



ROXY[®] Rice Production System

A "Strategic Partnership" to bring a new herbicide tolerant rice to California Growers



ROXY RPS



ROXY® RPS Review

ROXY® trait is a non-GM rice trait that provides tolerance to the post patent herbicide ALB2023 and ALB2024 (oxyfluorfen) has been recovered in the variety M-206, California's most widely grown Calrose variety. The first backcross to M-206 and M-210 have been increased and purified. ROXY trait has been tested in 2017-20 University of California Yield Tests. Breeders have successfully transferred this trait into other varieties and grain types.

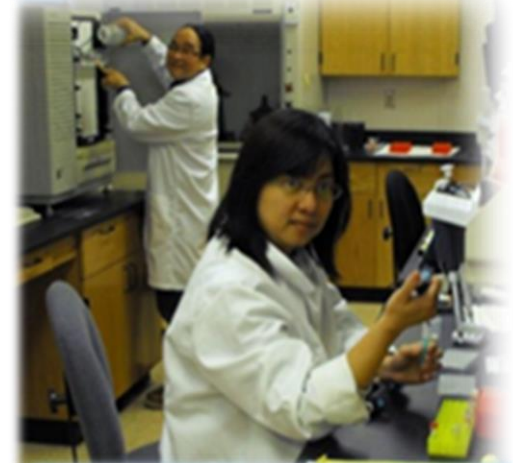
Rice Experiment Station scientists have shown the trait is controlled by a single recessive gene, identified and confirmed that gene, and the new mechanism for the herbicide tolerance. A provisional US patent for this trait was filed 9/2016, published 3/2018, additional discoveries filed 10/2019 and a ROXY® trademark was granted 9/2018.

Six years of research involving multiple locations show that ALB2023 applied preplant in a water-seeded system provides high levels of weed control with ROXY trait. It is also effective in drill seeded rice with a post-plant and pre-flood application and may have potential in other rice growing regions.



2020 RES ROXY® RPS Research

- ✓ Genetic Research
Gene mapping, discovery, sequencing, pathway, and confirmation by CRISPR
- ✓ Breeding Program
Replicated yield testing of advanced breeding lines under herbicide application rates
Drilled seeded F₂ populations screening and new crosses generated and advanced
17Y3000 and 19Y4000 and long grain germplasm seed increase and purification
UC Statewide Yield Testing for 17Y3000 and 19Y4000 under conventional herbicide program



2020 RES ROXY® RPS Research

Location	2020 UC Statewide Grain Yield (lb/acre)		
	M-206	17Y3000	19Y4000
BUTTE A	9,570	10,060	9,670
YOLO	9,550	9,650	9,280
GLENN	9,500	8,220	8,840
BUTTE B	9,490	9,070	9,350
SUTTER	9,380	9,690	8,600
BIGGS	8,500	8,670	8,790
COLUSA	8,820	8,510	8,490
BIGGS	8,740	8,770	8,860
BIGGS	8,560	9,270	9,230
YUBA	7,920	7,860	7,990
MEAN	9,050	8,980	8,910



EXPT	ID	Grain Yield (lb/a)	Harvest Moisture (%)	Seedling Vigor	Days to Heading	Lodging Score	Plant Height (cm)
RES1	17Y3000	8,670	15.4	4.9	78	19	99
	19Y4000	8,800	15.7	4.9	78	25	96
	M-206	8,950	15.9	4.8	78	23	101
RES3	17Y3000	9,270	17.0	4.9	81	3	100
	19Y4000	9,230	16.6	5.0	79	10	102
	M-206	8,560	16.4	4.8	79	0	97
RES7	17Y3000	8,770	15.8	4.9	78	5	96
	19Y4000	8,860	15.9	4.9	78	21	98
	M-206	8,740	16.1	4.9	78	5	94
AYROXY	17Y3000	9,034	22.0	4.9	88	43	104
2 pts./a	19Y4000	8,600	21.3	4.9	88	40	106
ALB 2023	M-206	5,550	24.7	1.9	93	0	100

