Integrated Weed Management in California Rice

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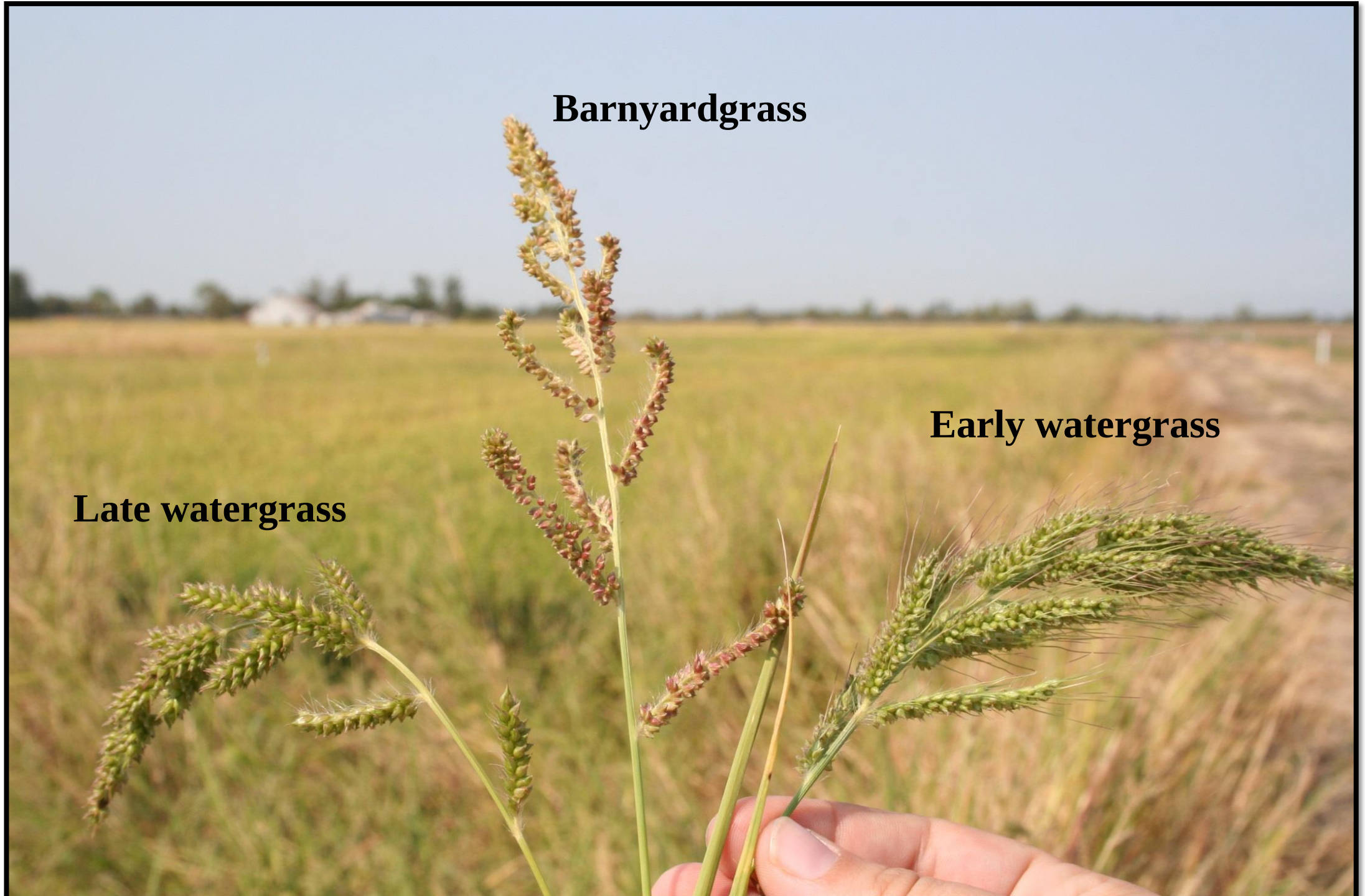
Weeds in California Rice

- Can reduce yields by as much as 50%-100%, if uncontrolled
- Particularly problematic in systems where the same crop is planted in a similar fashion, year after year
  - California rice: flooded, without rotation, for 100 years
- Most weed control:
  - Combination of flooding and herbicides
  - How does this translate to organic systems?




Barnyardgrass
Early watergrass
Late watergrass

Walter's barnyardgrass (also known as coast cockspur grass)

