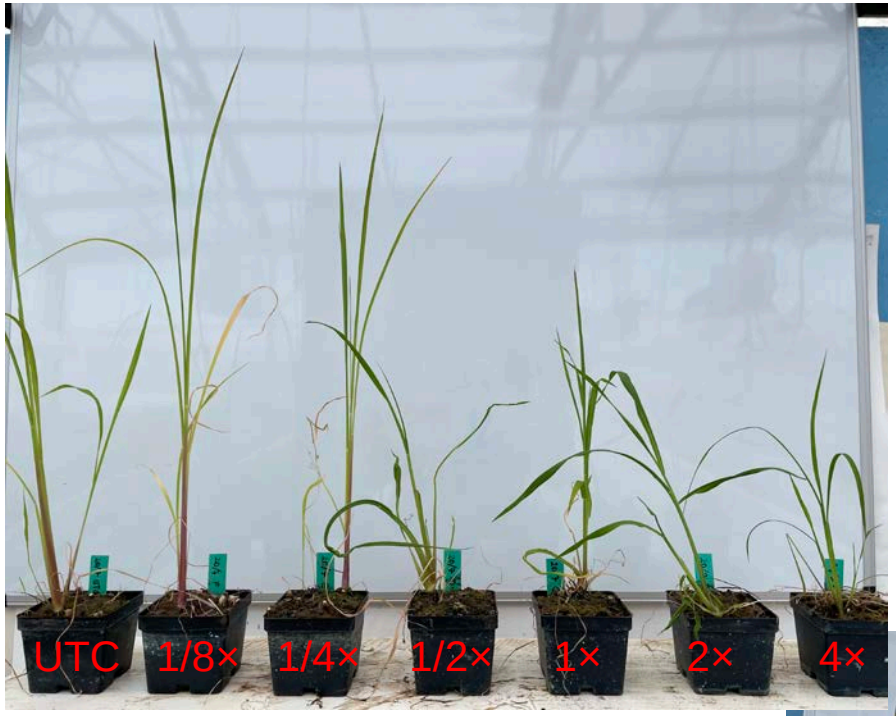
Optimize New Herbicides for Weed Control in Rice

- Loyant, florpyrauxifen-benzyl, it is available in the market since 2023 season
- Cliffhanger, benzobicyclon, approved by EPA/DPR and enter the market in 2024
- Zembu, pyraclonil, approved by EPA/DPR and enter the market in 2024
- Tetflupyrolimet (FMC grass control herbicide), package submitted to EPA for registration, expect to be in the market in 2027-2028
- Roxy Rice, package submitted to EPA for registration

Loyant

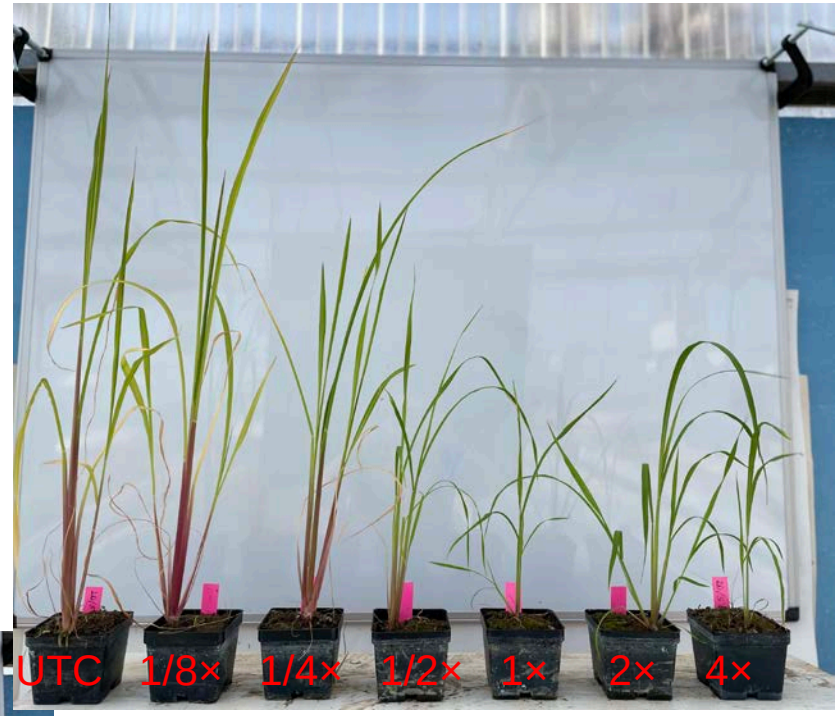
- Loyant is an auxin-type herbicide with novel binding site
- It is not a grass control herbicide, but it have activity on barnyardgrass. Good control of sedges and broadleaf weeds.
- Rate: 1.00-1.33 pint/A, allowed two applications (total 2.66 pint/A), two weeks apart
- Adjuvant: Methylated seed oil, others
- Ground application: Apply in 10 gpa or more when apply by ground
- Water management: Lower water in the field to expose 70% of weed foliage for spray.
- Timing: Applied from 2 leaf stage with no exposed roots up to 60 days before harvest, **late application may cause blanking.**
- Tank mixes: with Clincher, Regiment, Granite, propanil and Grandstand. No varietal response
- **Recommendation: It must be used as part of a program that utilizes multiple residual herbicides in front of a timely application of Loyant**