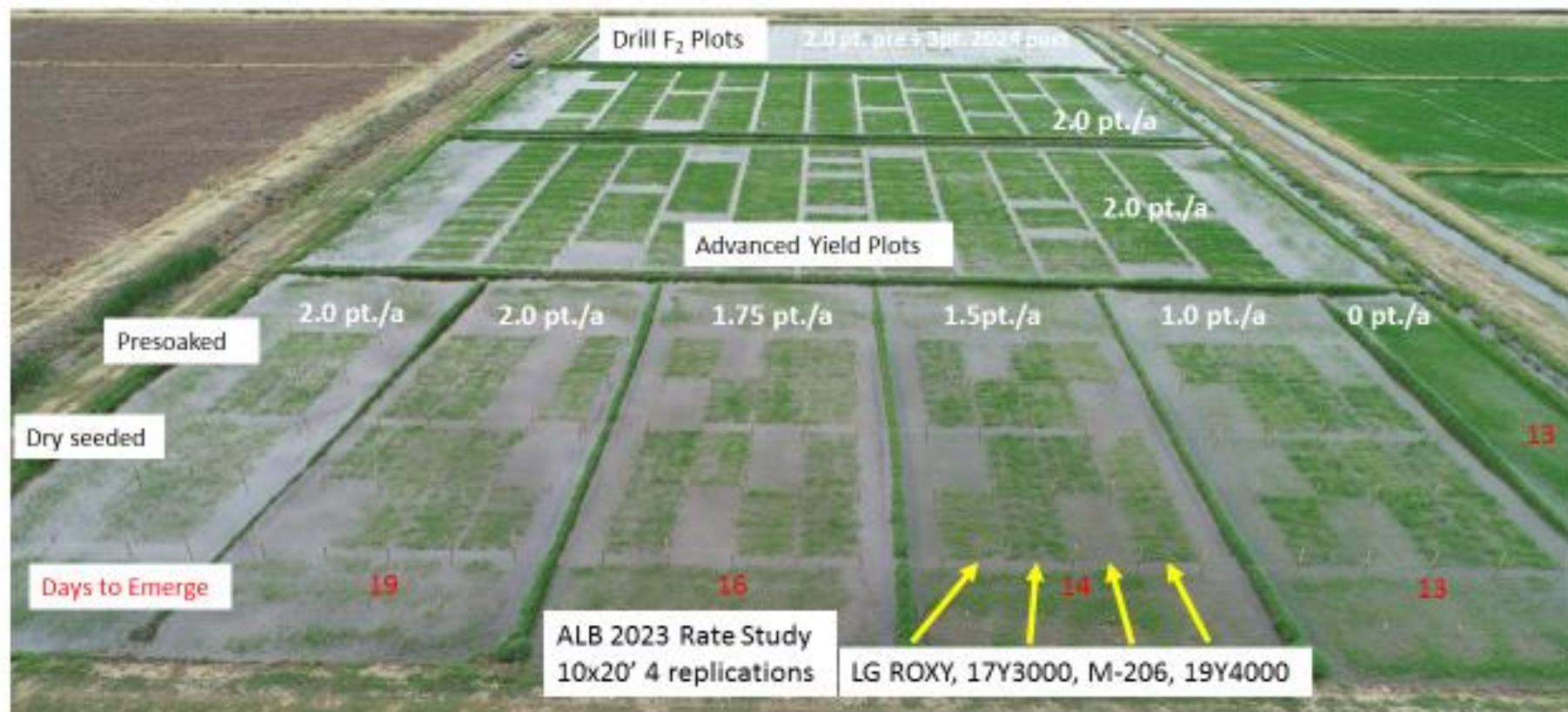


ROXY[®] Advanced Rice Lines Tested at 2 pts./a of ALB 2023

ID	Grain Yield (lbs/a)	RANK MEAN	Plant Height	Seedling Vigor	Days to Heading	Lodging	%BL SJ	SR Score
20Y158	9,990	1	103	4.8	96	0	3.3	HS
20Y4039	9,820	2	99	4.9	88	25	1.0	S
19Y4028	9,780	3	100	4.9	89	6	1.0	S
20Y4052	9,520	4	106	4.9	93	0	2.0	HS
20Y149	9,520	5	102	4.9	89	3	2.0	HS
17Y3000	9,040	19	104	4.9	88	43	2.0	HS
19Y4000	8,600	41	106	4.9	88	40	1.0	HS
M-209	6,090	66	105	1.9	93	0	2.0	HS
M-211	5,710	67	107	1.9	96	3	2.3	HS
M-206	5,550	68	100	1.9	93	0	1.0	HS



ROXY® Nursery RES Field J9
RES Drone Shot 6-15-2020 Seeded 5-13-2020



2020 Albaugh ROXY RPS Research

Efficacy Testing

- ✓ 2020 Albaugh Funded Efficacy Testing

BUCRA, Colusa County Farm Supply, Growwest, Wilbur-Ellis, UCD

Observed the California testing sites multiple times over the summer, weed control was very good at off station locations, also observed delayed emergence with increasing rates. A 2 pt./a treatment was effective in controlling weeds that had emerged before the initial flood at Hamilton Road.



