

Weedy Rice Research Updates

Weedy Rice Workshop

Colusa, CA

Aug 1, 2019

Materials & Methods

133 – CA Weedy Rice Collections

20 – Southern Weedy Rice (AR, LA, MS, MO, TX)

11- Wild rice (*O. rufipogon*, *O. barthii*, *O. glumaepatula*, *O. nivara*, *O. officinalis*, *O. alta*)

3 - Specialty Rice

21- Temperate Japonicas (CA rice varieties, 2 Jap variety)

5 – Tropical Japonicas (Southern USA rice)

5 – Indicas

5 - Aus

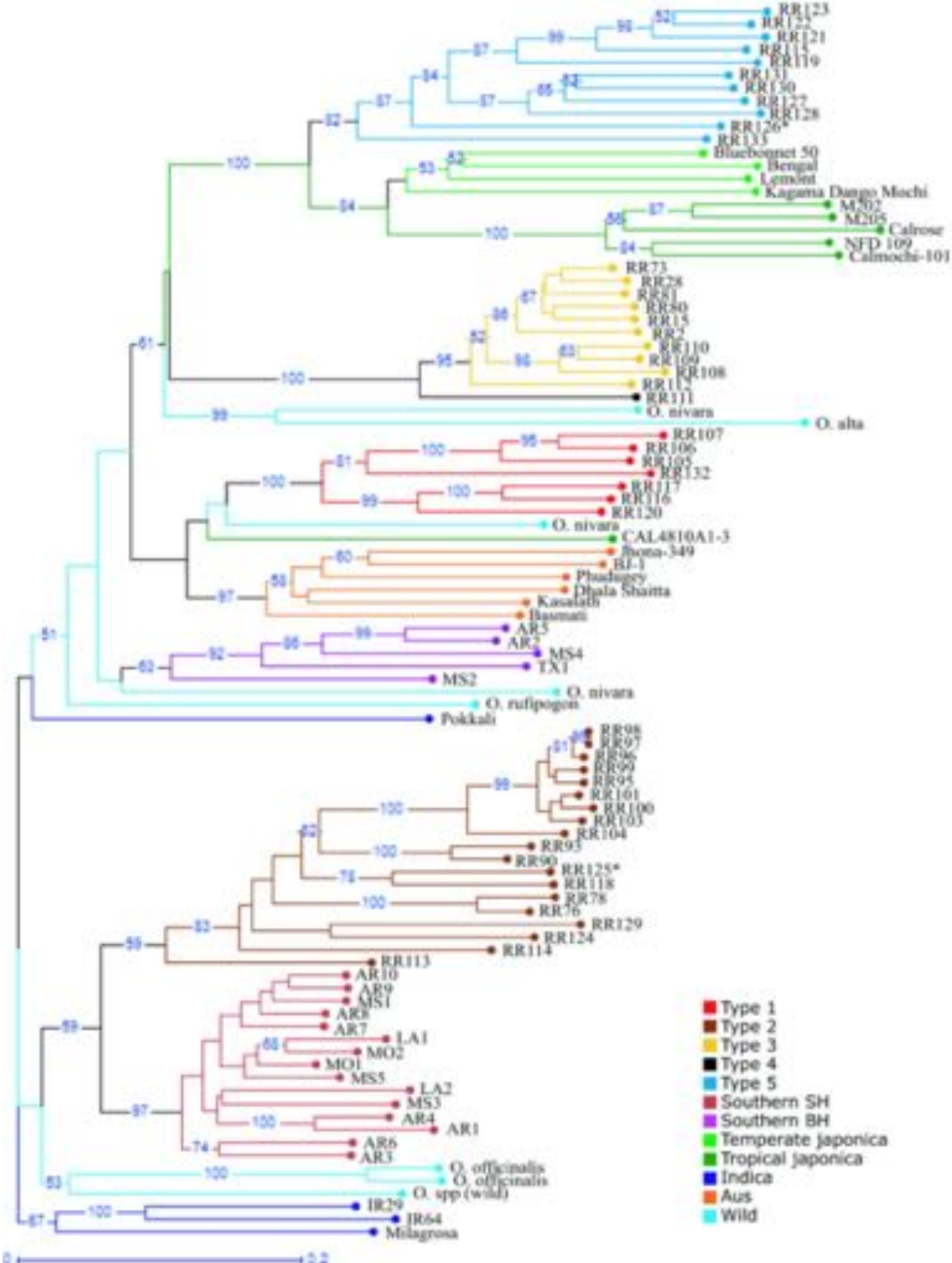


Phenotype

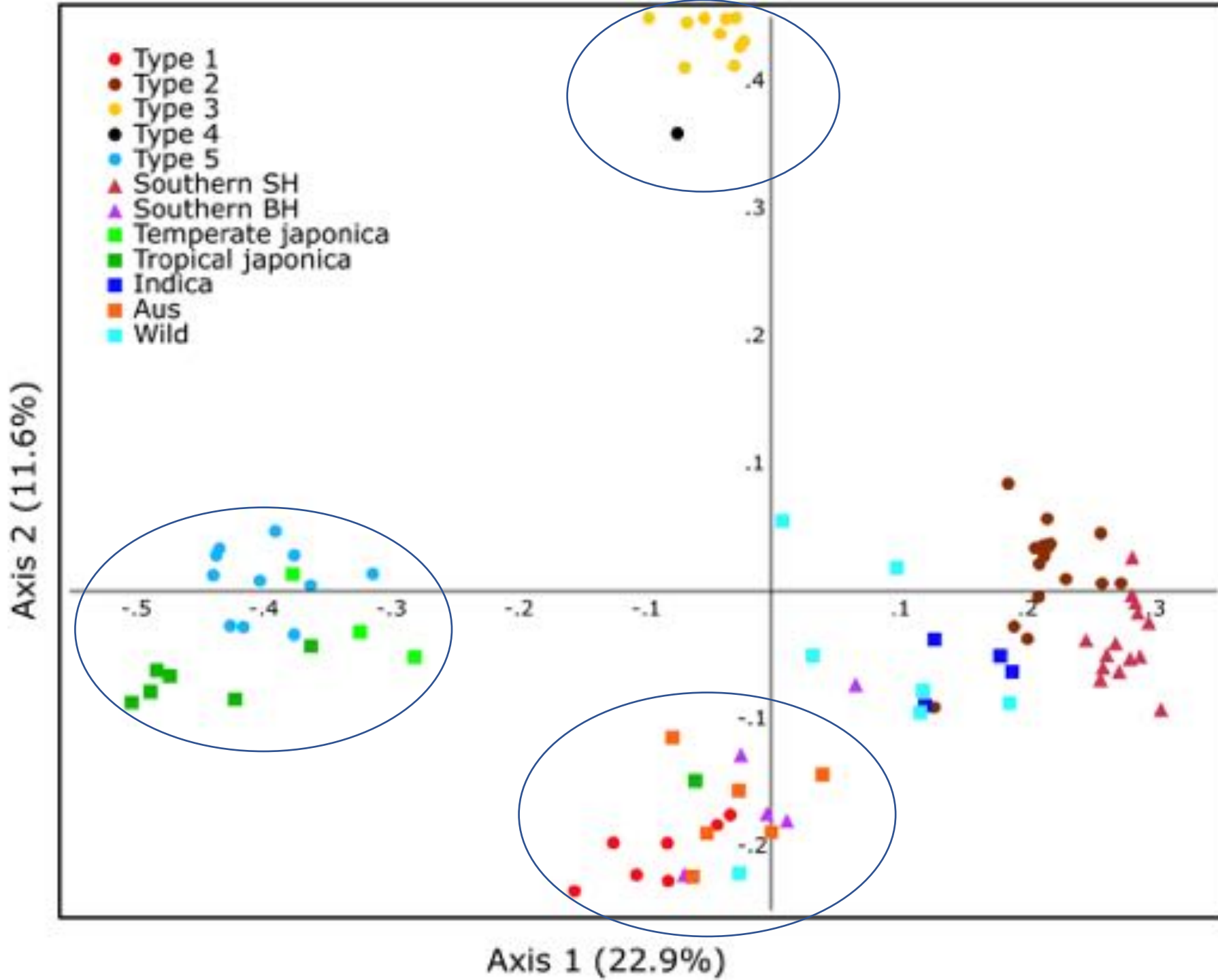
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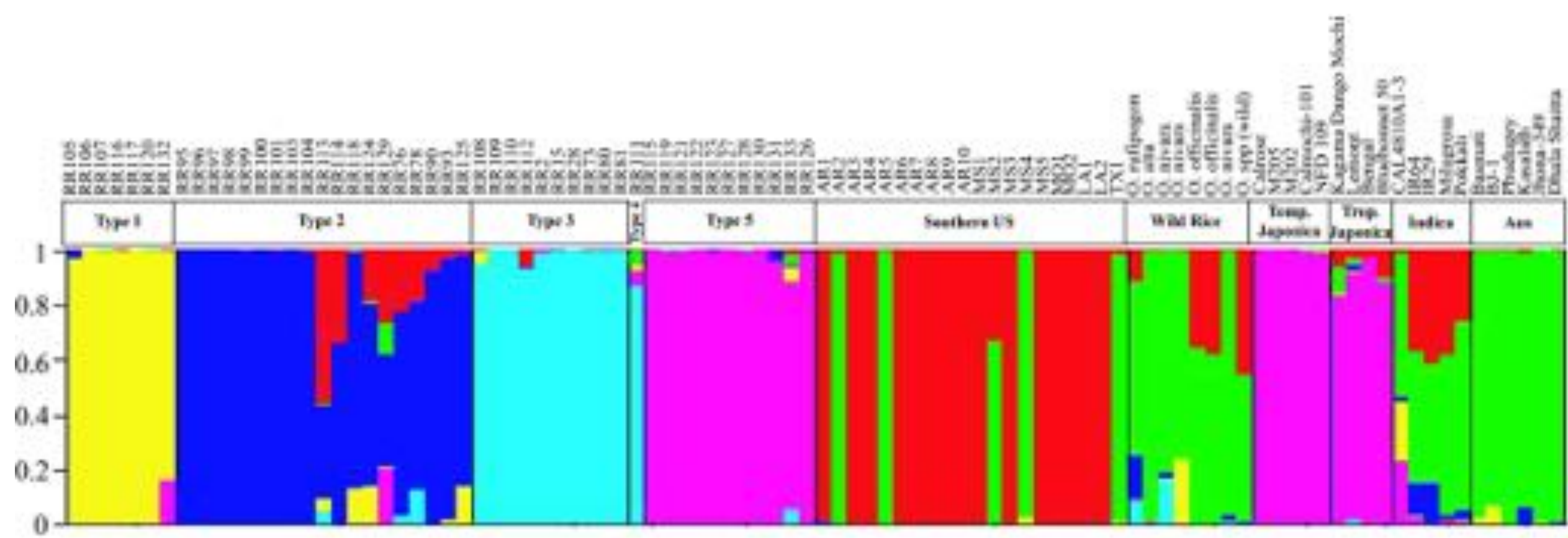
Genotype

characterizations



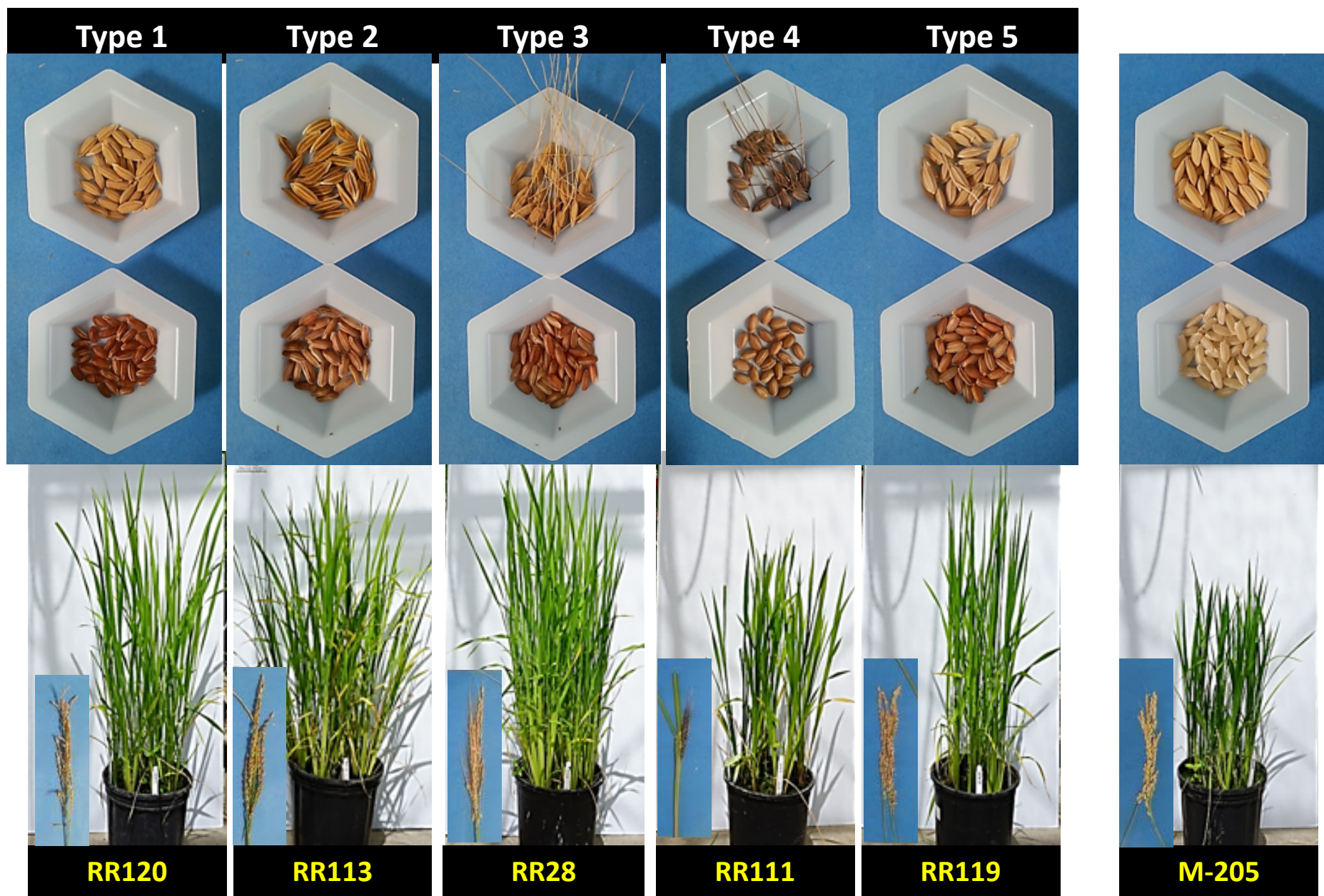
- Type 1: near an *O. nivara* individual and one temperate *japonica* variety as well as *aus* and Basmati rice
- Type 2: near southern SH weedy rice and some wild rice
- Type 3: grouped together with the Type 4 weedy rice. Most closely related to *O. nivara* and *O. alta* (wild rices)
- Type 5: near the *japonica* rice varieties Closely related to Type 3 and Type 4 weedy rice.
- Two noncertified introduced cultivated red-pericarped specialty rice varieties grown in California, (RR125 and RR126), clustered with California weedy rice.