Sprangleton

Sprangletop

Sedges & broadleafs

Smallflower umbrella sedge

Ricefield bulrush

Redstem

Arrowhead

Water plantain

Weedy Rice

Photos: Timothy Blank, CCIA

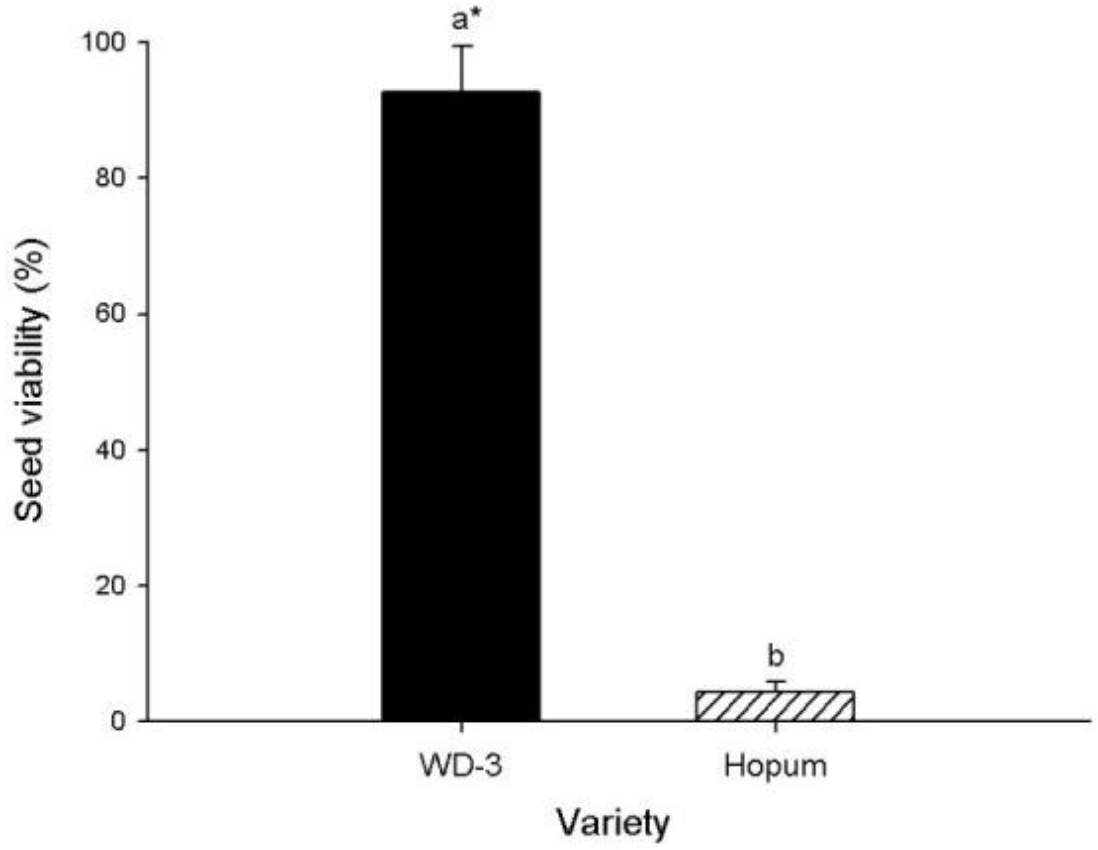
Use of Non-Chemical Controls in Rice

1. Winter Flooding
2. Stale Seedbed
3. Irrigation Management
4. Crop rotation or fallow?
5. Cover crops?

Winter flooding

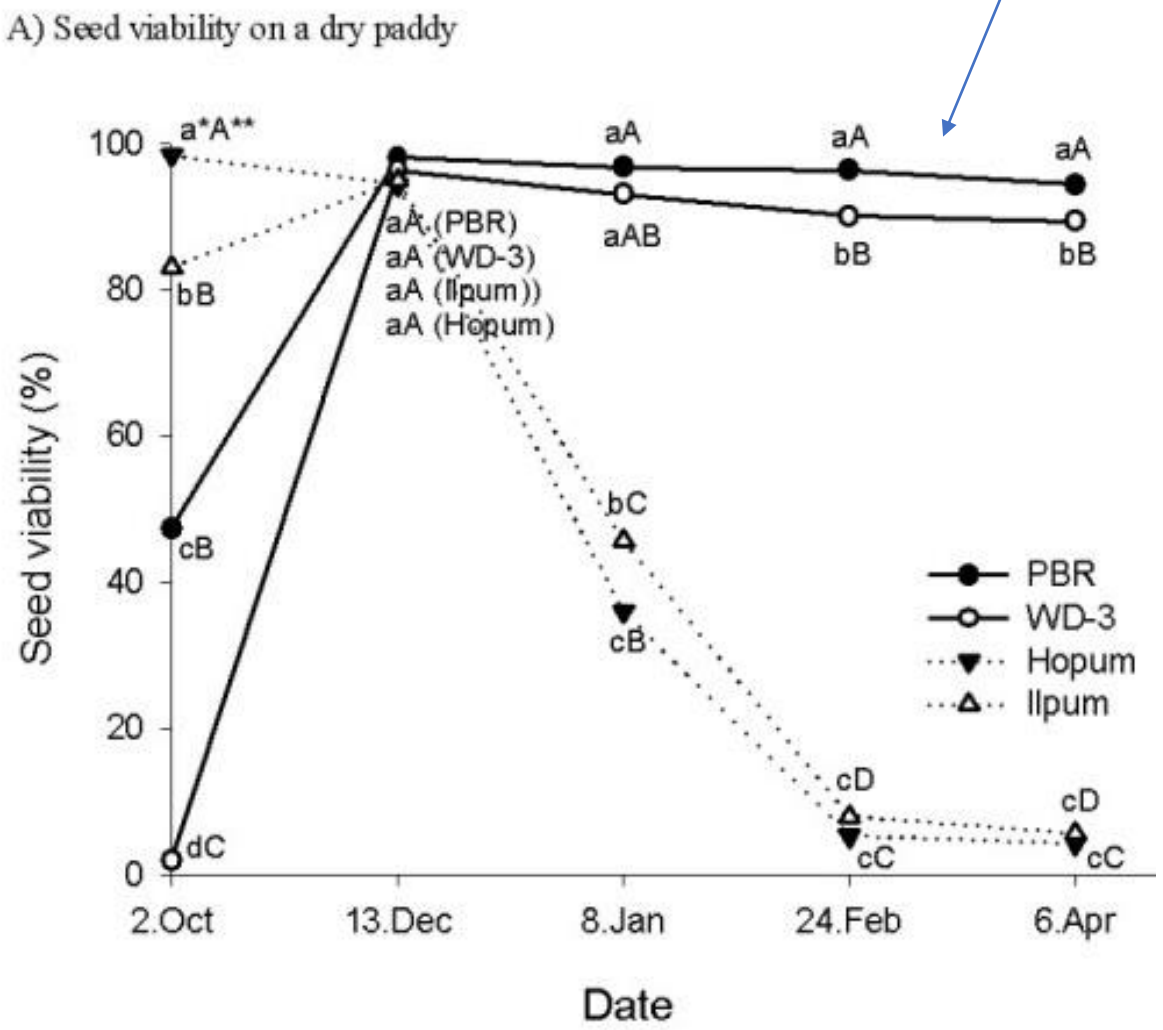
- Seed viability of weedy rice (WD-3) and cultivated rice (Hopum) after wintering on the surface of a paddy field
- November 2008 to April 2009