Loyant® CA efficacy on watergrasses



Barnyardgrass

Late watergrass



Early watergrass

Loyant, florpyrauxifen-benzyl

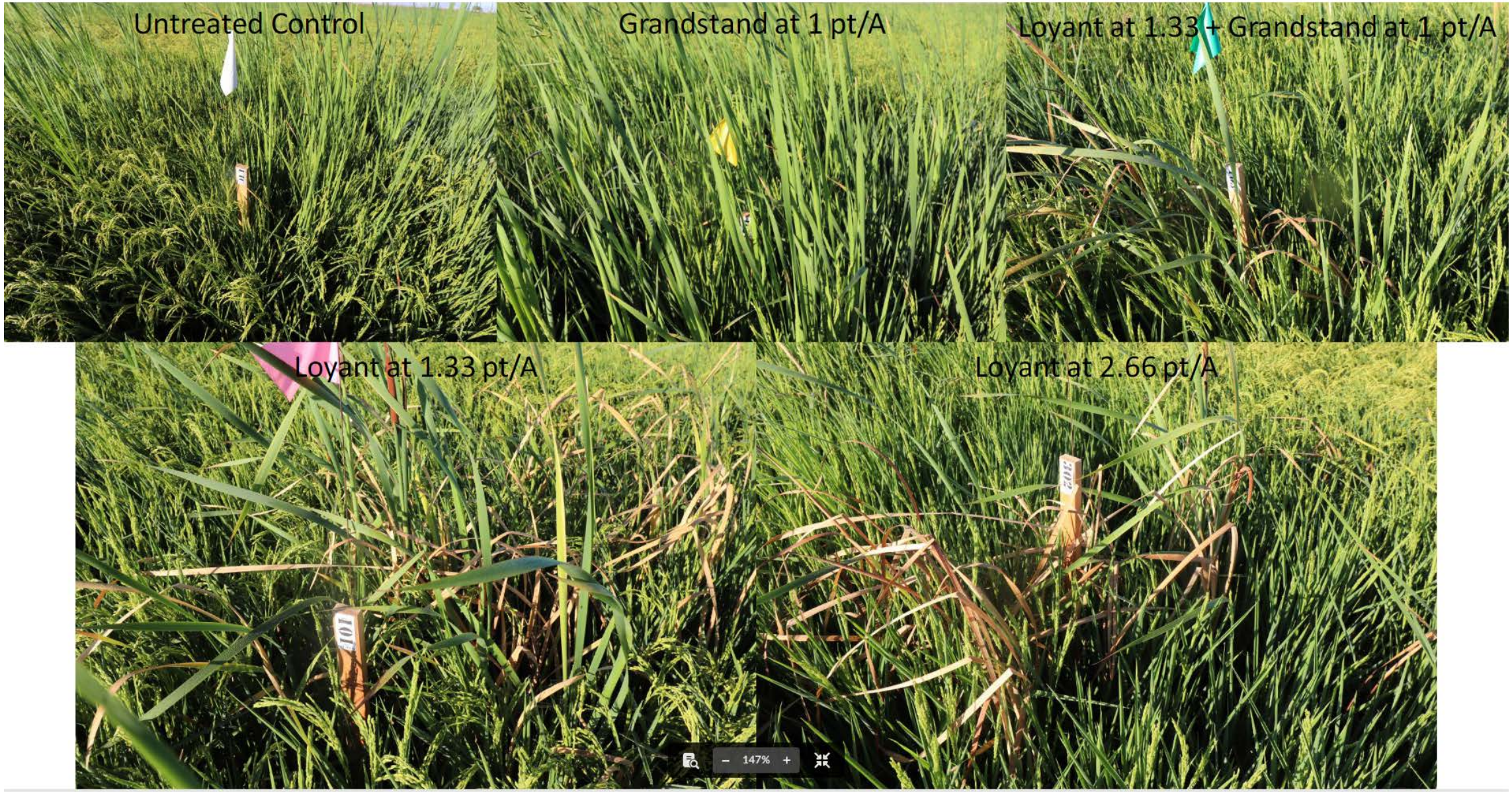
Non-treated control

Butte followed by Loyant

Bolero followed by Loyant

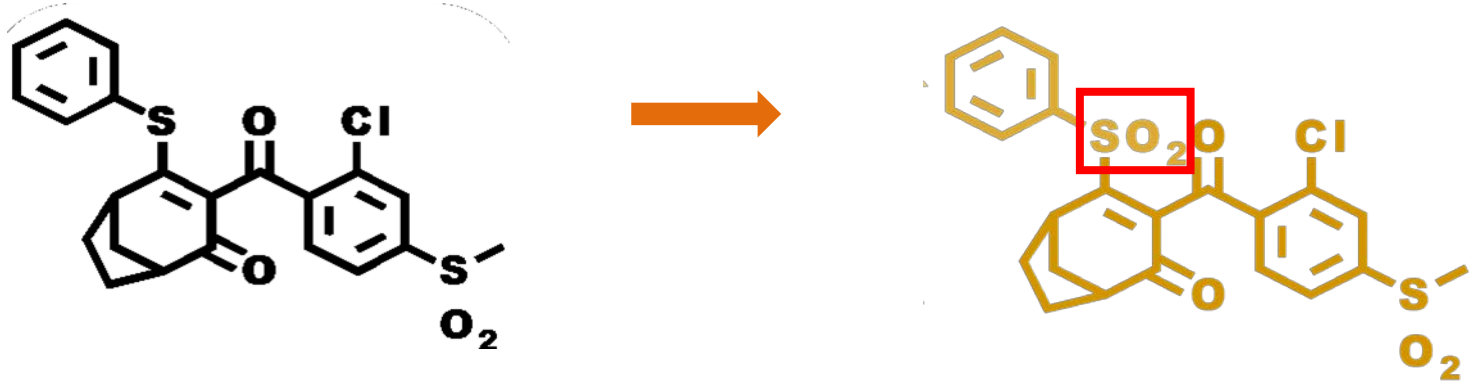
RebelEx followed by Loyant

Cattail Treatments at 42 DAT



Cliffhanger vs. Butte herbicide

- Both Butte and Cliffhanger have benzobicyclon which is a pro herbicide: Benzobicyclon hydrolysate (a metabolite) is a potent HPPD inhibitor.



- The conversion process needs water
- Butte: benzobicyclon + halosulfuron, granule formulation
- Field Use Rates: 7.5 – 9.0 lbs./A
- Cliffhanger: has only benzobicyclon, liquid formulation

Cliffhanger

- It is a liquid formulation that can be applied by ground rig or airplane.
- Use rate is 8.4 to 10.3 oz/A. Use MSO at 1%, however, you can use NIS if herbicide partners require that.
- Application timing: As early as day of seeding **to 82 days prior to harvest**.
- Applied in a minimum of 4 inches of water.
- For optimum sedge control apply from preemergence to 5 leaf stage. Delay application resulted in reduce efficacy.
- It is excellent herbicide to control sprangletop and rice bulrush, For optimum sprangletop control apply from preemergence to 2.5 leaf stage. Delay application resulted in reduce efficacy.
- Do not apply 50 ft from susceptible crops, our research showed no negative effect of peaches, prune, almond, walnut, pistachio and grape.
- Water holding: No warning on the label