Weed control efficacy test of 17Y3000 by Growwest Research in commercial rice production field in Colusa County in 2020.

Treatment	% Vigor Reduction	% Height/Vigor Reduction		% Height/Vigor Reduction		% Vigor Reduction	Ducksalad	Sprangletop	Smallflower Umbrella Plant	Redstem	Yield
	7 days	14 days		28 days		44 days	-----% control at 44 days-----				lbs./a
ALB 2023 1.5 pts./a	20	20	20	25	8	4	100	100	100	100	8310
ALB 2023 1.5 pts./a fb Super Wham	22	20	20	22	8	2	100	100	100	100	8286
ALB 2023 1.5 pts./a fb Regiment	20	20	20	28	10	3	100	100	100	100	8578
ALB 2023 2.0 pts./a	63	53	20	28	10	0	97	100	99	98	8390
ALB 2023 2.0 pts./a fb Super Wham	63	53	20	27	10	0	100	100	100	100	8461
ALB 2023 2.0 pts./a fb Regiment	63	53	20	28	12	3	97	100	97	100	8686
ALB 2023 2.5 pts./a	63	53	20	27	10	0	97	100	99	100	8027
ALB 2023 2.5 pts./a fb Super Wham	65	53	20	32	10	2	100	100	100	100	8131
ALB 2023 2.5 pts./a fb Regiment	67	52	20	28	10	3	100	100	98	100	8462
ALB 2023 1.5 pts./a fb Cerano	20	20	20	25	8	3	100	100	99	100	8906
ALB 2023 2.0 pts./a fb Cerano	20	18	20	32	10	3	98	100	100	99	8792
ALB 2023 2.5 pts./a fb Cerano	22	22	20	32	10	2	99	100	100	99	8346
Avg.	42	37	20	28	10	2	99	100	99	100	8448



Weed control efficacy test of 17Y3000 by BUCRA Research in rice research nursery in Butte County in 2020.

Treatment	% Phytotoxicity	EWG ⁱ	SPT	SFU	RFB	DS	WH	RS	AH	Yield
	18 days	-----% control at 78 days-----								lbs./a
ALB2023 1 pts./a	10.0 d	82 b	98 a	99 a	75 b	99 a	99 a	89 a	96 a	6670 b
ALB2023 1.5 pts./a	10.0 d	98 a	99 a	99 a	90 ab	99 a	99 a	99 a	96 a	7190 ab
ALB2023 1.75 pts./a	20.0 b	95 a	99 a	99 a	85 ab	99 a	99 a	99 a	99 a	7820 ab
ALB2023 2 pts./a	25.0 a	96 a	99 a	99 a	96 a	99 a	99 a	99 a	99 a	7210 ab
ALB2023 2.25 pts./a	25.0 a	98 a	98 a	99 a	98 a	99 a	99 a	99 a	99 a	8730 ab
ALB2023 2.5 pts./a	25.0 a	97 a	99 a	99 a	99 a	99 a	99 a	99 a	99 a	9480 a
ALB2023 2 pts./a fb Stam	25.0 a	99 a	99 a	99 a	93 a	99 a	99 a	99 a	92 a	8230 ab
ALB2023 2 pts./a fb Regiment	25.0 a	97 a	99 a	99 a	98 a	99 a	99 a	99 a	96 a	8220 ab
ALB2023 2 pts./a	15.0 c	99 a	99 a	99 a	98 a	99 a	99 a	99 a	99 a	8590 ag
ALB2023 2.5 pts./a	15.0 c	99 a	99 a	99 a	99 a	99 a	99 a	99 a	98 a	8100 ab

ⁱ EWG = early watergrass, SPT = sprangletop, SFU = small flower umbrella, RFB = rice field bullrush, DS = ducksalad, WH = water hyssop, RS = redstem, and AH = arrowhead

Values with the same letter are not significantly different at the 0.05 level.



Weed control efficacy test of 17Y3000 by Colusa County Farm Supply Research in rice research nursery in Colusa County in 2020.