- Does this work for other weed species?
  - We are finishing up data for this in California rice (on weedy rice)
  - Unknown at this time
  - Likely similar pattern for large-seeded weeds (watergrass)

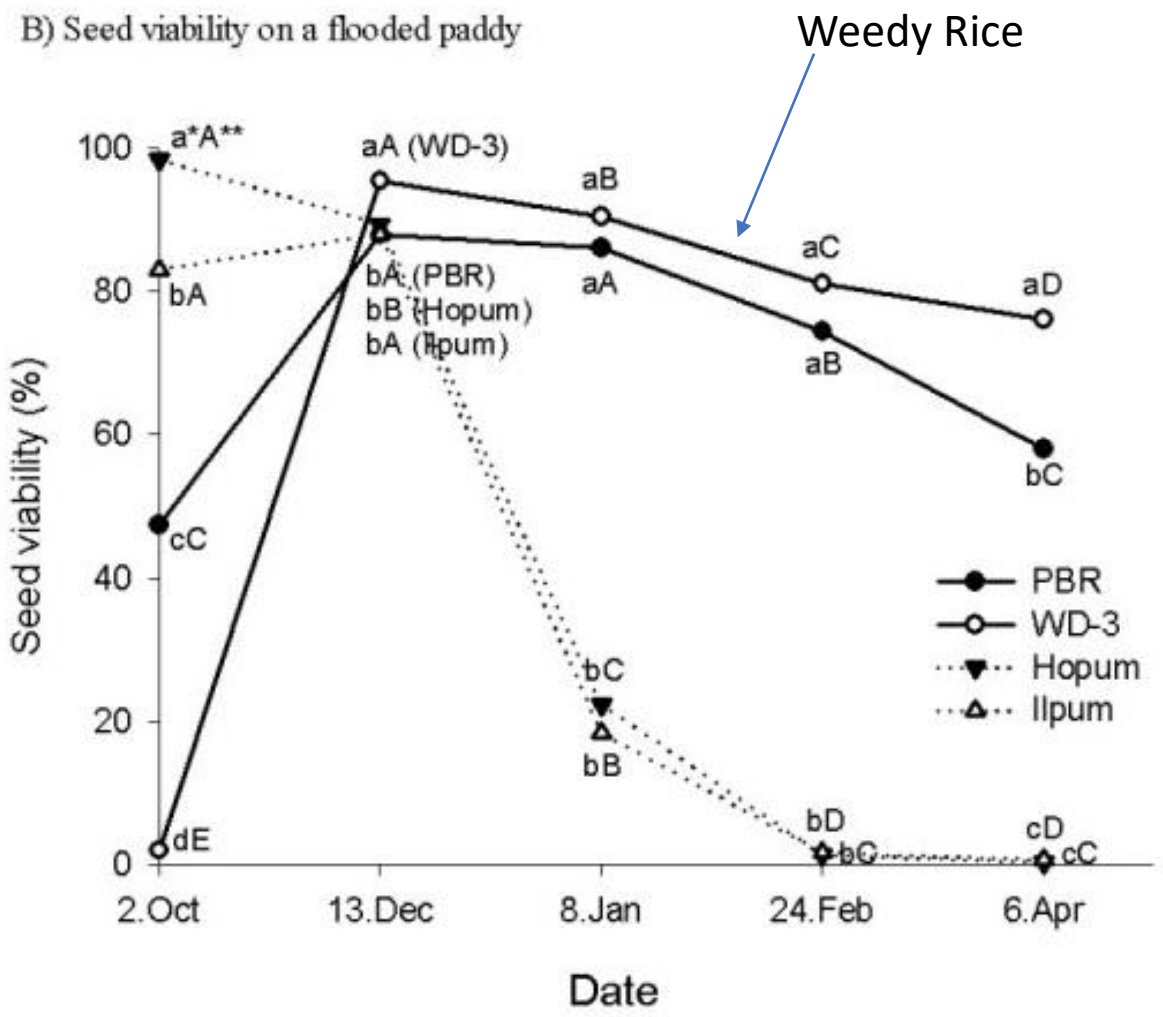


Baek and Chung, 2012

Weedy Rice

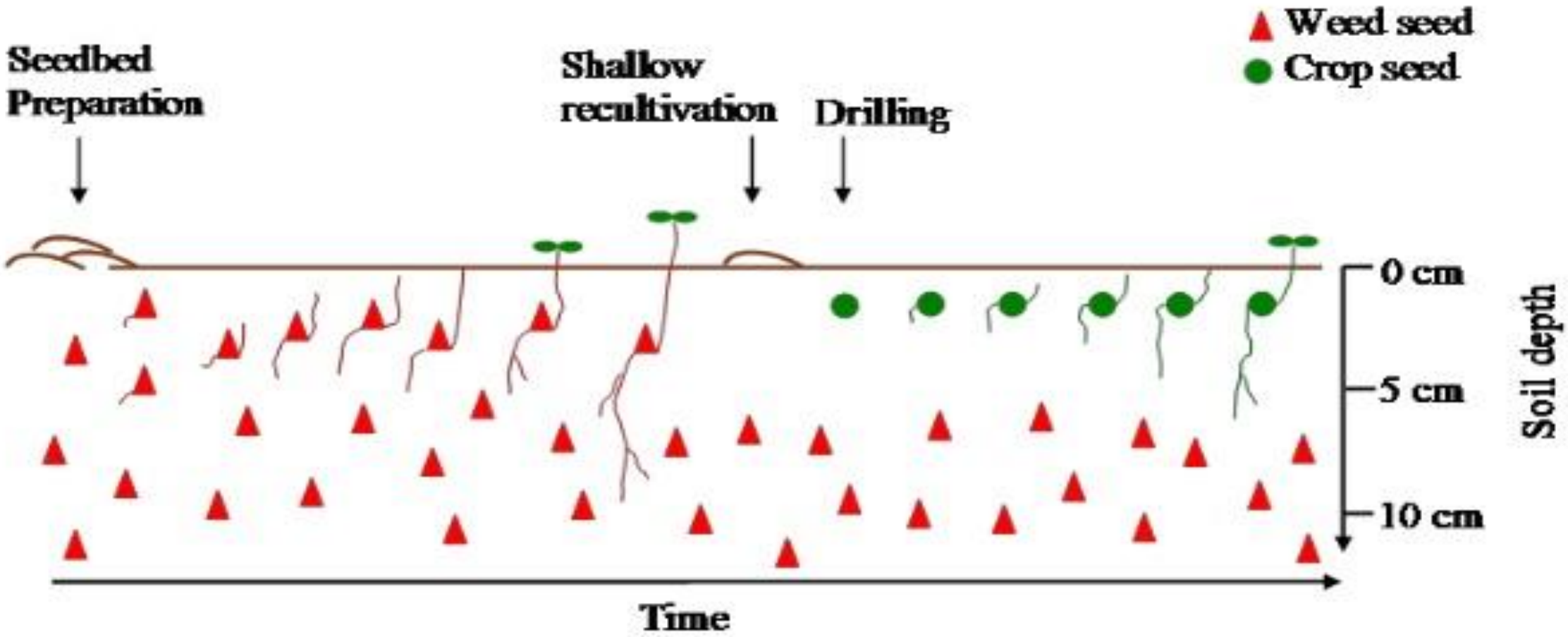