***Watergrass*:**
½ leaf – 2 leaf

***Sprangletop*:**
PRE – 2.5 leaf

***Sedges*.:**
PRE – 5 leaf

Water Management

4” at time of application; 5-7 days static

No water holding requirement

HERBICIDE PROGRAM	RATE/ACRE	TIMING	WEED CONTROL (%)											
			40 DAT						60 DAT					
			WATERGRASSES	SPRANGLETOP	RICEFIELD BULRUSH	SMALLFLOWER	DUCKSALAD	REDSTEM	WATERGRASSES	SPRANGLETOP	RICEFIELD BULRUSH	SMALLFLOWER	DUCKSALAD	REDSTEM
Butte	9 lb	0.5-1 LSR	66	98	100	100	100	37	66	96	100	100	98	32
Cliffhanger + MSO	10.3 floz + 1% v/v	0.5-1 LSR	83	100	100	100	100	27	80	100	100	100	92	40
Zembu	14.9 lb	DOS	100	100	100	100	100	100	100	100	100	100	100	100
Cliffhanger + MSO	10.3 floz + 1% v/v	3.5-4 LSR												
Cerano	10 lb	DOS	94	99	100	100	100	72	93	100	100	100	97	85
Cliffhanger + MSO	10.3 floz + 1% v/v	3.5-4 LSR												
Cliffhanger + Granite SC + MSO	10.3 floz 2.5 floz + 1% v/v	3.5-4 LSR	66	100	100	100	93	23	60	100	100	100	97	28
Cliffhanger + MSO	10.3 floz + 1% v/v	0.5-1 LSR												
Regiment CA + Grandstand CA + Dyne-Amic	0.8 oz 0.5 pt + 5 floz	Mid-Tiller	88	100	100	100	100	80	85	100	100	100	98	88
Cliffhanger + MSO	10.3 floz + 1% v/v	0.5-1 LSR												
RebelEX CA + MSO	20 floz + 1.25 %v/v	Mid-Tiller	84	71	93	80	80	67	79	66	96	66	91	82
Cliffhanger + MSO	10.3 floz + 1% v/v	0.5-1 LSR												
Regiment CA + Dyne-Amic	0.8 oz + 5 floz	Mid-Tiller	94	99	100	100	100	93	90	100	100	100	93	92
SuperWham! + COC	4 qt + 2.5 % v/v	Full-Tiller												
Cliffhanger + MSO	10.3 floz + 1% v/v	0.5-1 LSR												
SuperWham! + Grandstand CA + COC	4 qt 0.5 pt + 2.5 % v/v	Full-Tiller	91	99	100	100	100	90	91	100	100	100	98	94

Prowl H2O (Pendimethalin) Optimization in Water-Seeded Rice

- Efficacy of pendimethalin in herbicide mixtures applied post-emergence at different rates
- Efficacy of pendimethalin as an overlay post-emergence residual application for season-long weed control
- Rice response to pendimethalin herbicide mixture applications at 3 leaf stage
- Prowl H_2O applied after draining the field 7 days after planting then pendimethalin applied in pinpoint application in herbicide mixtures