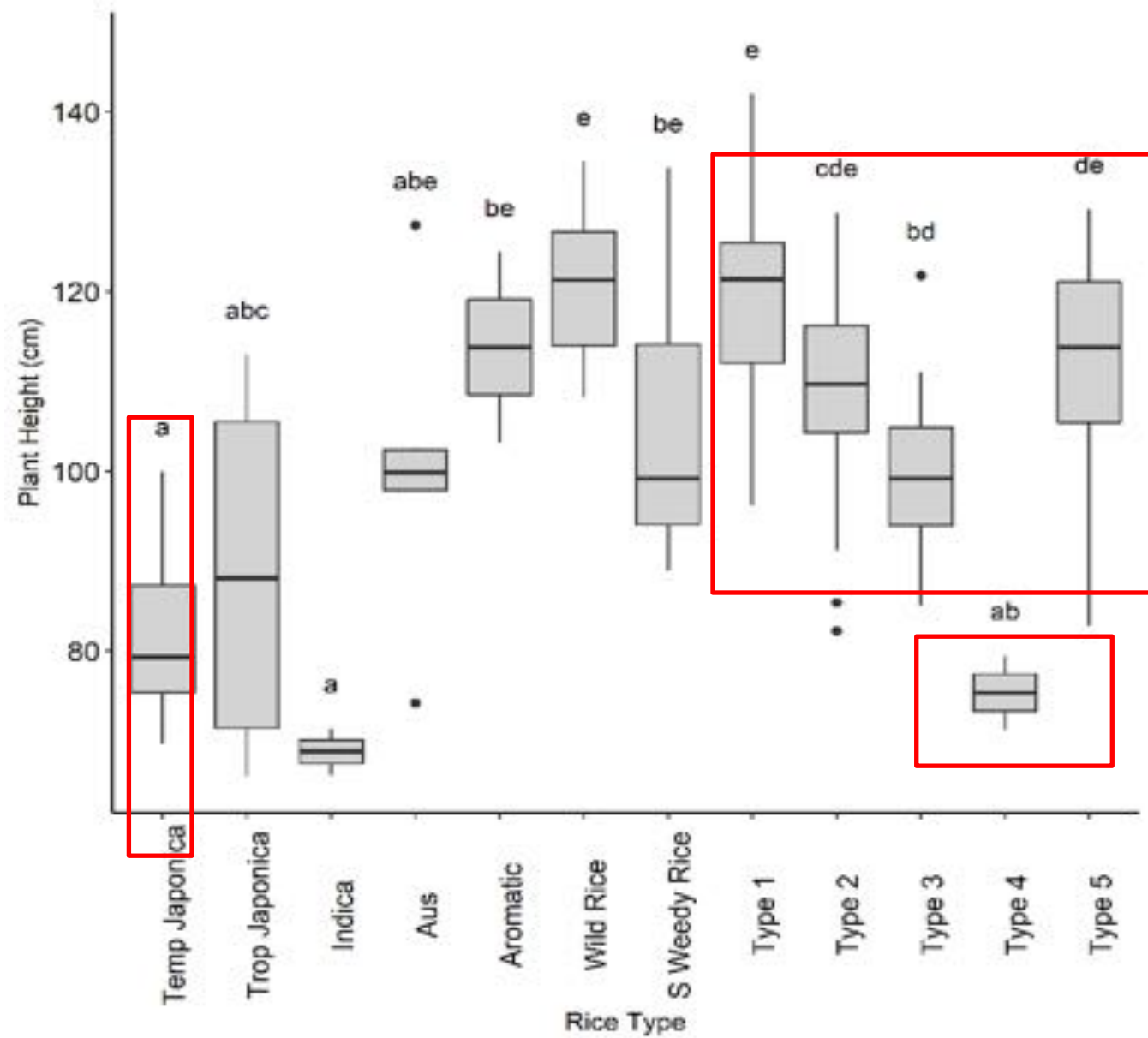


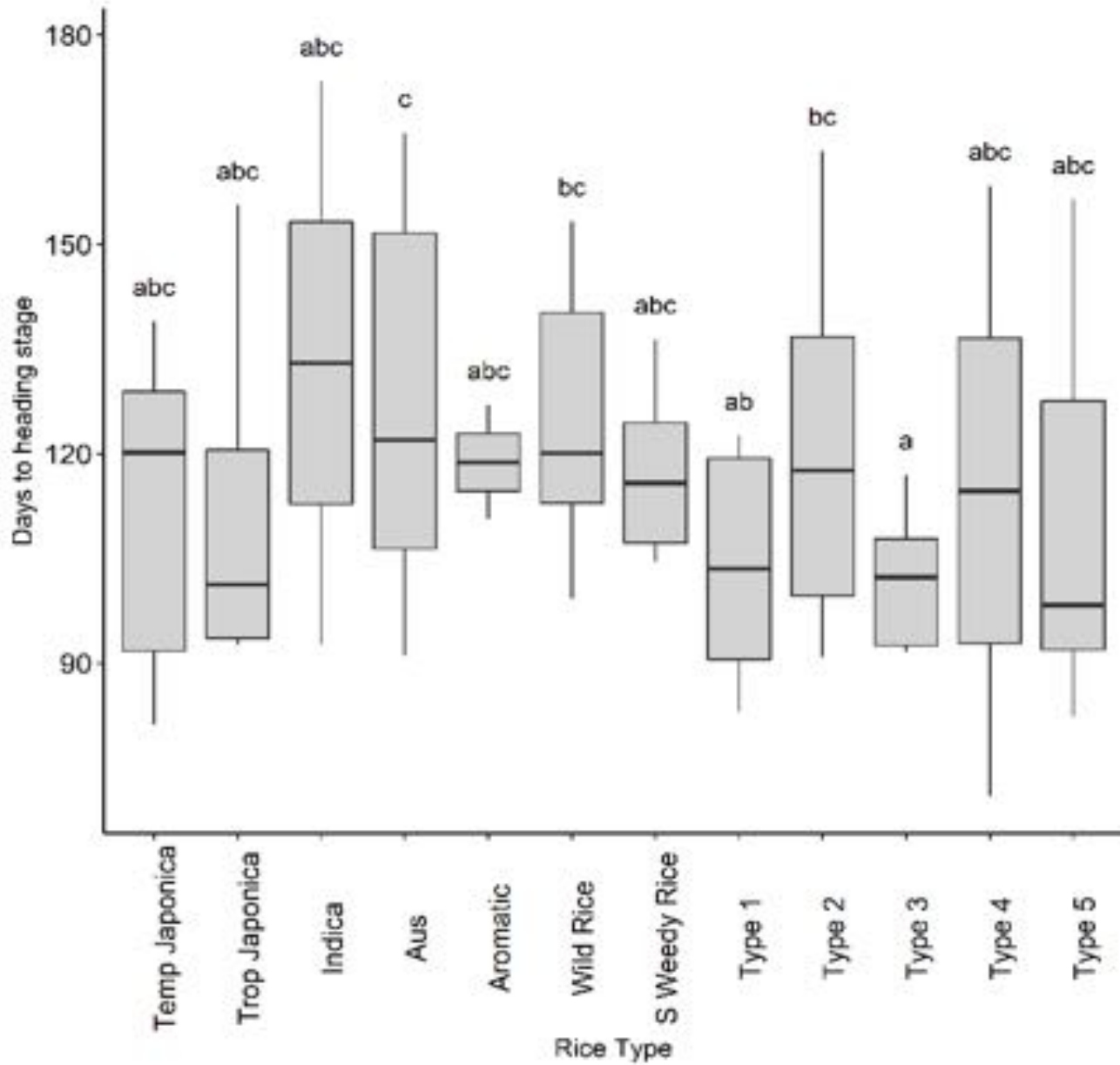


- Type 1 cluster: genetic contributions from *O. nivara*, one *indica* rice variety, and some Type 2 weedy rice individuals.
- Type 2: individuals show admixture with strawhull weedy rice from the southern United States, *indica* rice, or wild rice species.
- Type 3 and Type 4 rice: minor contributions from wild rice
- Type 5 weedy rice: cluster genetically with both tropical and temperate *japonica* rice