Weedy Rice



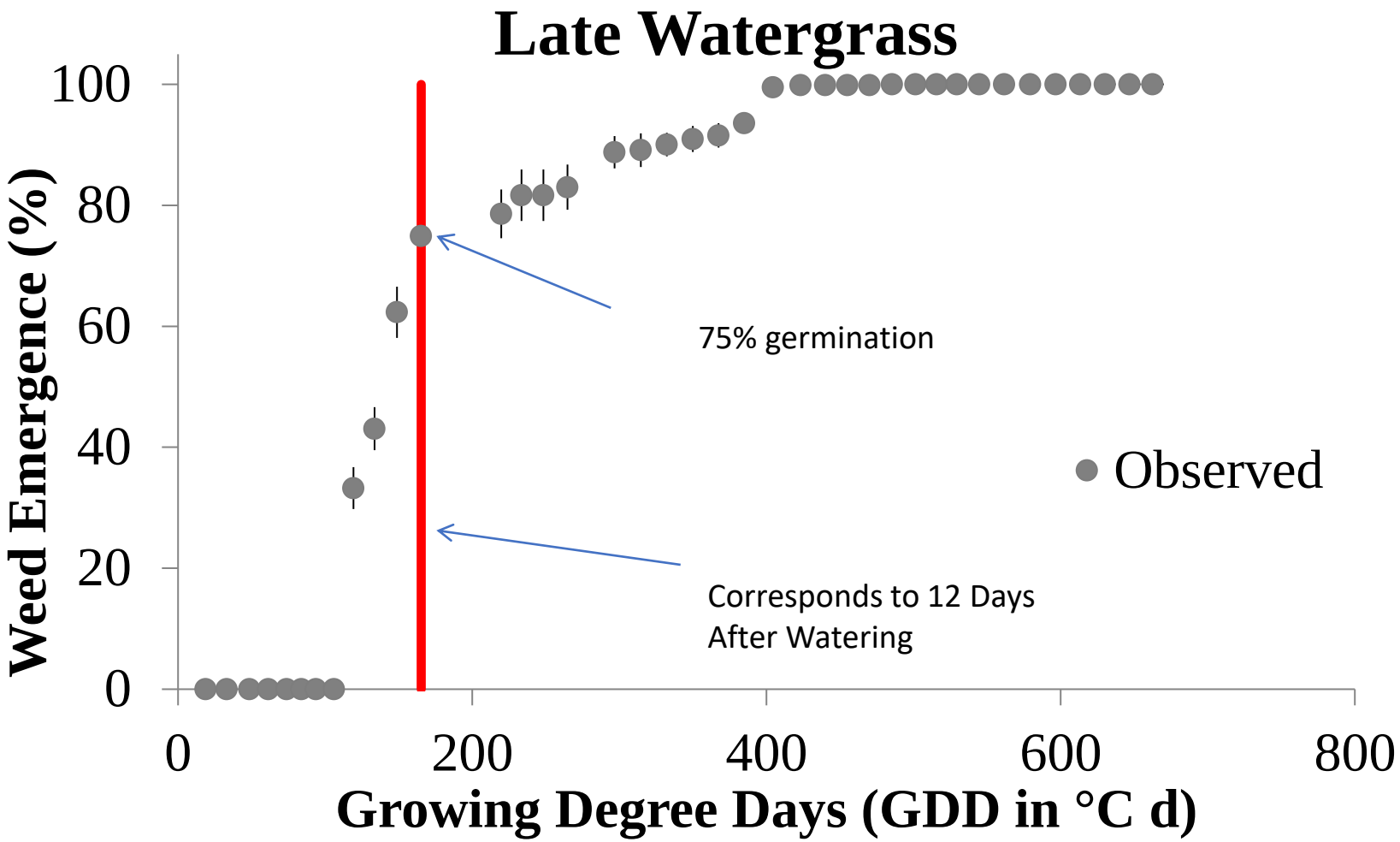
Baek and Chung, 2012

Stale (False) Seedbed



Stale Seedbed: Example Application in Rice

- Field flooded and then water was allowed to subside
- Timing of application based on GDD predictions for late watergrass