3-rice leaf stage after leathering

				WEED CONTROL (%)						Yields
				42 DAT						
#	HERBICIDE PROGRAM	RATE/ACRE	TIMING	WATERGRASSES	SPRANGLETOP	RICEFIELD BULRUSH	SMALLFLOWER	DUCKSALAD	REDSTEM	lbs. / acre
1	Untreated	-	-	0 c	0 c	0 e	0 b	0 e	0 c	1,523 b
2	Pendimethalin + SuperWham!® CA + COC	67.4 fl oz 5 qt + 1% v/v	3 LSR	74 b	34 b	80 d	88 a	18 d	95 b	8,972 a
3	Pendimethalin + SuperWham!® CA + Clincher® CA + COC	67.4 fl oz 5 qt 15 fl oz + 1% v/v	3 LSR	96 a	97 a	86 cd	93 a	20 d	98 ab	8,980 a
4	Pendimethalin + SuperWham!® CA + Loyant® CA + MSO	67.4 fl oz 5 qt 1.33 pt + 0.5 pt	3 LSR	97 a	80 a	90 bc	95 a	95 a	99 ab	8,041 a
5	Pendimethalin + SuperWham!® CA + Regiment® CA + Dyne-A-Pak	67.4 fl oz 5 qt 0.67 oz + 1% v/v	3 LSR	95 a	90 a	85 cd	93 a	66 b	99 ab	8,467 a
6	Pendimethalin + SuperWham!® CA + Clincher® CA + Loyant® CA + MSO	67.4 fl oz 5 qt 15 fl oz + 1.33 pt 0.5 pt	3 LSR	97 a	96 a	96 ab	94 a	99 a	100 a	8,925 a
7	Pendimethalin + SuperWham!® CA + Sandea® CA + NIS	67.4 fl oz 5 qt 1 oz + 0.25% v/v	3 LSR	94 a	36 b	99 a	90 a	39 c	100 a	9,116 a
8	Pendimethalin + SuperWham!® CA + Clincher® CA + Grandstand® CA + NIS	67.4 fl oz 5 qt 15 fl oz 12 fl oz + 0.25% v/v	3 LSR	97 a	97 a	95 ab	97 a	71 b	99 ab	8,208 a
9	SuperWham!® CA + Clincher® CA + Loyant® CA + MSO	5 qt 15 fl oz + 1.33 pt 0.5 pt	3 LSR	95 a	96 a	96 ab	93 a	98 a	100 a	8, 741 a
10	Untreated #2	-	-	0 c	0 c	0 e	0 b	0 e	0 c	1,584 b