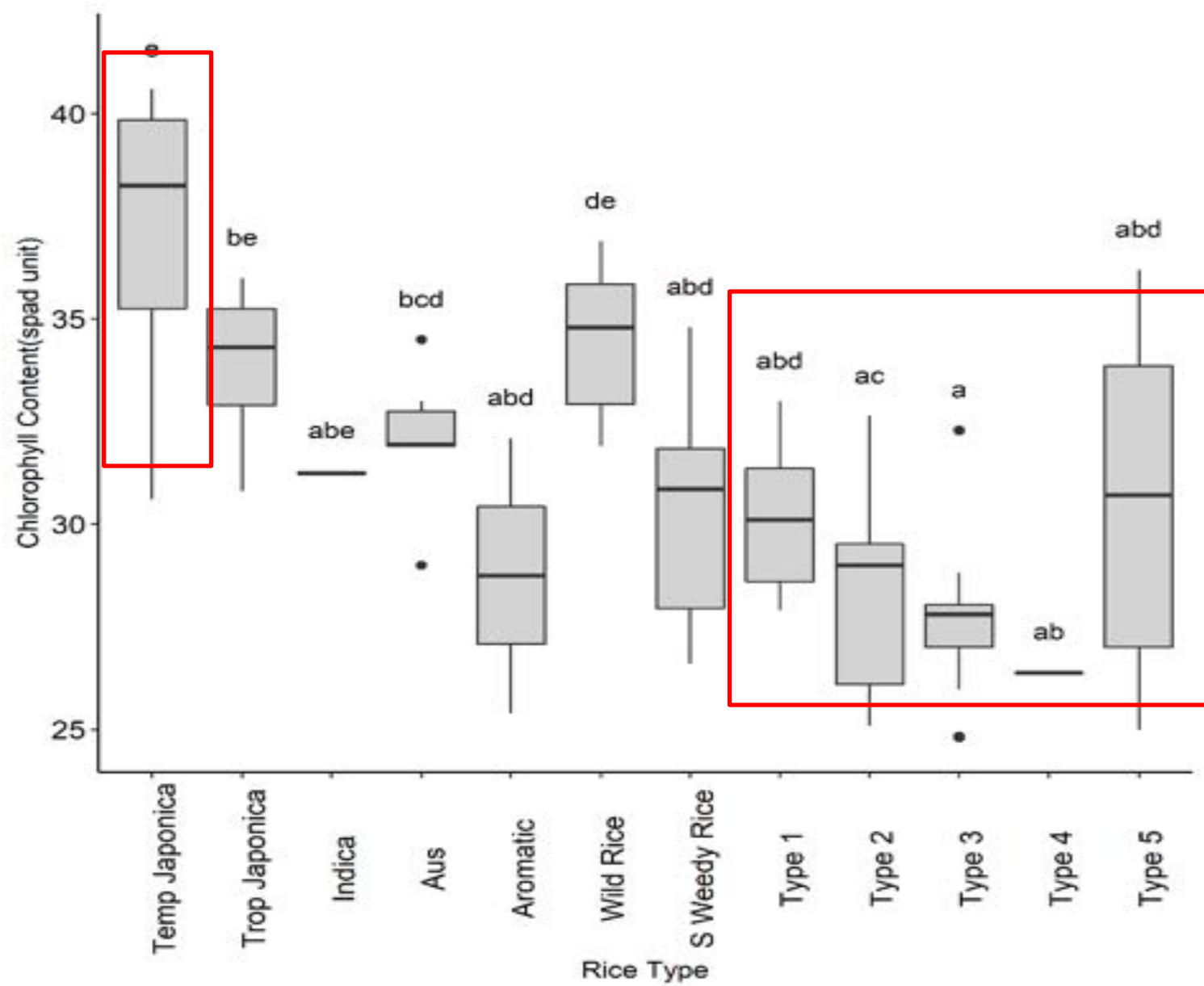
California weedy red rice ecotypes

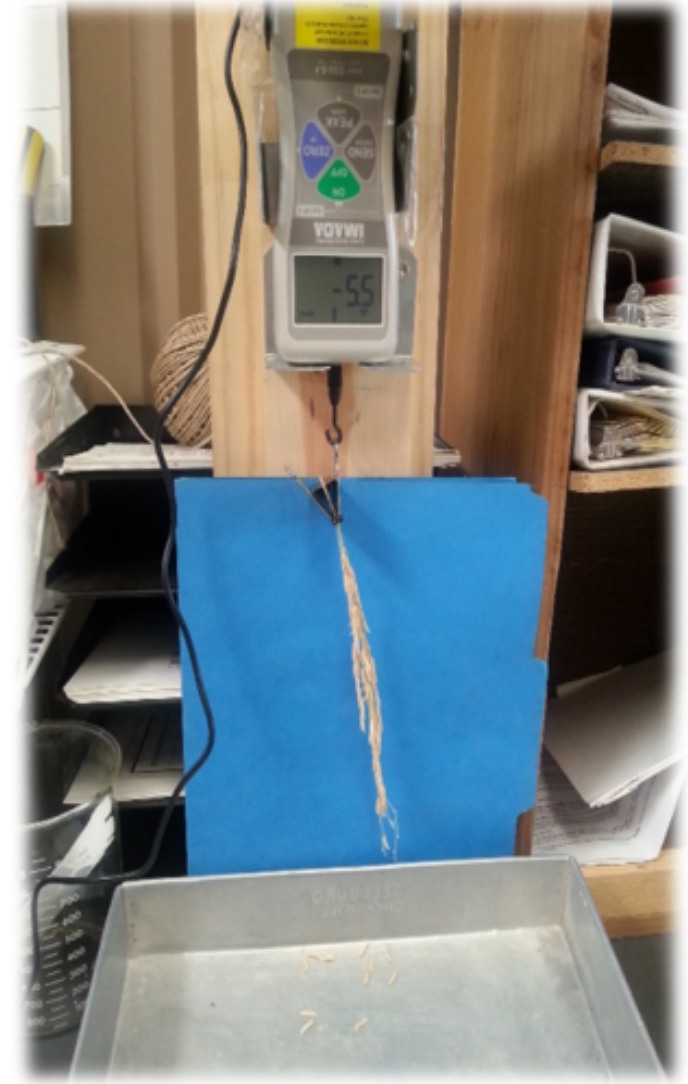
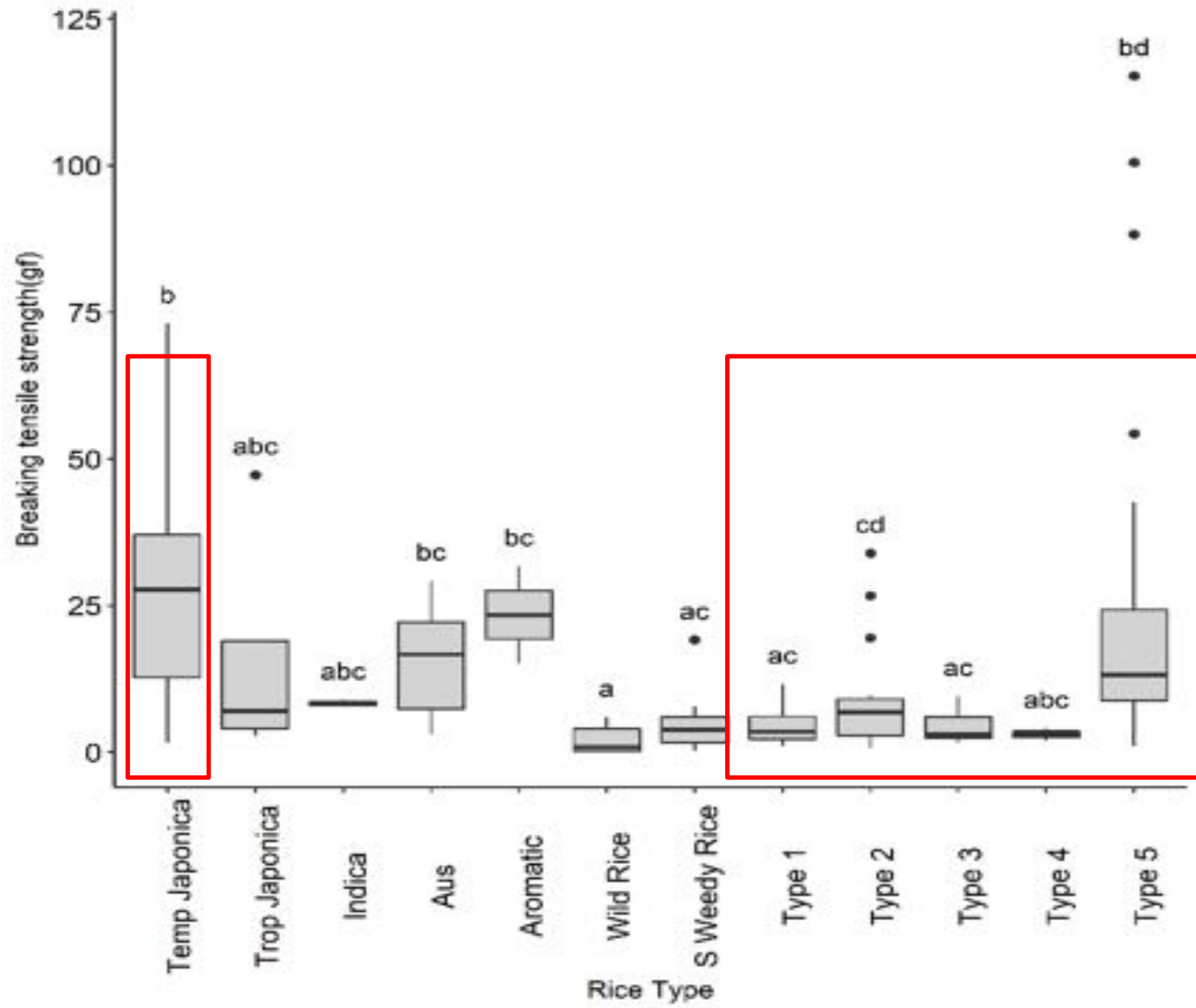


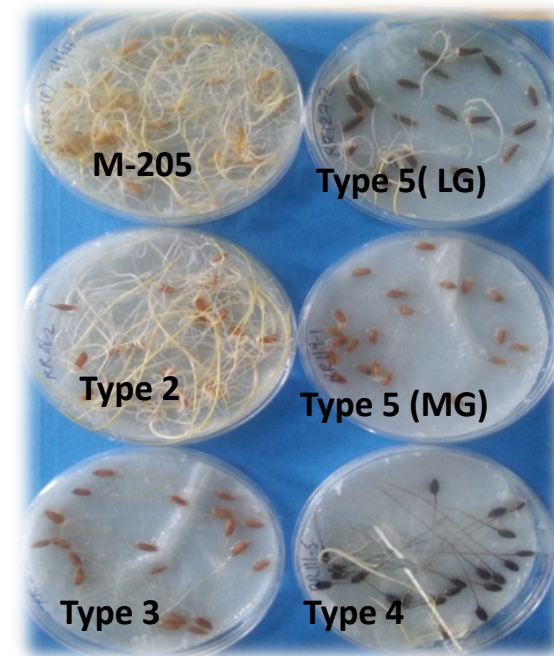
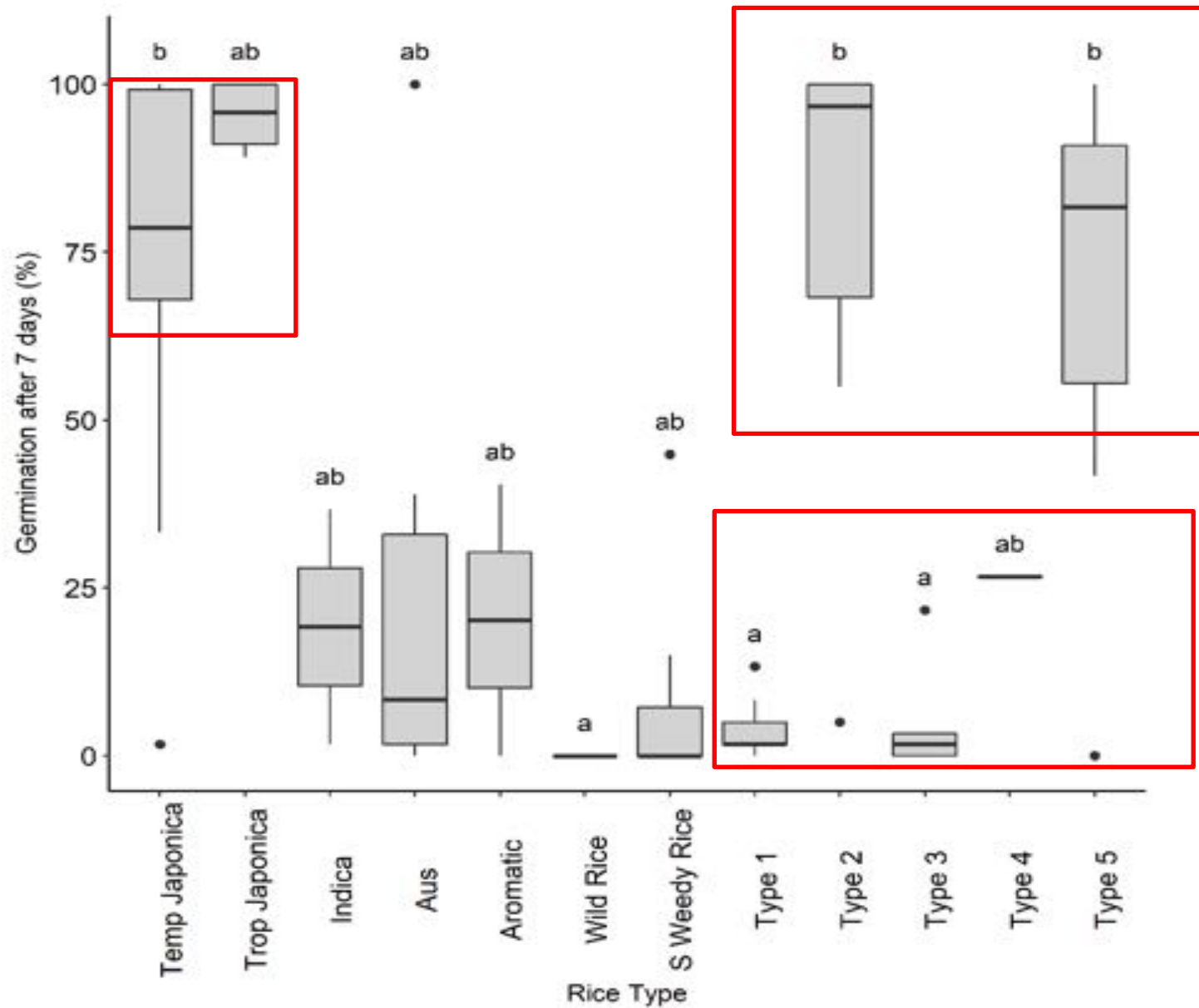




- No significant differences in heading date
- Will confirm in the field experiments in the next few years