- Sprayed glyphosate 12 Days After beginning of watering based on :
  - Predicted 90% emergence for Flood:
    - 154 GDD

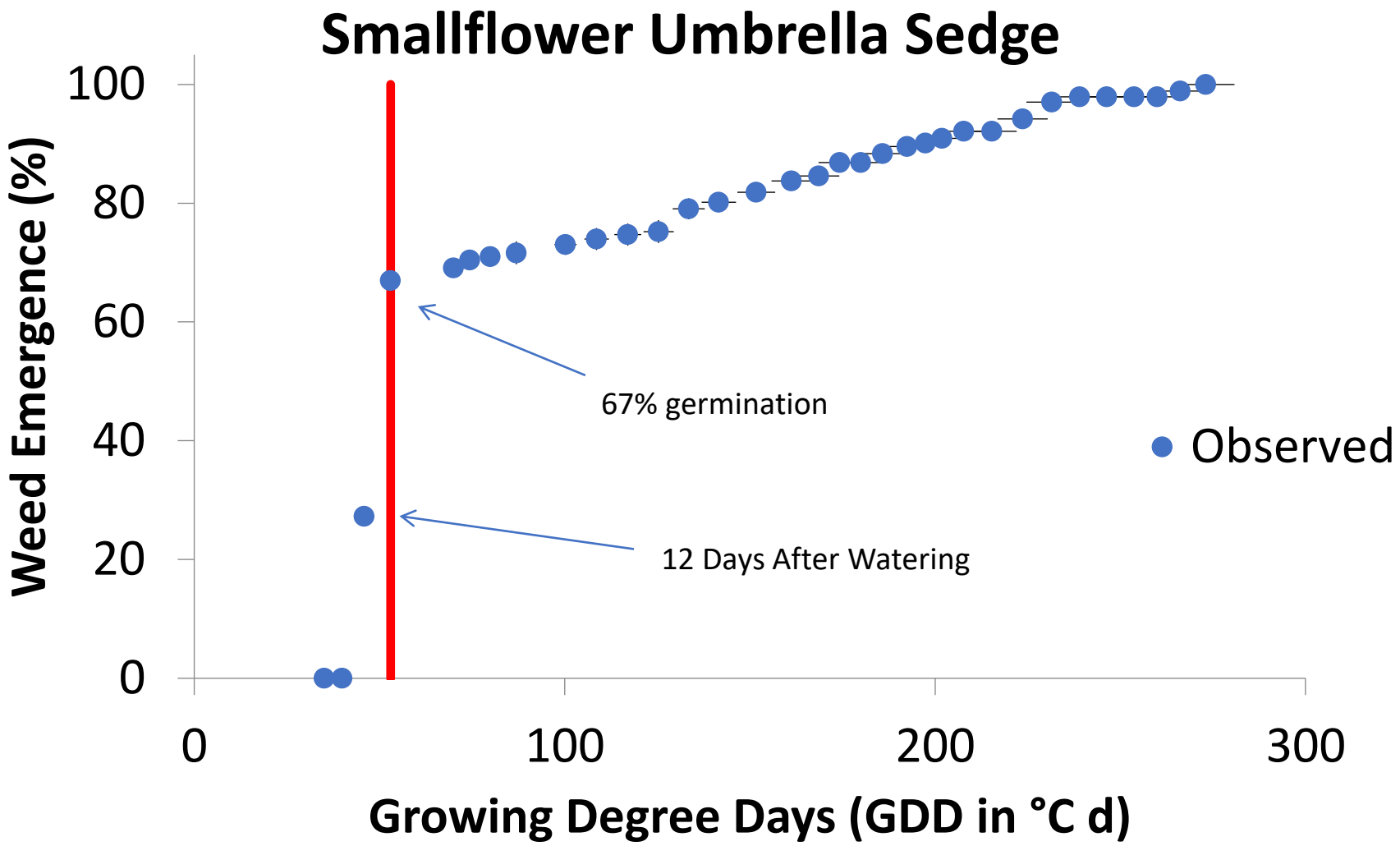

Late Watergrass
Weed Emergence (%)
100
80
60
40
20
0
0
200
400
600
800
Growing Degree Days (GDD in °C d)
75% germination
Corresponds to 12 Days
After Watering
Observed