Treatment	Stunting at 14 days	Stunting at harvest	Minic watergrass	Yield
	%	%	% control	lbs./a
ALB 2023 1.0 pts./a	25	0	75	9890
ALB 2023 1.5 pts./a	25	0	78	10640
ALB 2023 1.75 pts./a	25	0	83	12020
ALB 2023 2.0 pts./a fb propanil	40	0	98	9133
ALB 2023 2.0 pts./a fb Regiment	40	0	92	11700
ALB 2023 2.25 pts./a	45	10	98	9280
ALB 2023 2.5 pts./a	45	10	98	11400
Avg.	35	3	89	10580

CCFS 2 acre basin 4/29 to 9/25	Phytoxicity	Early Watergrass	Late Watergrass	Sprangletop	Small Flower	Rice Field Bullrush	Red Stem	Yield lbs./a	
ALB 2023 1.75 pts./a pre flood 17Y3000 @185 lbs./a	%	% control	% control	% control	% control	% control	% control	Sample	Basin
	0	85	90	90	100	100	100	11300	11200



2020 Drill-Seeded Pre and Post Rate Study

(RES 17Y3000, 19Y4000, 18P4116, and M-206 in large plot experiment with 4 reps)

Treatments*	SV1 6/1/20	SV2 6/5/20	SV3 6/5/20	Height 1 (cm)	Height 2 (cm)	Height 2 (cm)	50% (days)	Yield (lbs./a)	Entries
ALB 2023 (2.25 pt/A)	4.9	7.9	7.3	14	39	102	83	8790	18P4116
ALB 2023 (3.00 pt/A)	4.8	7.9	7.3	15	38	102	83	8625	17Y3000
ALB 23(1.5pt)+ALB24 (3.0pt)	4.9	8.3	7.5	15	37	100	83	8614	19Y4000
ALB 23(2.0pt)+ALB24 (2.0pt)	4.9	8.2	7.5	16	36	102	83	8677	
Mean	4.9	8.1	7.4	4	38	101	83	8676	
LSD (0.05)	0.07	NS	NS	0.44	1.7	NS	NS	NS	

*Plots Counts for Grass (<1), Sprangle top (<2), and Total Weeds (<5) were NS.



2020 Drill-Seeded Pre and Post Rate Study Weedy Rice Simulation

(RES 17Y3000, 18P4116, and M-206 with 20% Koshihikari in large plot experiment with 4 reps)

Treatments	SV1	SV2 6/1/20	SV3 6/5/20	Height 1 (cm)	Height 2 (cm)	Height 2 (cm)	50% (days)	Yield (lbs./a)	Entry Yield	Entries
ALB2023 (2.25 pt/A) fb										
ALB2024 (1.5 pt/A)	4.8	8.2	6.6	14	33	100	84	7234	9815	18P4116
ALB2023 (2.0 pt/A) fb										
ALB2024 (2.0 pt/A)	4.8	8.1	6.4	14	33	102	84	7207	9591	17Y3000
ALB2023 (1.75 pt/A) fb										
ALB2024 (2.5 pt/A)	4.8	8.4	7.0	15	34	103	83	7354	2616	M-206
ALB2023 (1.5 pt/A) fb										
ALB2024 (3.0 pt/A)	4.9	8.5	7.2	14	34	100	84	7567		20%
Mean	4.8	8.3	6.8	14	33	101	83	7341	7341	KOSH
LSD (0.05)	NS	NS	0.5	NS	NS	NS	NS	NS	602	

*Plots counts for Grass (<1), Sprangle top (<1), RFBR (<1), and Total Weeds (<5), were NS. KOSH were not found in ROXY lines, but were present in the M-206 (Avg 7)



This drill seed experiment was an effort to evaluate how a susceptible rice would survive mixed in with a ROXY line and applications of ALB 2023 and 2024 used in pre- and post-emergence applications.



2020 Drill-Seeded Pre and Post Rate Study Weedy Rice Simulation

17Y3000 +30% Koshihikari



No Koshihikari plants and
complete weed control

M-206 +30% Koshihikari



Some M-206 (filled), Koshihikari
(tall heading), and sprangle top
RFBR plants surviving



ROXY® Rice Production System

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ROXY® RPS offers a very attractive and new rice production system:

- Pre-flooding application for early weed control
- ALB2023 and ALB024 provide growers with a Group 14 herbicide mode of action and CA currently has no rice weed resistance to PPO herbicides.
- The **ROXY® RPS** will provide growers with enhanced herbicide performance and value
- **ROXY® RPS** can be used as part of a best management practice to address weedy red rice

ROXY® RPS

1. ROXY® RPS is Driven by:

- ✓ Patent Pending Trait
- ✓ Branded Herbicides
- ✓ Elite Germplasm
- ✓ Industry Stewardship



2. EPA submission 1st QTR of 2021 w/ CA DPR Concurrent Review

3. ROXY® RPS Innovation Tours and Rice Field Day in 2021

4. Launch ROXY® RPS for CA rice growers in 2023