Seed germination at 30°C,
7 days after sowing

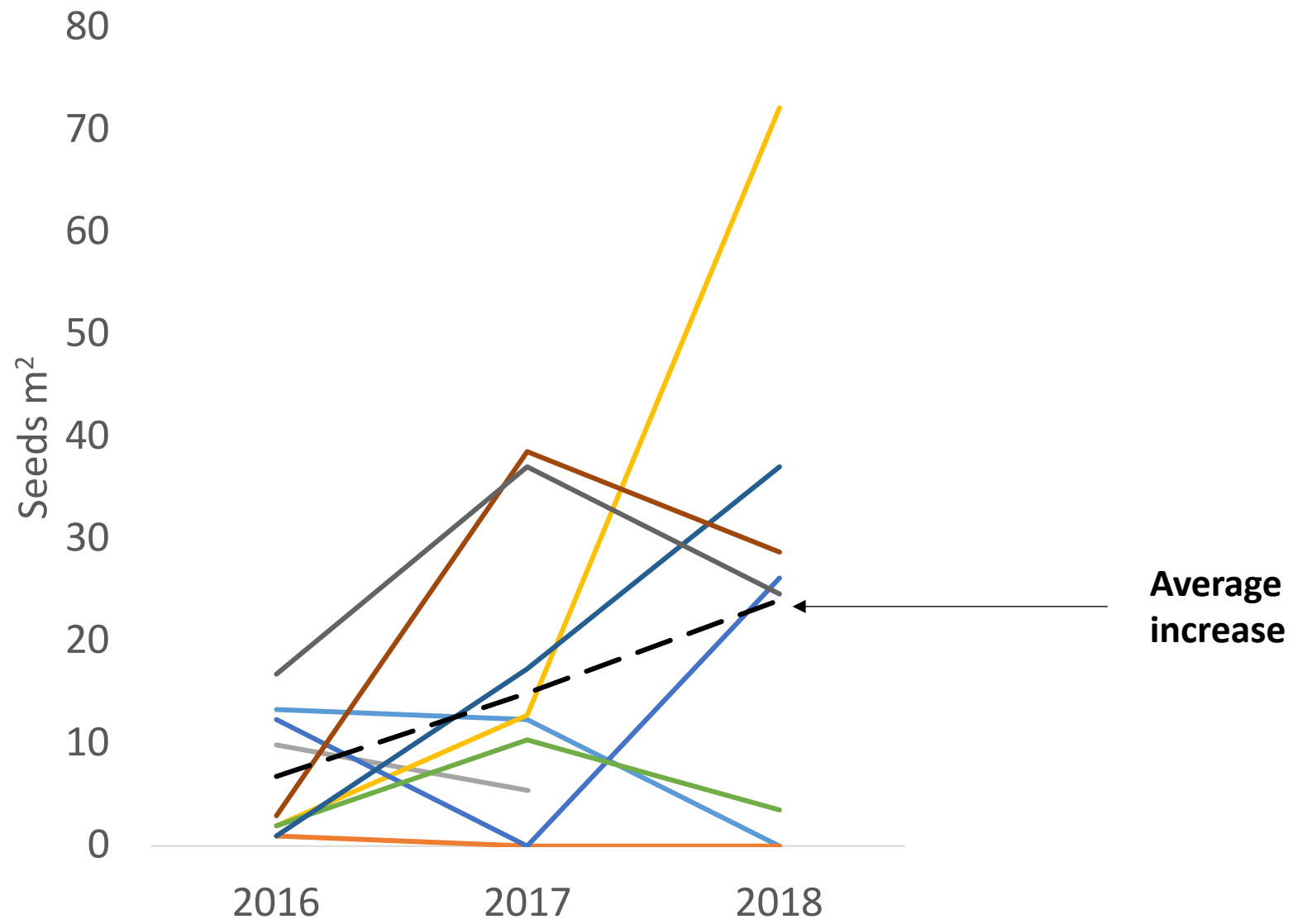
Soil Seedbank Surveys: Fall 2016-2018

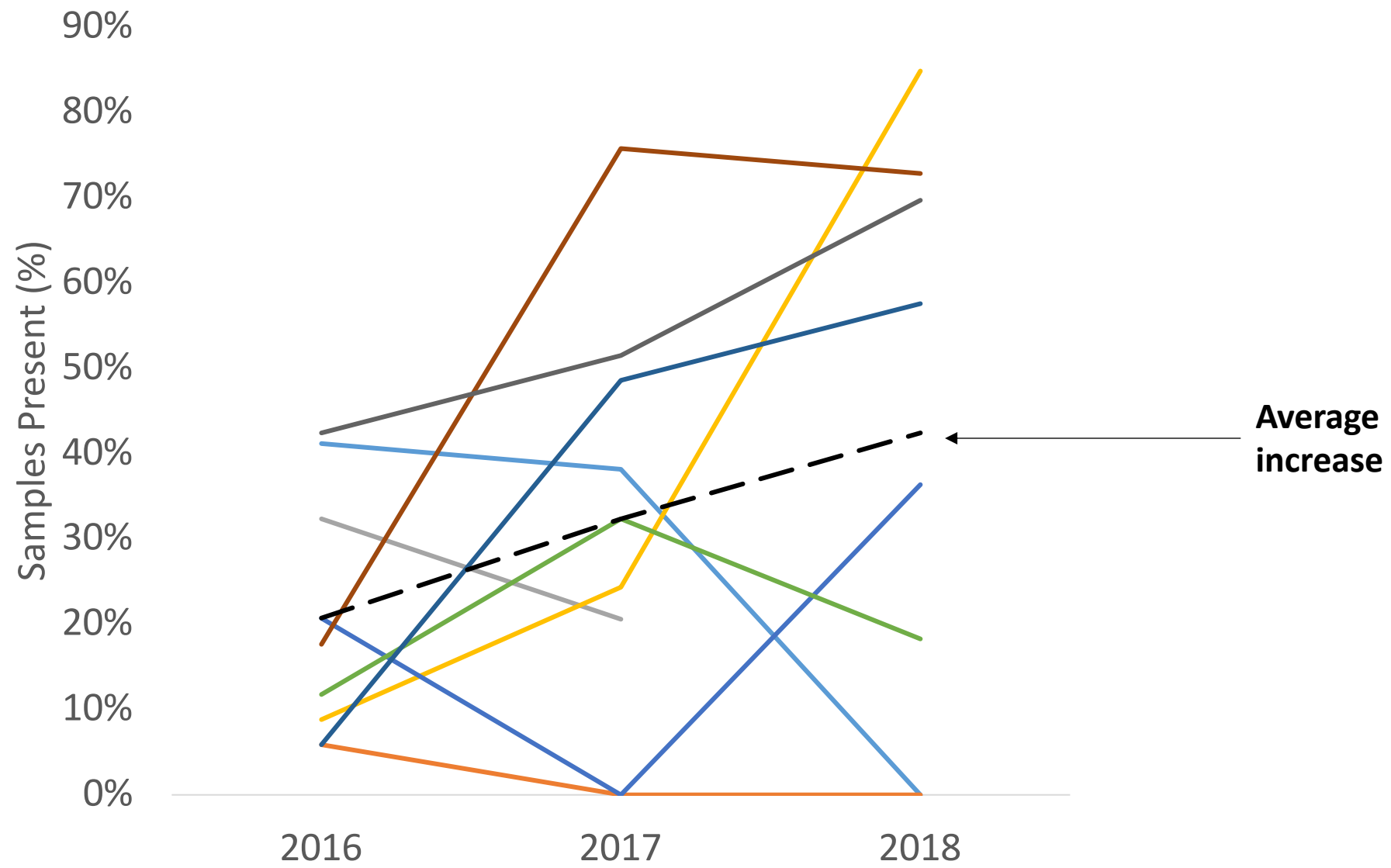
- Sample 10 fields with known infestations
 - Participating growers
- 34 soil cores taken every 20 feet along transect
- Soil samples were washed in a saline (salt) solution to extract organic matter
- Rice seeds found in each core were subjected to a KOH (potassium hydroxide) test



Weedy rice seed counts from soil samples collected in fall 2016, 2017, and 2018.

County	Ecotype	Seeds m ⁻²			Samples Present (%)		
		2016	2017	2018	2016	2017	2018
Butte	1	13.4	12.4	0	41	38	0
Sutter	1	1.0	0	0	6	0	0
San Joaquin	1	9.9	5.4	n.d.	32	21	n.d.
Glenn	1	2.0	12.9	72.2	9	24	85
Yuba	2	12.4	0	26.2	21	0	36
Sutter	2	2.0	10.4	3.46	12	32	18
Colusa	3	1.0	17.3	37.1	6	48	58
Colusa	3	3.0	38.6	28.7	18	76	73
Sutter	5	16.8	37.1	24.7	42	52	70

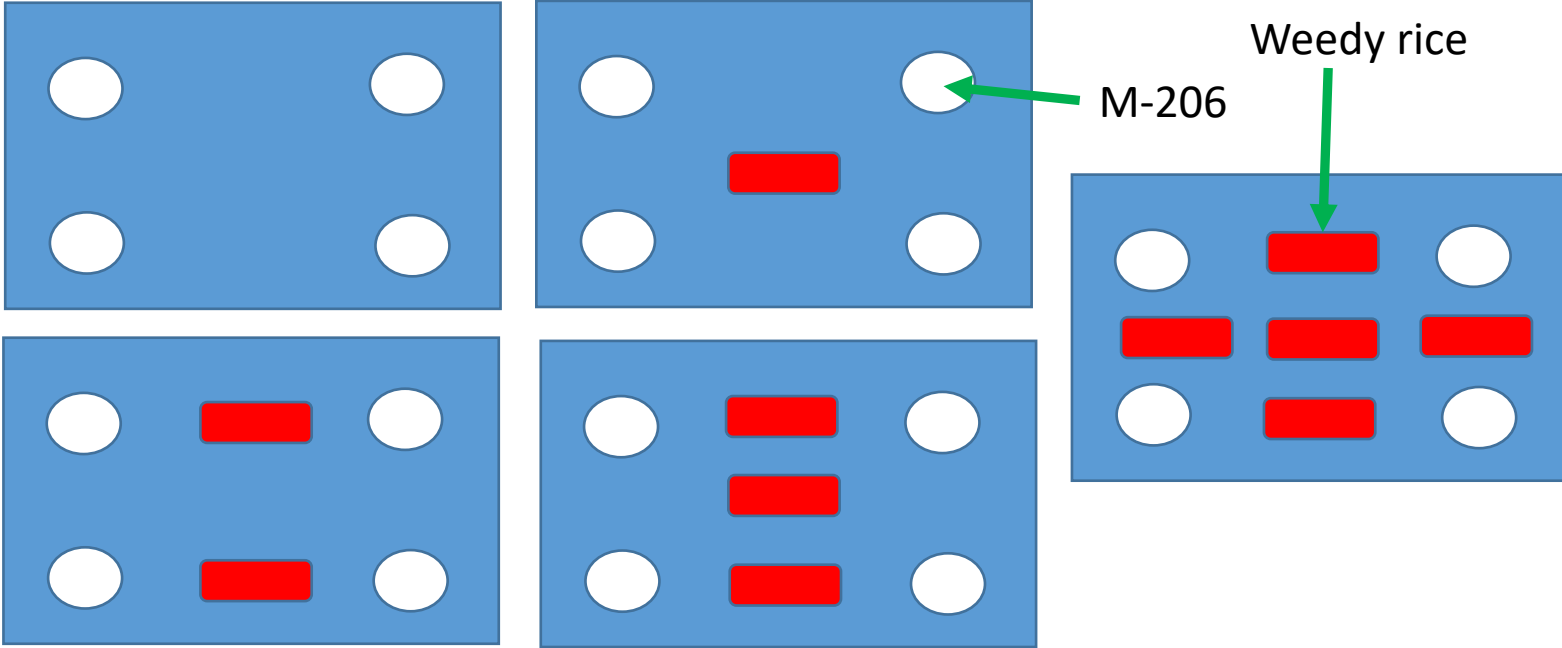




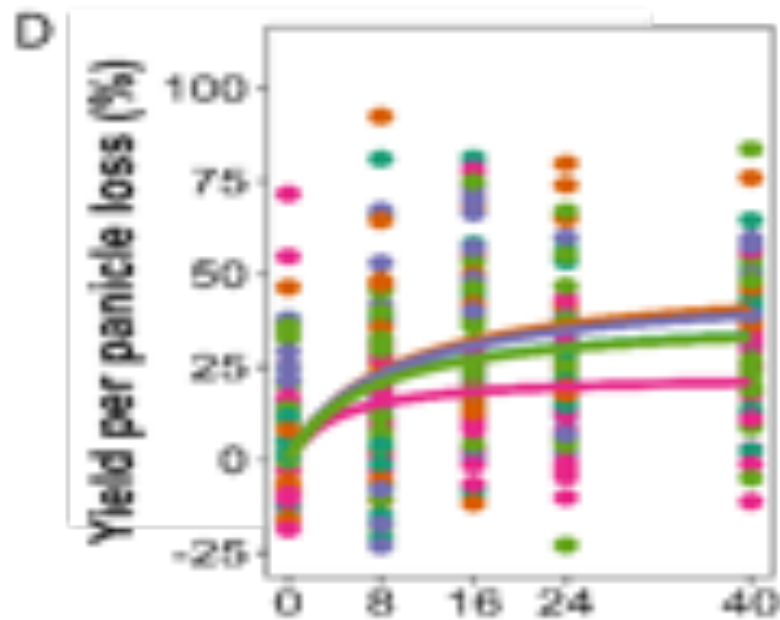
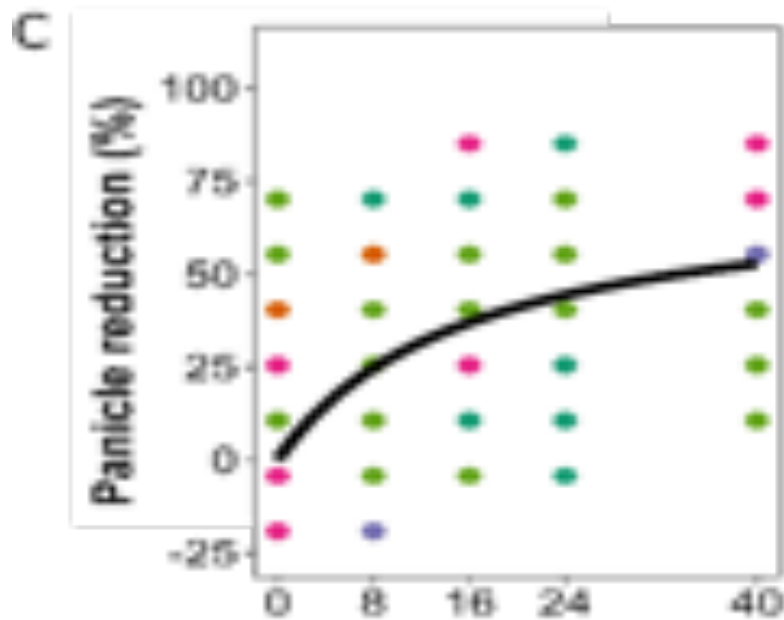
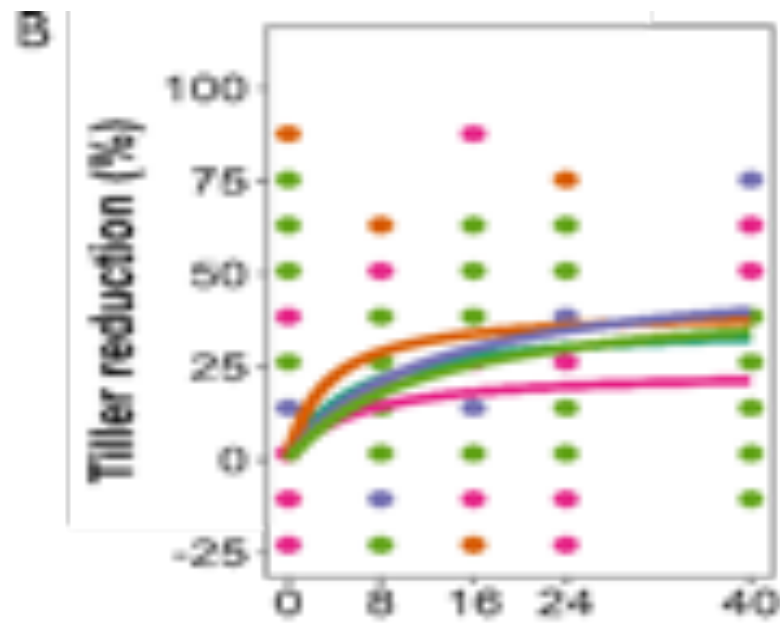
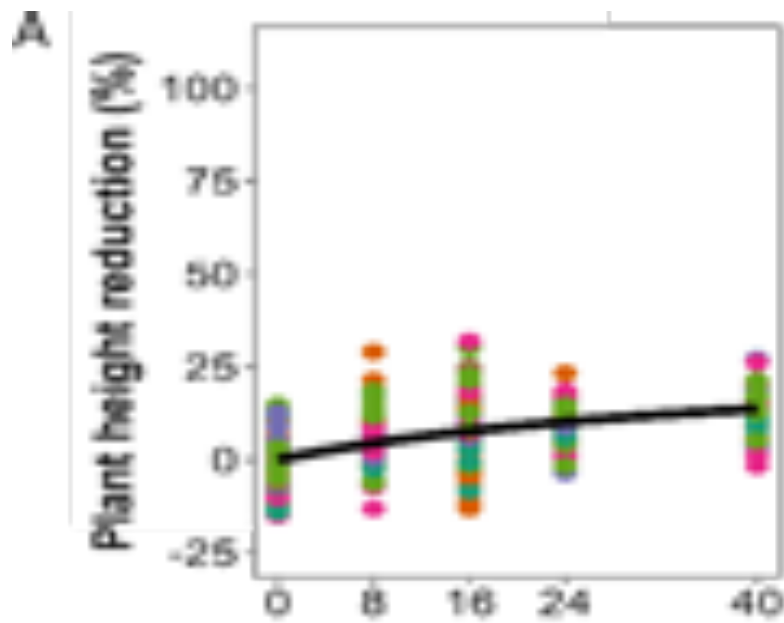
Competition Study