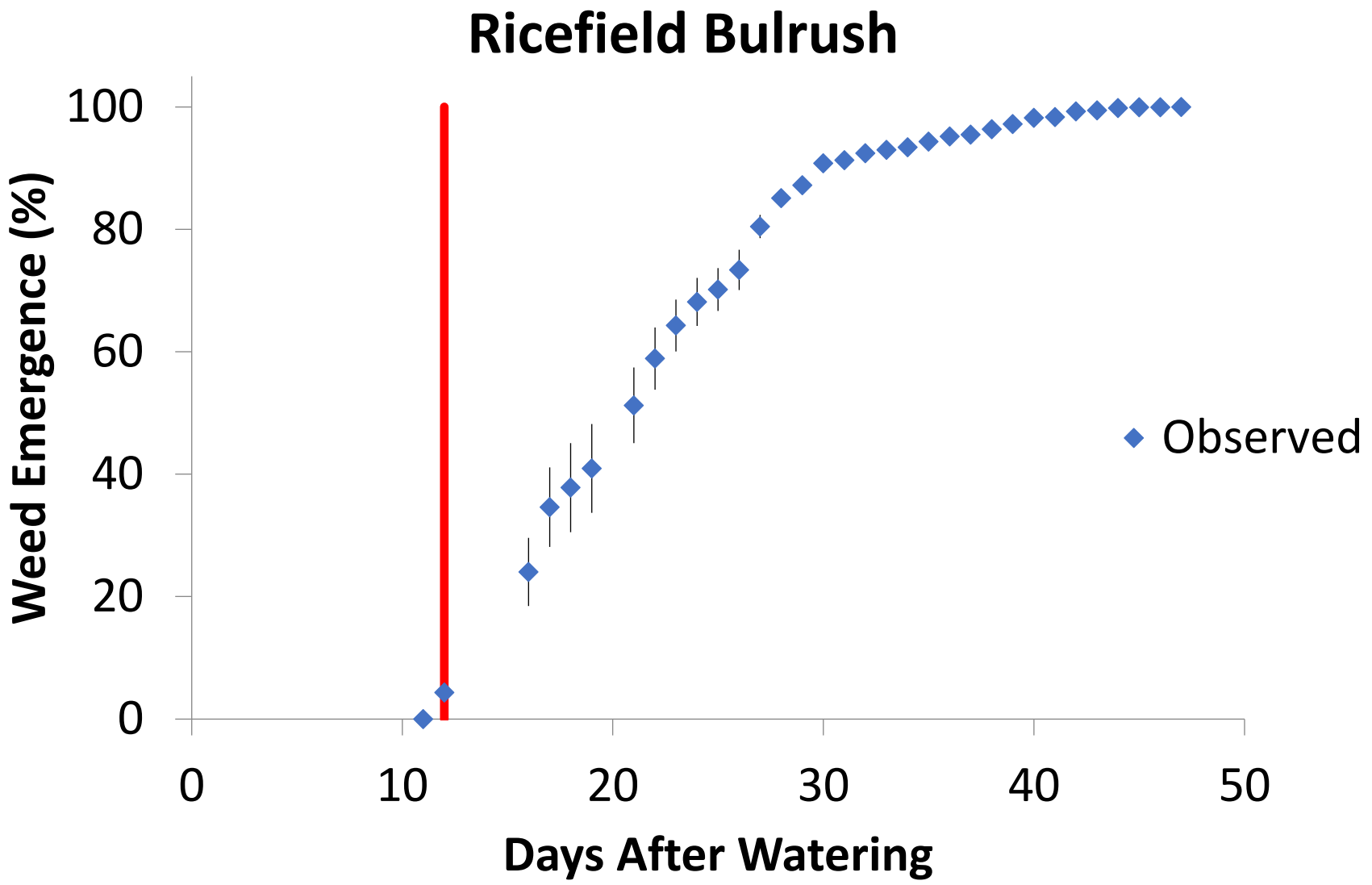
Stale Seedbed

Conventional Flood

Stale Seedbed

Conventional Flood


Smallflower Umbrella Sedge
Weed Emergence (%)
100
80
60
40
20
0
0
100
200
300
Growing Degree Days (GDD in °C d)
67% germination
12 Days After Watering
Observed


Ricefield Bulrush
Weed Emergence (%)
100
80
60
40
20
0
0
10
20
30
40
50
Days After Watering
Observed

2019

Watergrass

Multiple herbicides applications

2020

Watergrass

Pre-plant stale seedbed plus follow up foliar application

2020

Stale Seedbed

- Instead of using a chemical method (glyphosate), tillage could also be used
  - Must be shallow tillage, to ensure that more weed seeds are not brought to the surface
  - In organic systems, SUPPRESS could be used in a similar fashion
    - No testing completed to judge efficacy or rate
- Alternatively, could be used during a fallow season:
  - Repeated flushing and tilling
- Most effective for
  - Watergrass/barnyardgrass species
  - Weedy rice