New Herbicide, Tetflupyrolimet - FMC Grass Control Herbicide

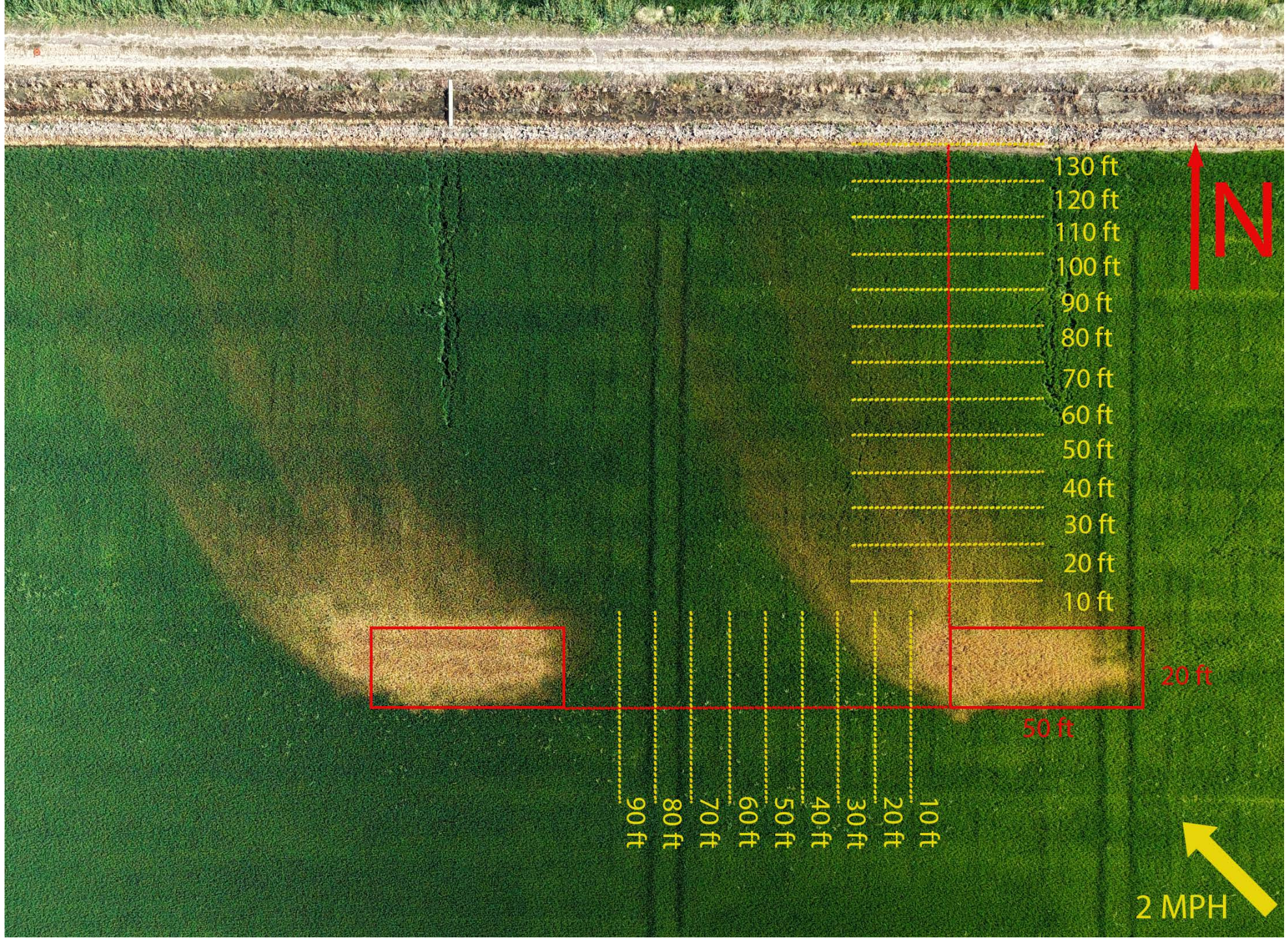
				CROP INJURY (%)								WEED CONTROL (%)											
				7 DAT				28 DAT				14 DAT						42 DAT					
#	HERBICIDE PROGRAM	RATE/ACRE	TIMING	BLEACHING	CHLOROSIS	STUNTING	STAND REDUCTION	BLEACHING	CHLOROSIS	STUNTING	STAND REDUCTION	WATERGRASSES	SPRANGLETOP	RICEFIELD BULRUSH	SMALLFLOWER	DUCKSALAD	REDSTEM	WATERGRASSES	SPRANGLETOP	RICEFIELD BULRUSH	SMALLFLOWER	DUCKSALAD	REDSTEM
1	Untreated	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Dodhylex™	8.9 lb	DOS	0	0	0	0	0	5	0	7	100	99	100	100	100	100	100	98	58	98	98	17
	Shark® H20	7.5 oz	2 LSR																				
3	Dodhylex™	8.9 lb	DOS	0	0	0	0	0	6	2	7	100	100	100	100	100	100	100	100	100	100	100	0
	Butte®	7.5 lb	1.5 LSR																				
4	Dodhylex™	8.9 lb	DOS	0	0	0	0	0	8	10	17	100	100	95	100	100	100	100	100	93	100	97	72
	Bolero® UltraMax	23.3 lb	1.5 LSR																				
	SuperWham!® CA + Agri-Dex	6 qt 1.25% v/v	Mid Tiller																				
5	Dodhylex™	8.9 lb	DOS	0	0	0	0	0	2	0	0	100	100	0	0	100	100	100	100	87	87	95	58
	SuperWham!® CA + Grandstand® CA + Agri-Dex	6 qt 6 floz 1.25% v/v	Mid Tiller																				
6	Butte®	7.5 lb	DOS	0	0	27	18	0	7	5	12	100	100	100	100	100	100	100	100	100	100	100	0
	Dodhylex™	13.4 lb	1.5 LSR																				

New name for Dodhylex: Keenali™

Roxy Rice

- Evaluate rates and combinations for weed control and crop safety
- Excellent weed control except ricefield bulrush and sprangletop
- Stunting for two weeks with no yield reduction
- Optimum oxyflurofen rate is 1.5 to 1.75 Ib ai/A

Drone-based herbicide applications


130 ft
120 ft
110 ft
100 ft
90 ft
80 ft
70 ft
60 ft
50 ft
40 ft
30 ft
20 ft
10 ft
N
20 ft
50 ft
90 ft
80 ft
70 ft
60 ft
50 ft
40 ft
30 ft
20 ft
10 ft
2 MPH


Thanks!