Additive Design:

8, 16, 24 and 40 plants per meter squared

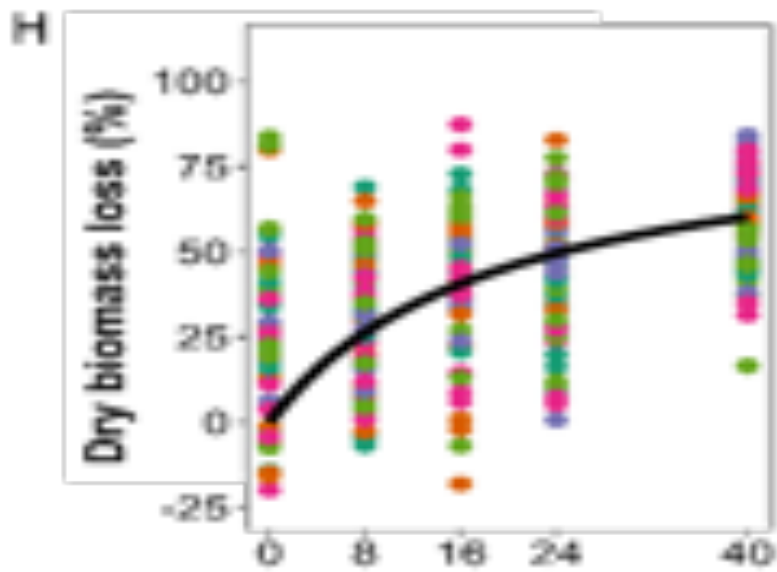
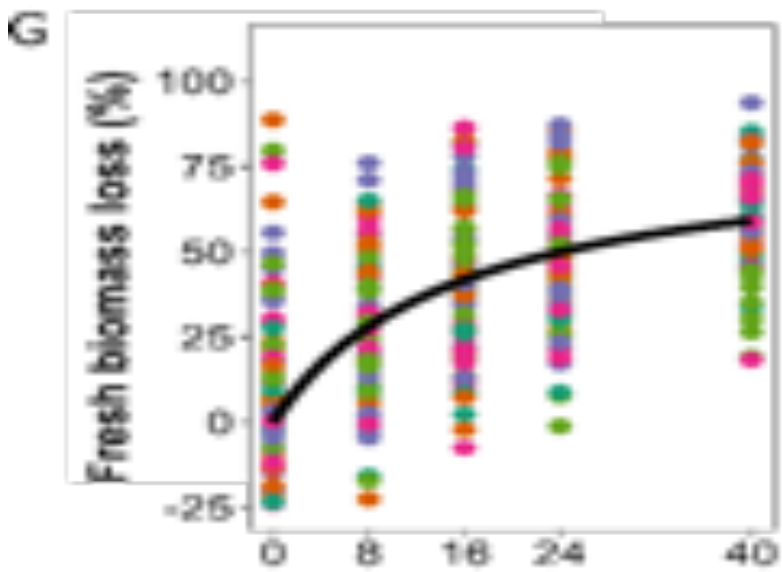
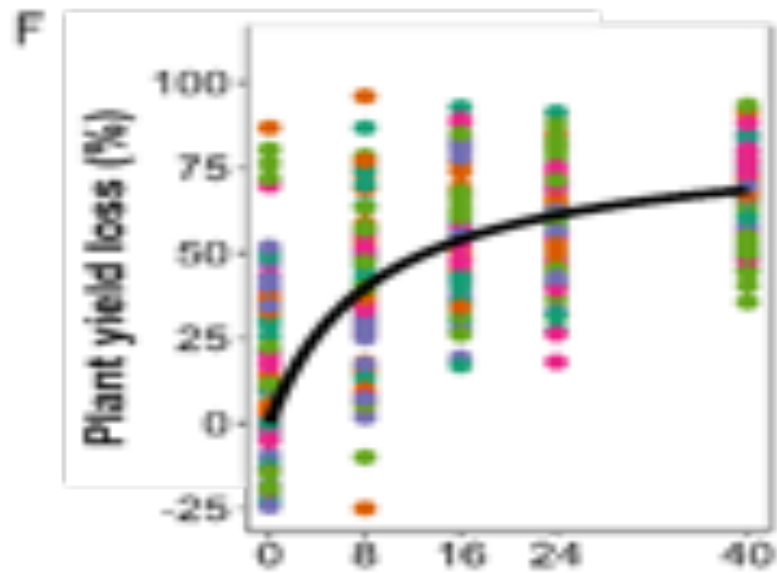
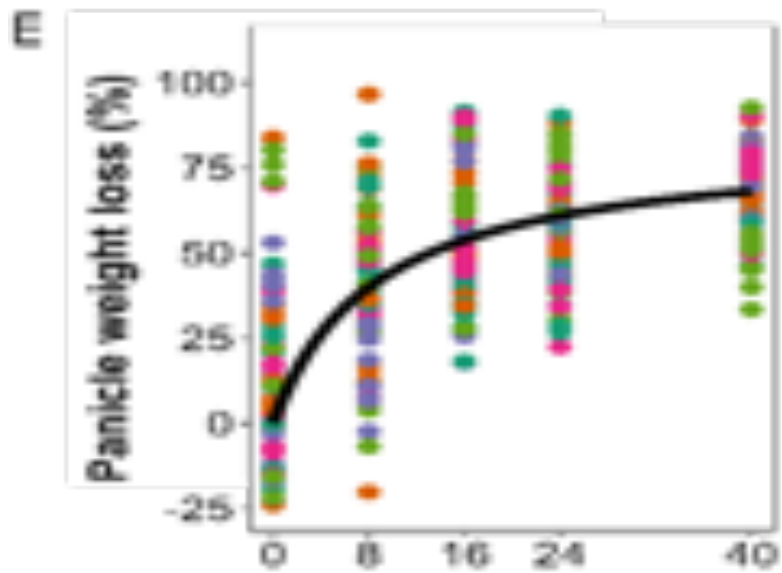


Weed Density (plants m ⁻²)	0	8	16	24	40
Plant Height (cm)	104.3 d	99.4 c	96.4 bc	93.8 b	89.9 a
SE	0.4	0.4	0.5	0.3	0.3
Tiller Number	8.1 d	7.2 cd	6.7 bc	5.9 ab	5.0 a
SE	0.2	0.1	0.1	0.1	0.1
Panicle Number	6.7 d	5.0 c	4.2 b	3.8 b	3.1 a
SE	0.1	0.1	0.1	0.1	0.1
Total Panicle Weight (g)	21.37 d	12.88 c	9.62 b	8.68 b	6.69 a
SE	0.42	0.26	0.20	0.17	0.13
Yield per Panicle (g)	3.22 c	2.59 b	2.28 ab	2.28 ab	2.08 a
SE	0.05	0.04	0.04	0.03	0.03
Yield per Plant (g)	19.46 d	11.78 c	8.72 b	7.85 ab	6.04 a
SE	0.38	0.25	0.18	0.16	0.12
Fresh Biomass (g)	45.00 d	31.94 c	26.17 b	23.31 b	17.88 a
SE	0.83	0.51	0.51	0.44	0.35
Dry Biomass (g)	21.42 d	15.60 c	12.64 b	11.21 b	8.30 a
SE	0.46	0.29	0.23	0.20	0.14
100 Seed Weight (g)	3.01 a	3.01 a	2.95 a	3.08 a	3.07 a
SE	0.12	0.13	0.16	0.15	0.17



— All biotypes 1 2 3 4 5

- Differences between biotypes in tiller reduction and yield loss per panicle:
 - Type 4 causes least reduction
- 10% reduction in height
- 15-40% reduction in tillering
- 50% reduction in number of panicles
- 15-40% reduction in yield per panicle

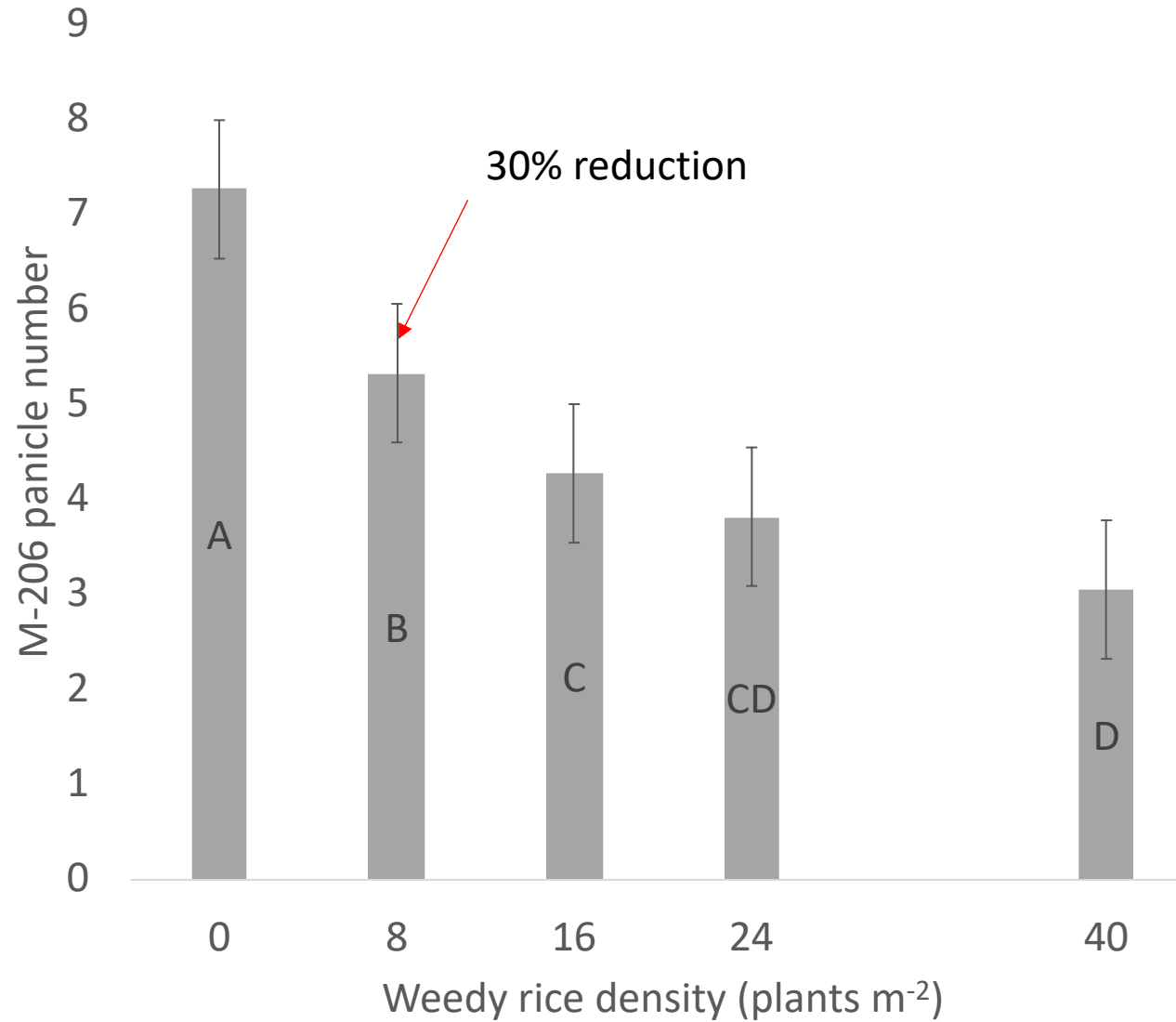


- 60% reduction in total panicle weight
- 65% reduction in yield per plant
- 50% reduction in fresh and dry biomass