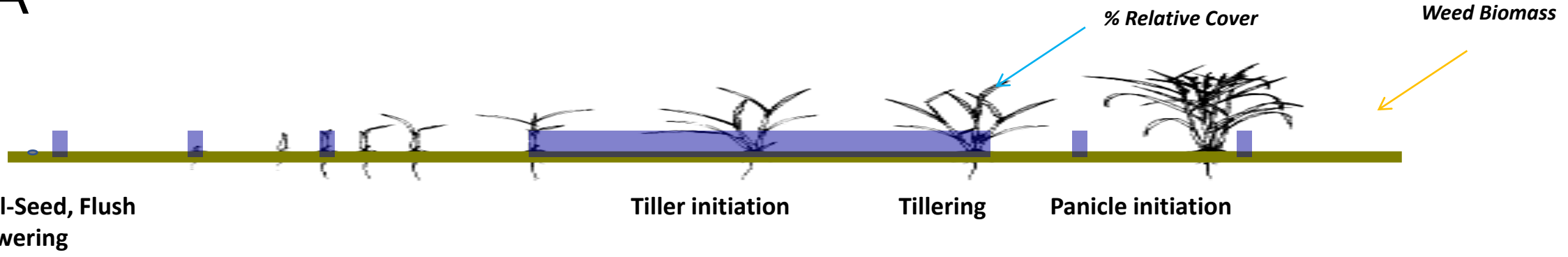
Irrigation Management

- Alternative irrigation methods:
  - Dry-seeding (using a drill) vs. wet-seeding
  - No permanent flood (flush irrigation)
  - Systems from other parts of the world:
    - **Alternate Wetting and Drying (AWD)**