Panicle Number

Weedy rice density:

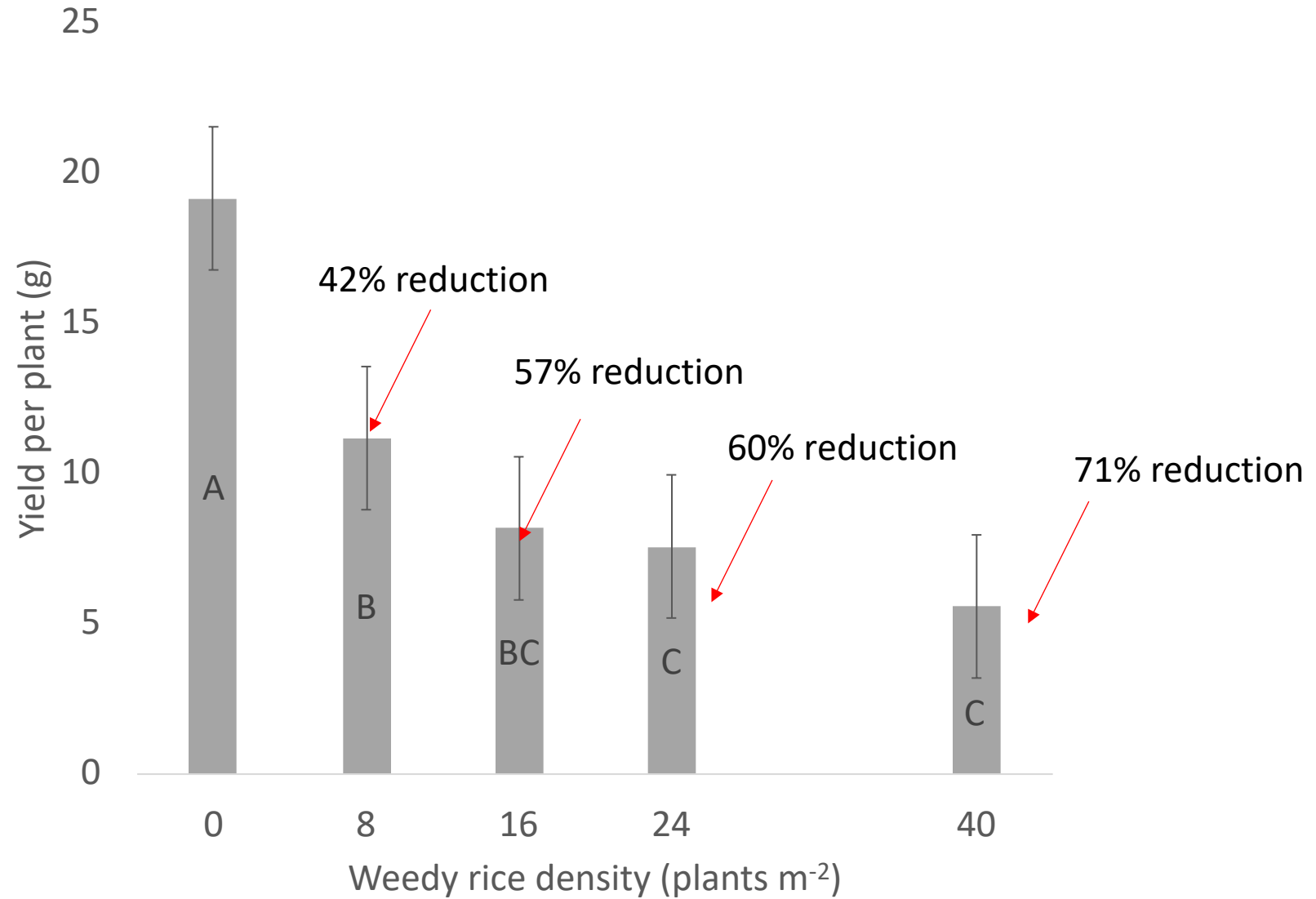
- Significant reduction in M-206 panicle number, with only 8 plants m^{-2}



Yield per Plant

Weedy rice density:

- Significant reduction in M-206 yield per plant, with only 8 plants m^{-2}



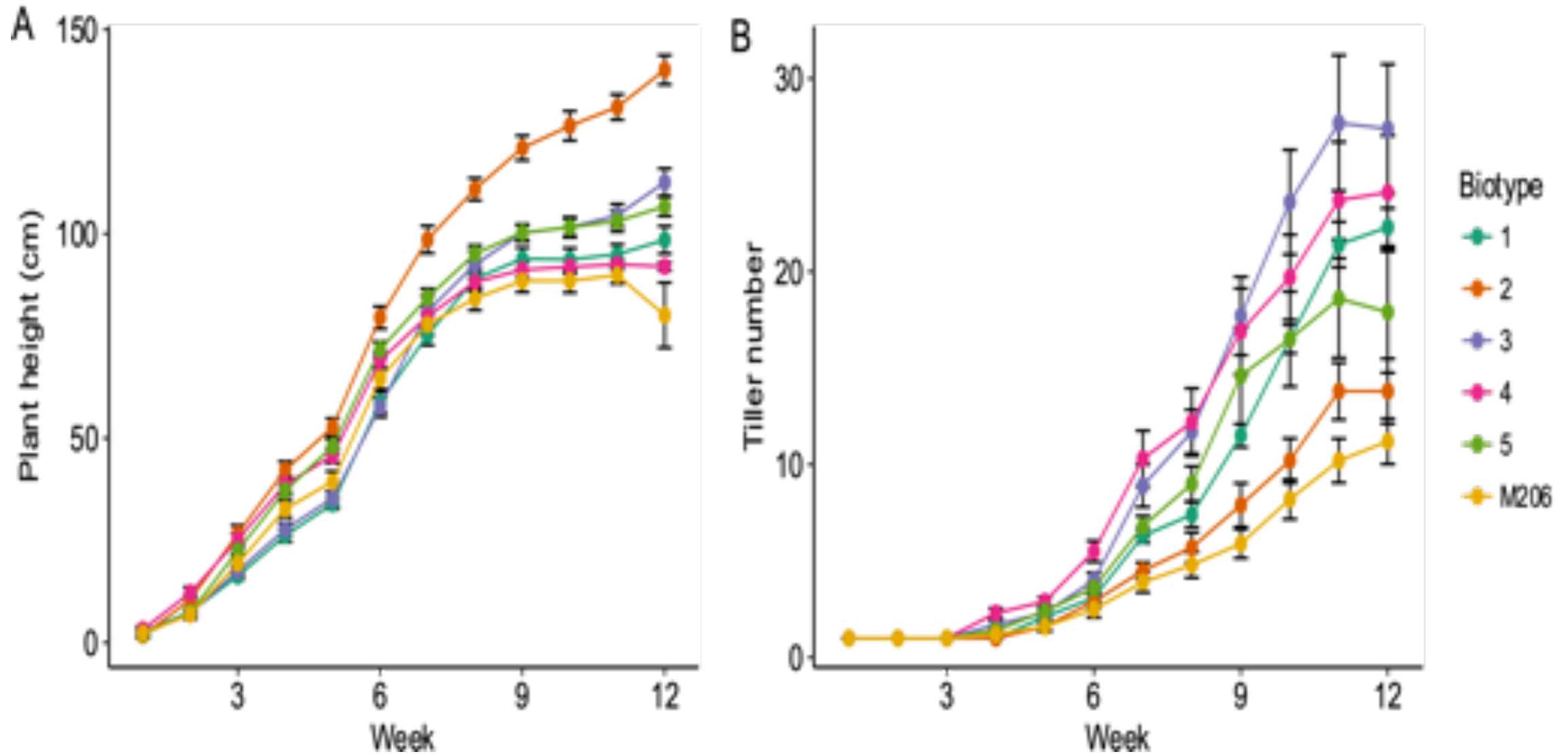
Weedy Rice Growth Potential

Biotype	<i>M-206</i>	1	2	3	4	5
Plant Height (cm)	<i>106.5 b</i>	155.0 d	146.5 d	130.2 c	92.3 a	124.7 c
SE	<i>1.6</i>	4.8	2.7	4.7	1.5	1.7
Tiller Number	<i>11.4 a</i>	18.2 ab	11.5 a	23.8 bc	26.8 c	18.4 ab
SE	<i>1.1</i>	0.8	1.2	2.4	2.4	1.9
Panicle Number	<i>11.2 a</i>	18.4 b	14.5 ab	33.0 c	29.1 c	16.8 ab
SE	<i>1.1</i>	0.9	1.2	3.0	3.1	2.0
Total Panicle Weight (g)	<i>35.23 a</i>	49.54 a	35.59 a	41.44 a	39.37 a	32.64 a
SE	<i>4.51</i>	3.68	4.97	5.51	5.43	4.61
Yield per Plant (g)	<i>29.76 ab</i>	44.06 b	30.30 ab	32.53 ab	24.99 a	28.01 ab
SE	<i>3.84</i>	2.96	4.27	4.59	3.55	4.12
Fresh Biomass (g)	<i>90.58 ab</i>	166.64 c	116.58 b	132.41 bc	48.88 a	120.23 bc
SE	<i>7.75</i>	10.66	14.18	17.27	6.66	10.29
Dry Biomass (g)	<i>24.77 ab</i>	49.43 c	35.26 b	36.04 bc	13.51 a	36.16 bc
SE	<i>2.10</i>	3.03	3.52	4.51	1.56	3.70
Root Dry Biomass (g)	<i>19.05 ab</i>	43.79 b	22.57 ab	37.31 b	12.63 a	47.09 b
SE	<i>2.79</i>	9.73	5.34	10.72	3.59	17.04
100 Seed Weight (g)	<i>2.62 c</i>	2.00 a	2.78 d	2.54 bc	2.45 b	2.48 b
SE	<i>0.03</i>	0.01	0.03	0.02	0.03	0.03

Summary

- Type 1 and 2 tallest, Type 4 shortest
- Type 3 and 4 greatest number of tillers and panicles
- Type 1 significantly higher yielding than other types
- Types 1 and 3 significantly higher biomass than M-206
- Type 4 lower biomass than M-206
- Type 1, 3, and 5: large root biomass compared to M-206
- Type 4: Root biomass much smaller than M-206
- Type 1 significantly lower 100-seed weight

Weekly early growth measurements of plant height (A) and number of tillers (B) for M-206 rice and weedy rice biotypes during the vegetative growth stage.



Weedy Rice Field Experiment

Location: UC Davis Plant Sciences Field

Experimental Setup

- 2018: Established weedy rice populations in the field
 - Biotypes 1, 2, 3, and 5
 - Not enough seed for Biotype 4
- 2019: Started experiment
 - Conventional Flood
 - Rotation (Rice-Sorghum-Rice)
 - Stale Seedbed



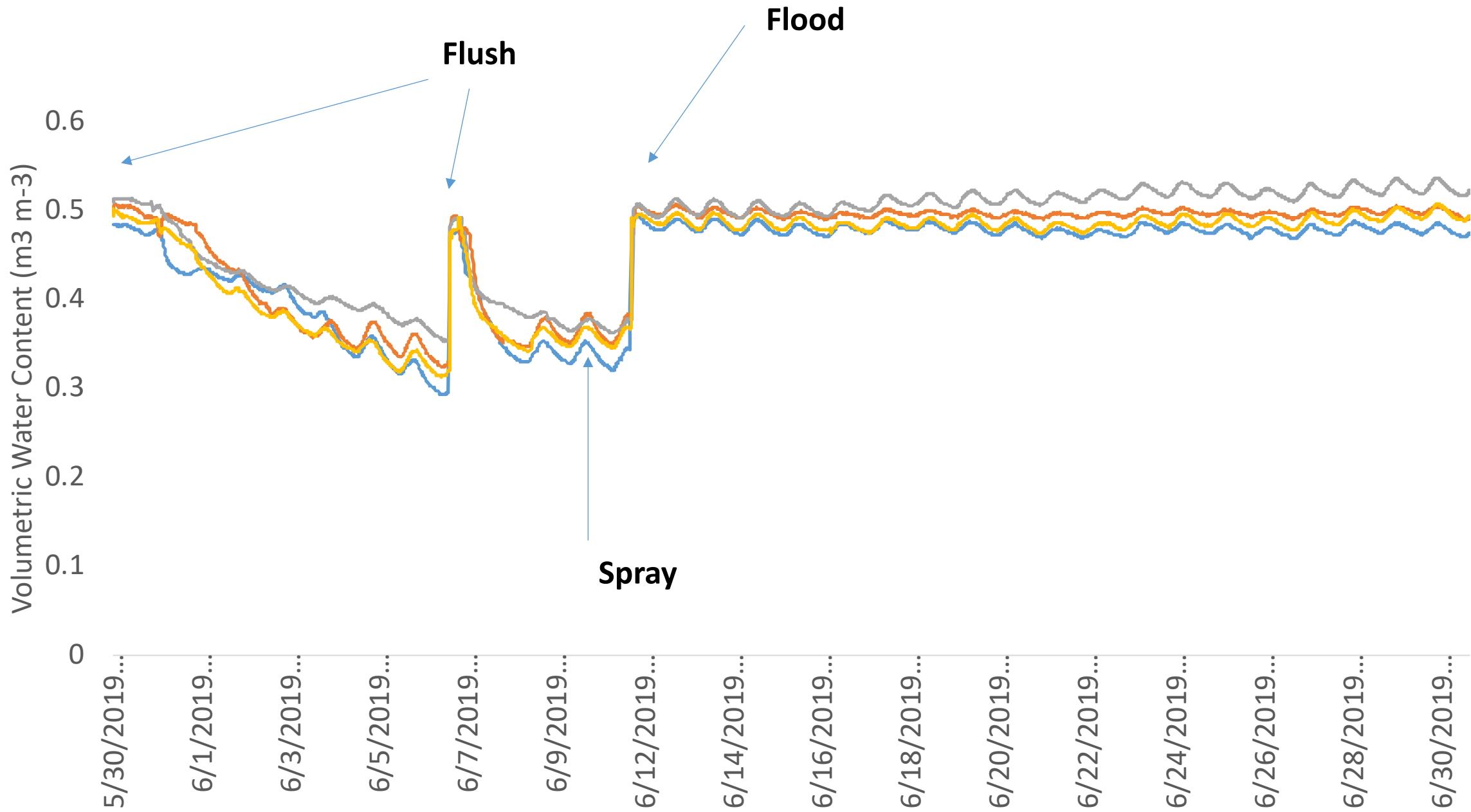


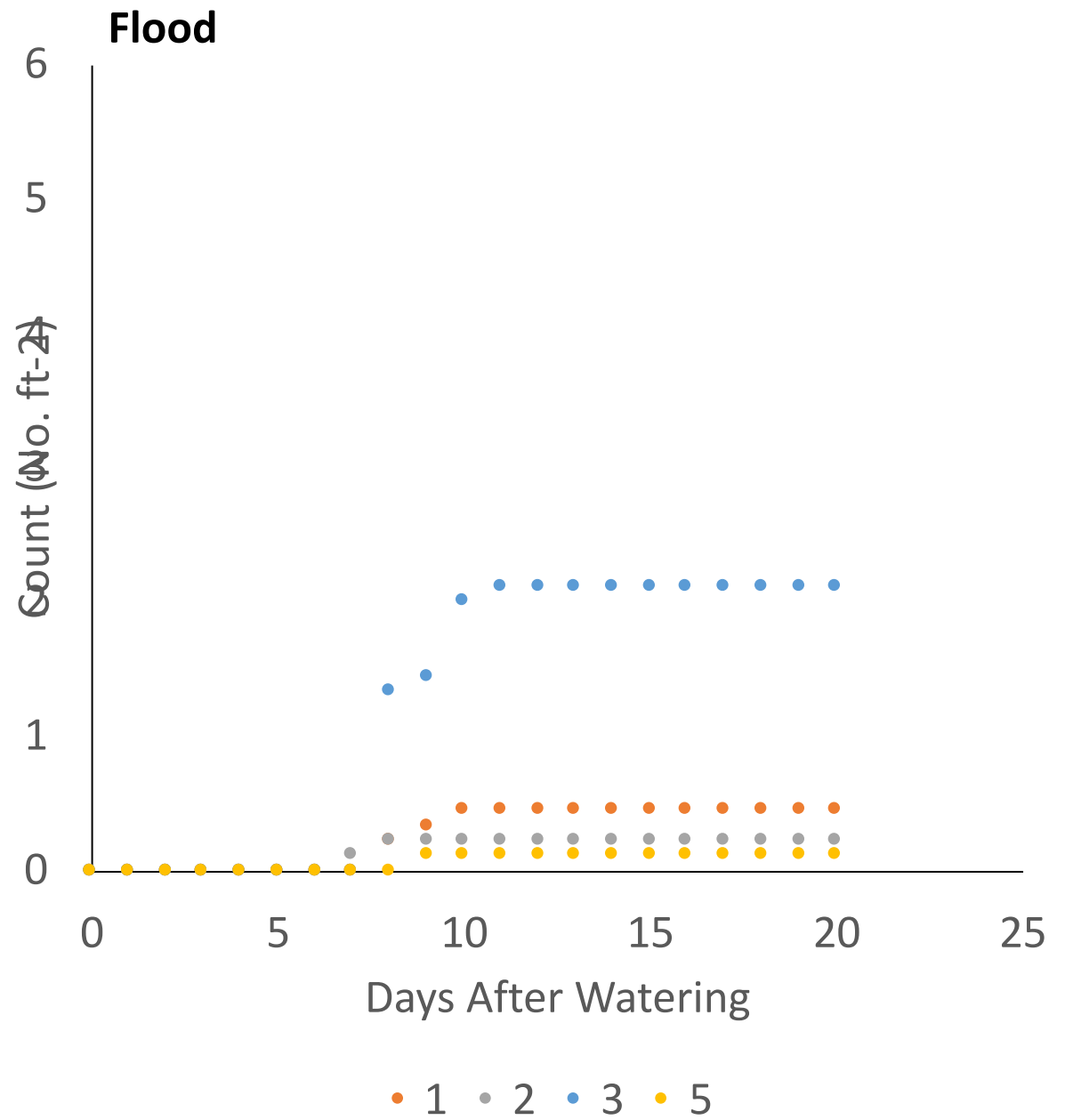
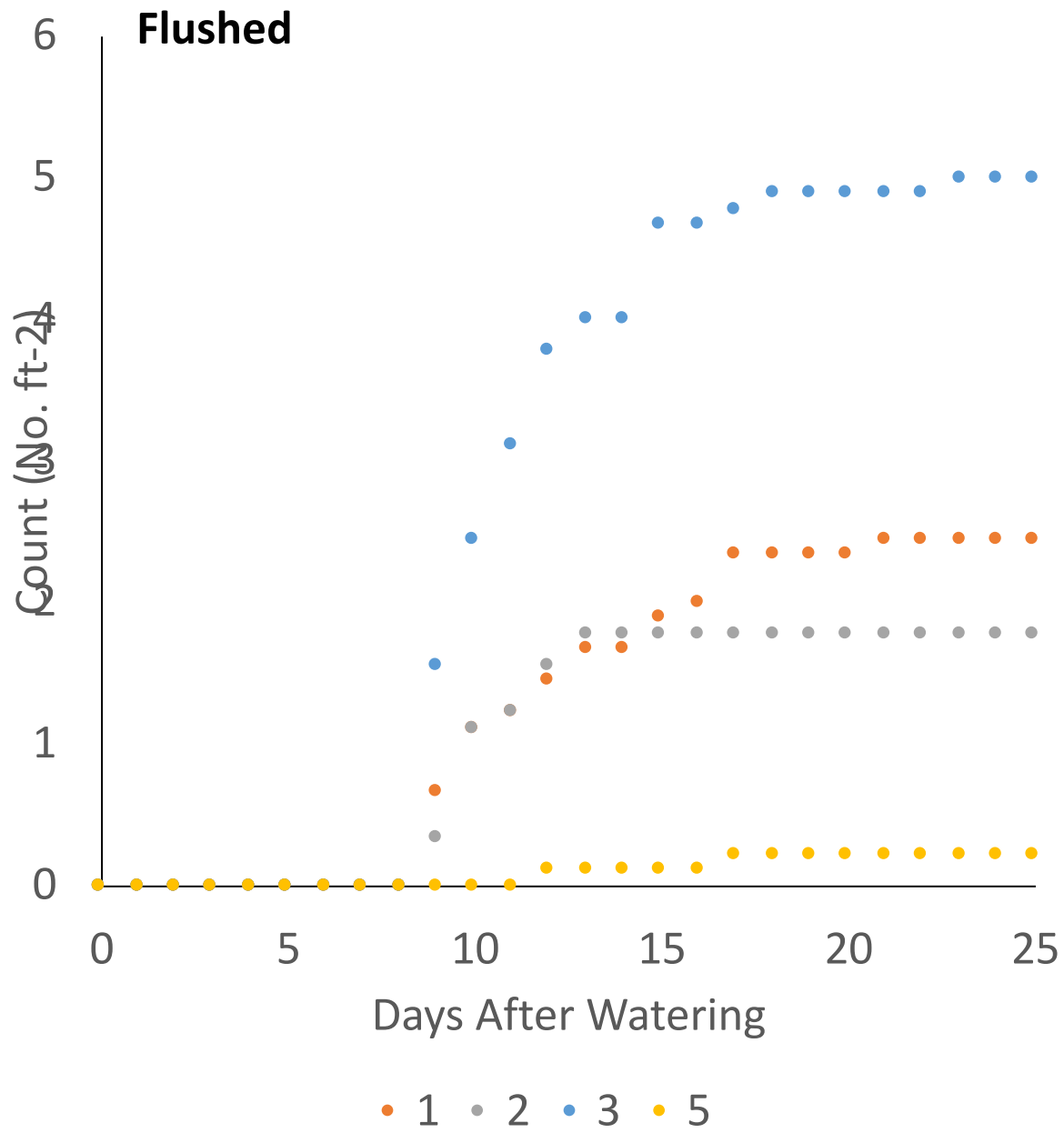
Treatments

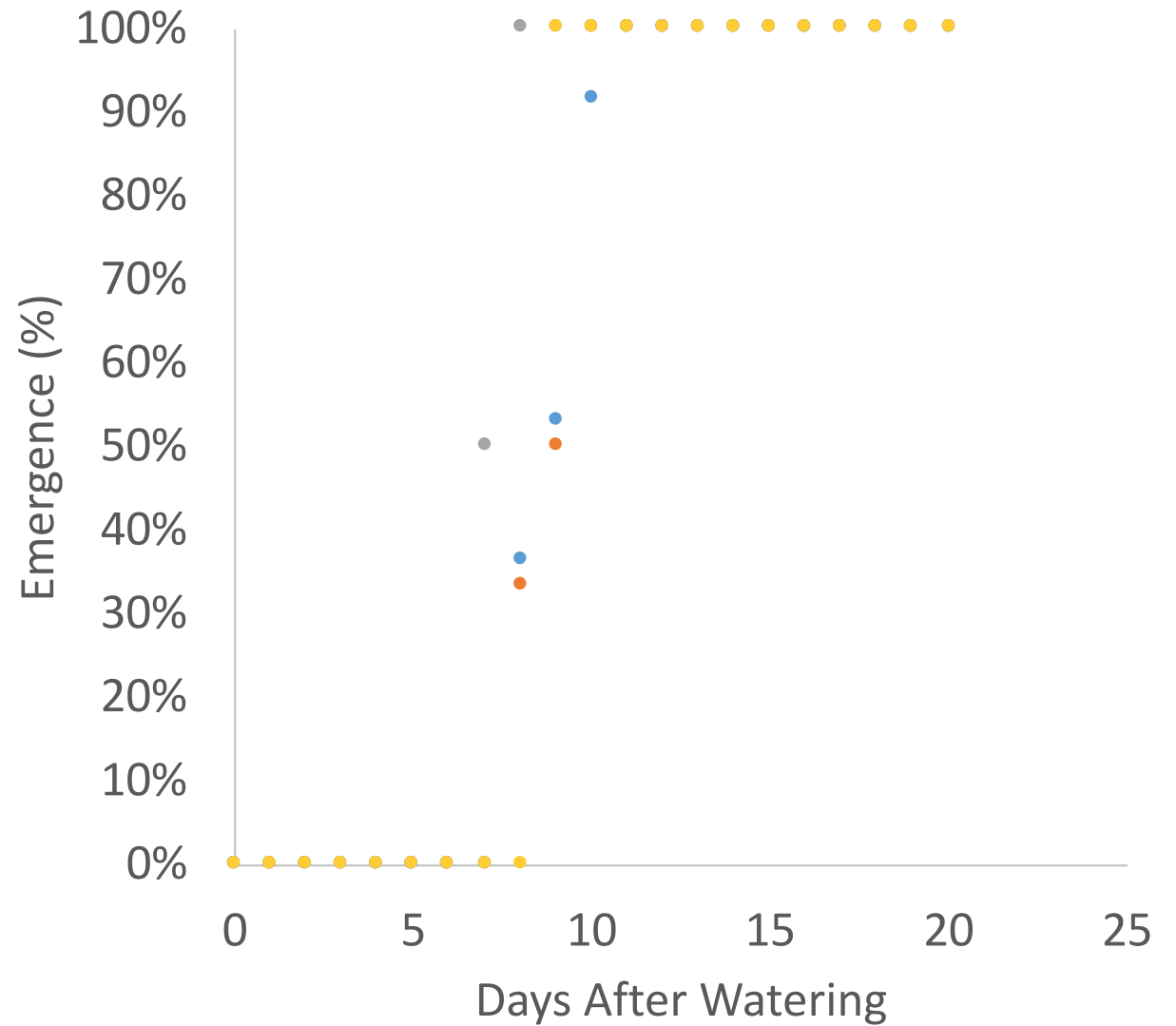
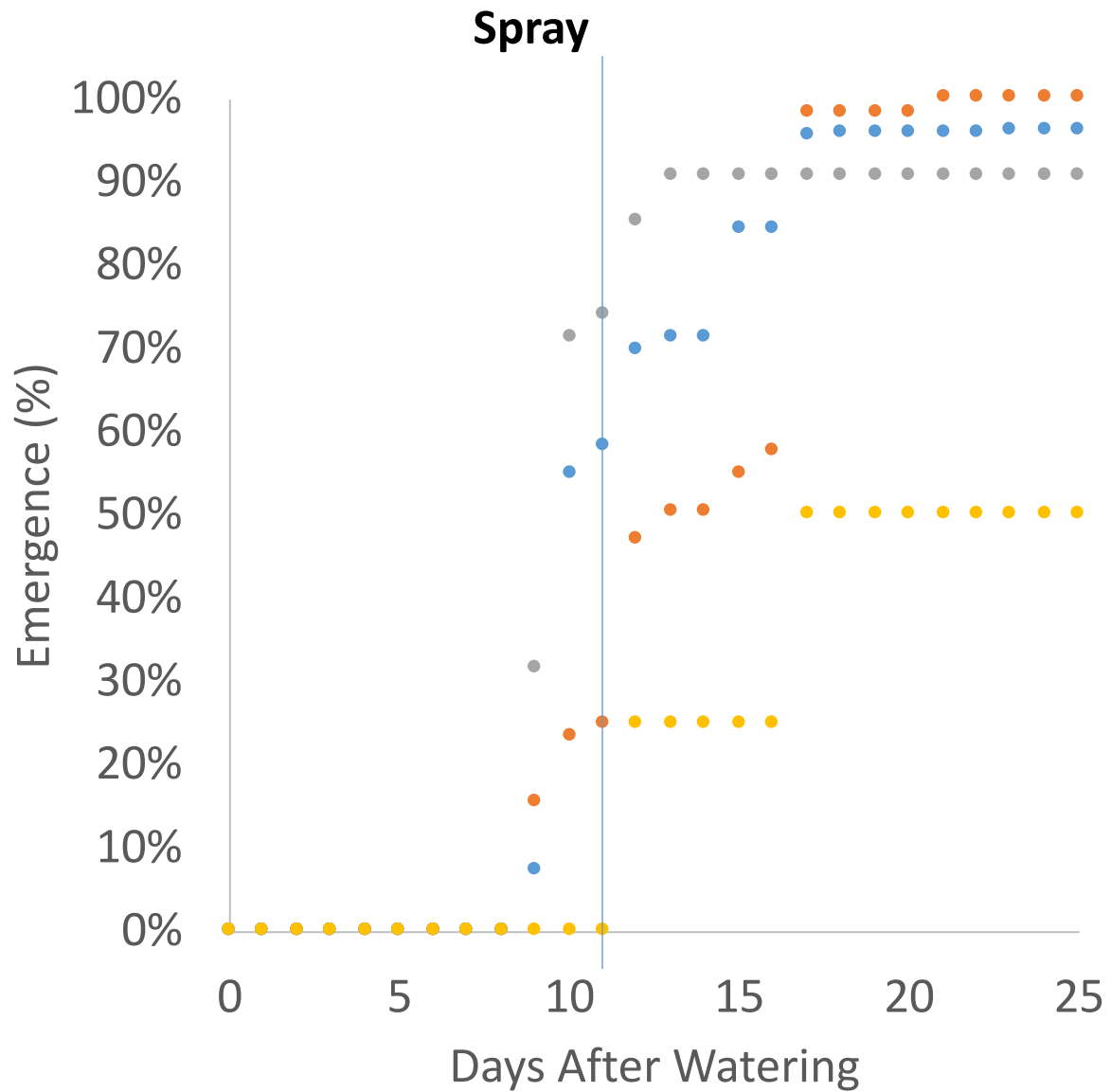
- Stale Seedbed:
 - Flushed: 5/30/19
 - Flushed again: 6/7/19
 - Sprayed glyphosate: 6/10/19
 - Flood up: 6/12/19
- Rotation:
 - Continuous flood applied: 6/12/19
- Control:
 - Continuous flood applied: 6/12/19











• Biotype 1 • Biotype 2 • Biotype 3 • Biotype 5

• Biotype 1 • Biotype 2 • Biotype 3 • Biotype 5

Stale seedbed

- Sprayed 11 days after field was flushed:
 - Type 1: 25% control
 - Type 2: 75% control
 - Type 3: 58% control
 - Type 5: 0% control
- Needs to be repeated (will repeat next year), and validated in the field, if possible

Summary

- Stale seedbed (flushed):
 - Emergence started around 9 days
- Flood:
 - Emergence started around 8 days
- Will re-calculate with Growing Degree Days (to see if there is any real difference)
- About twice as many plants per square foot emerge under flushed conditions, compared to flooded





Rice Management Survey

Methods

- Survey mailed to about 1200 people
 - Used Agricultural Commissioner's lists
- Emailed to about 800
 - California Rice Commission email lists
- Response rate
 - Roughly 8%
- Trying to obtain information related to management practices and weedy rice infestations

Survey Respondents

	Total	Percent	Organic		
Rice Grower	143	89%	No	134	84%
Rice Grower/PCA	6	4%	Yes	11	7%
PCA	2	1%	No response	15	9%
No response	9	6%			

	Number	Average (Acres)	Min (Acres)	Max (Acres)
Glenn	47	600.9	24	7000
Butte	39	754.4	5	3000
Sutter	38	1087	28	8500
Colusa	30	991.6	65	10000
Yuba	21	597	10	1500
Yolo	16	1837	10	1000
Placer	10	415.6	95	900
Sacramento	9	295.5	40	925
San Joaquin	2	1100	1100	1100

Problematic Weeds (1= most, 5= least)

	1	2	3	4	5	X (no rank)
Watergrass	68	35	17	8	5	11
Barnyardgrass	5	13	18	16	14	4
Mimic	12	12	6	6	13	0
Smallflower	39	47	24	13	2	9
Ricefield Bulrush	13	15	35	23	17	7
Redstem	4	5	21	21	29	1
Ducksalad	3	7	10	18	23	3
Weedy rice	0	1	2	1	12	0
Sprangletop	2	3	7	3	3	5
No response	8					

Same Between Biotypes

- All are lighter in color
- All have rough leaves
- All have red pericarp
- Heading date likely similar to japonicas (further data will be collected in field)
- All show evidence of hybridization

A close-up photograph of rice panicles in a field. The panicles are brown and appear to be maturing. The background is a blurred green field under a blue sky. Two white text boxes are overlaid on the image, one on the left and one on the right, containing bulleted text.

- **Type 1:**

- Awnless
- Straw hull color
- Tall stature
- No color on nodes

- **High dormancy**
- **High shattering**
- **Highest yielding**
- **Large root and shoot biomass**
- **Lowest 100-seed weight (small seeds)**



- **Type 2:**

- Awnless
- ***Bronze hull color***
- Tall stature
- No color on nodes



- **Low dormancy**
- **High shattering**

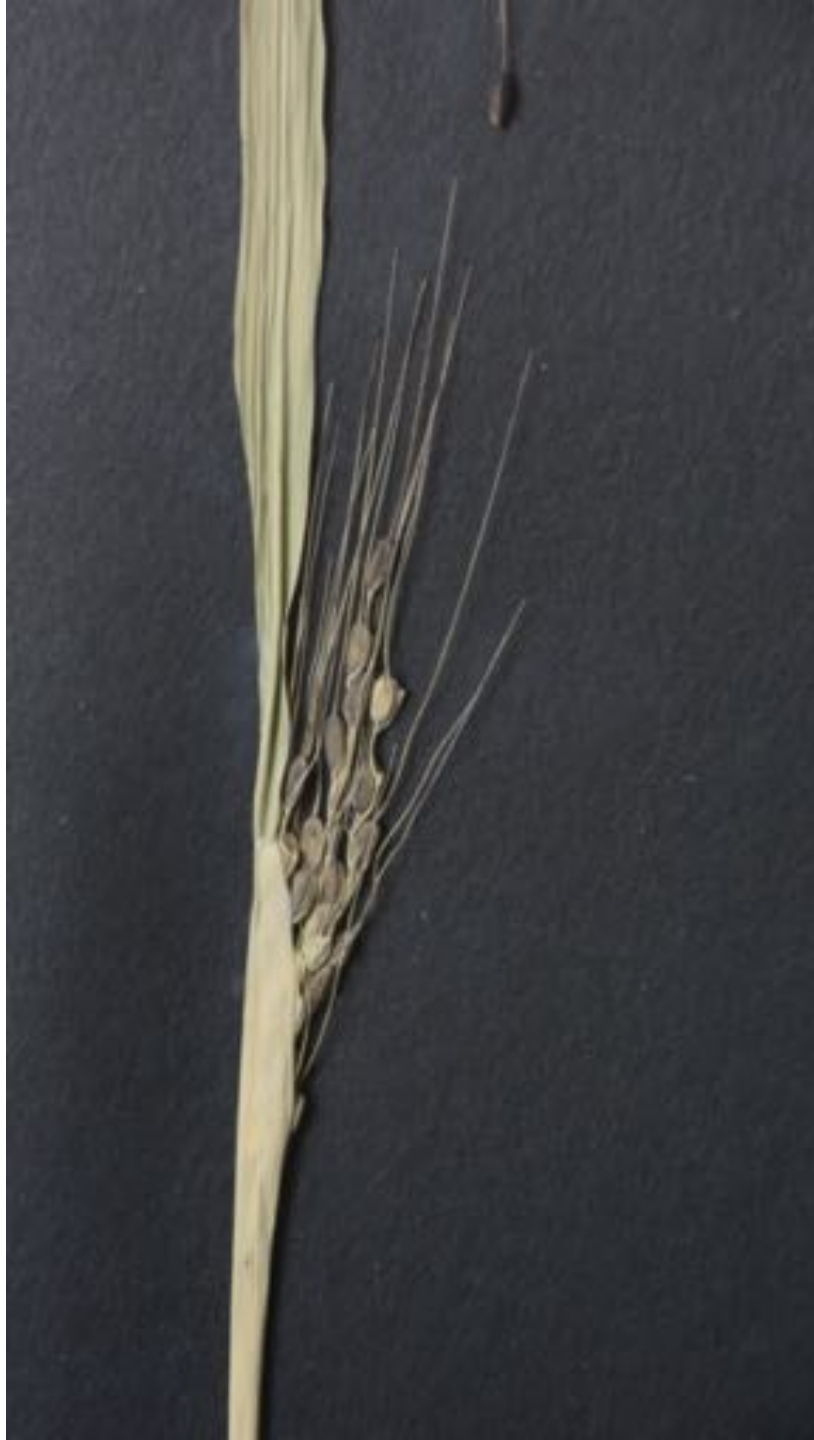
- **Type 3:**

- *Awned*
- Straw hull color
- Tall stature
- No color on nodes

- **High dormancy**
- **High shattering**
- Highest tillering and number of panicles
- Greatest biomass compared to M-206



- **Type 4:**
 - *Awned*
 - *Black hull color*
 - *Short stature*
 - No color on nodes



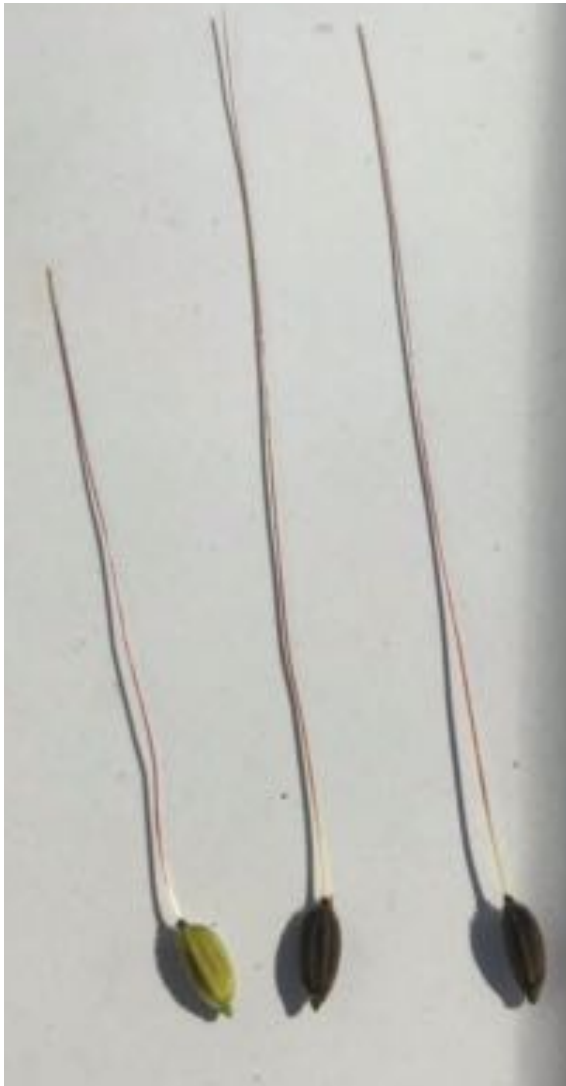
- **High dormancy**
 - **High shattering**
 - Highest tillering and number of panicles
 - Lowest shoot and root biomass
-
- **Currently in one location, Glenn County**

- **Type 5:**

- Awnless
- Straw hull color
- Tall stature
- ***Purple-colored nodes***



- **Low dormancy**
- **High shattering**
- High root biomass



Type 6:

- Black-hulled
- Awned
- Awns are red in color before maturity
- Plant height is similar to other types
- 1 location (Butte County)

Acknowledgements