- **Why? Different weeds germinate under different irrigation systems**

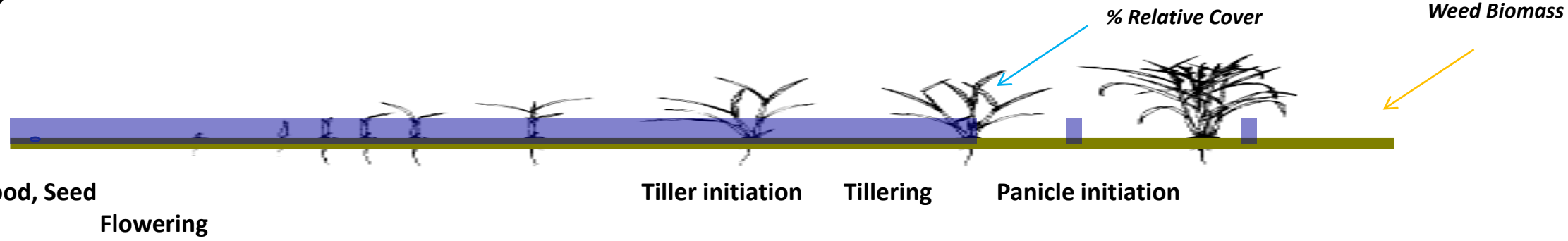
A

DRILL-SEEDED ALTERNATE WET DRY



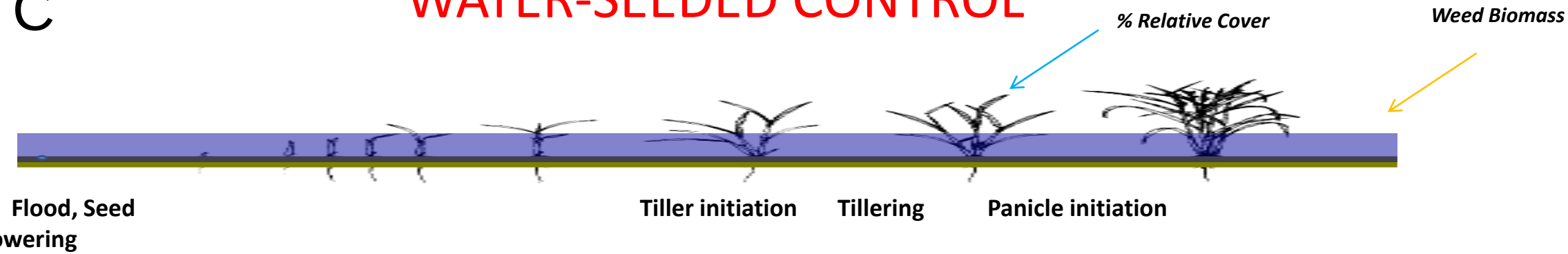
B

WATER-SEEDED ALTERNATE WET DRY



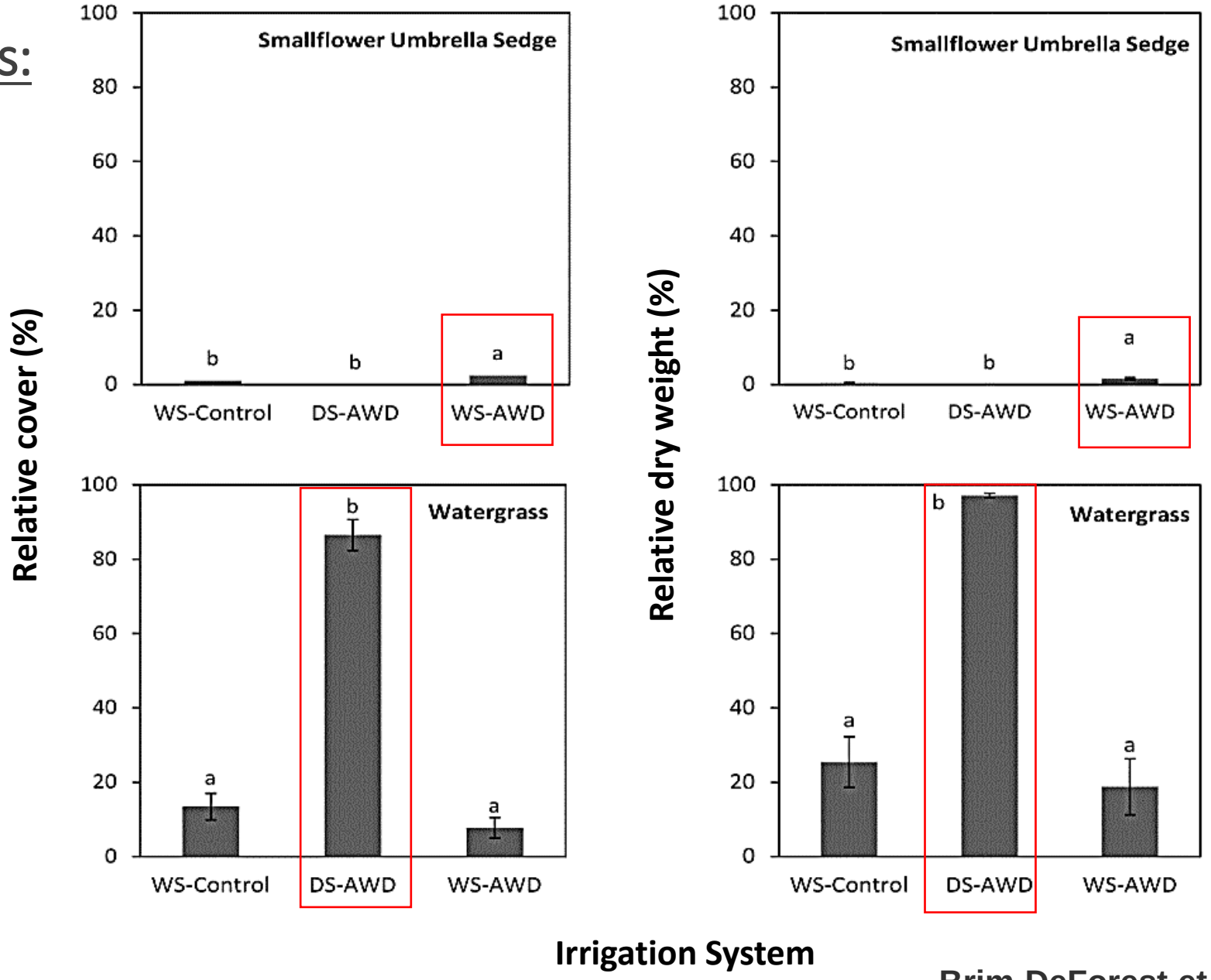
C

WATER-SEEDED CONTROL



Within-Season Differences: Smallflower and Watergrass

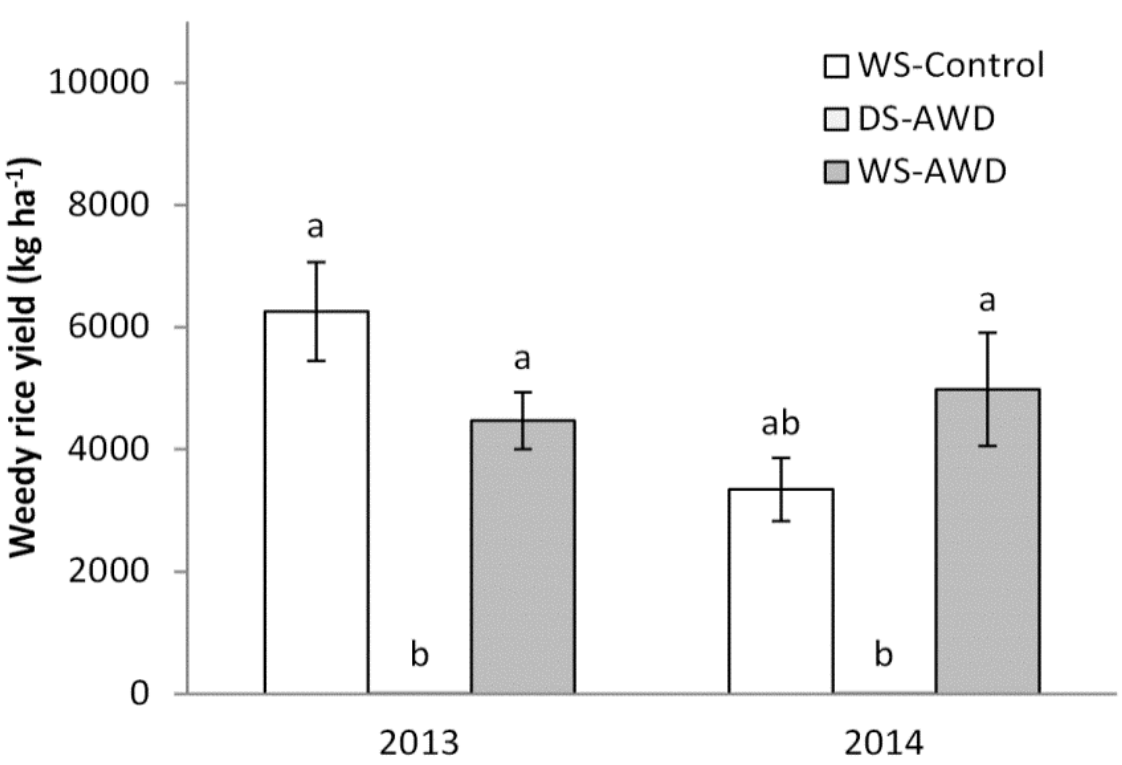
% Cover at Tillering

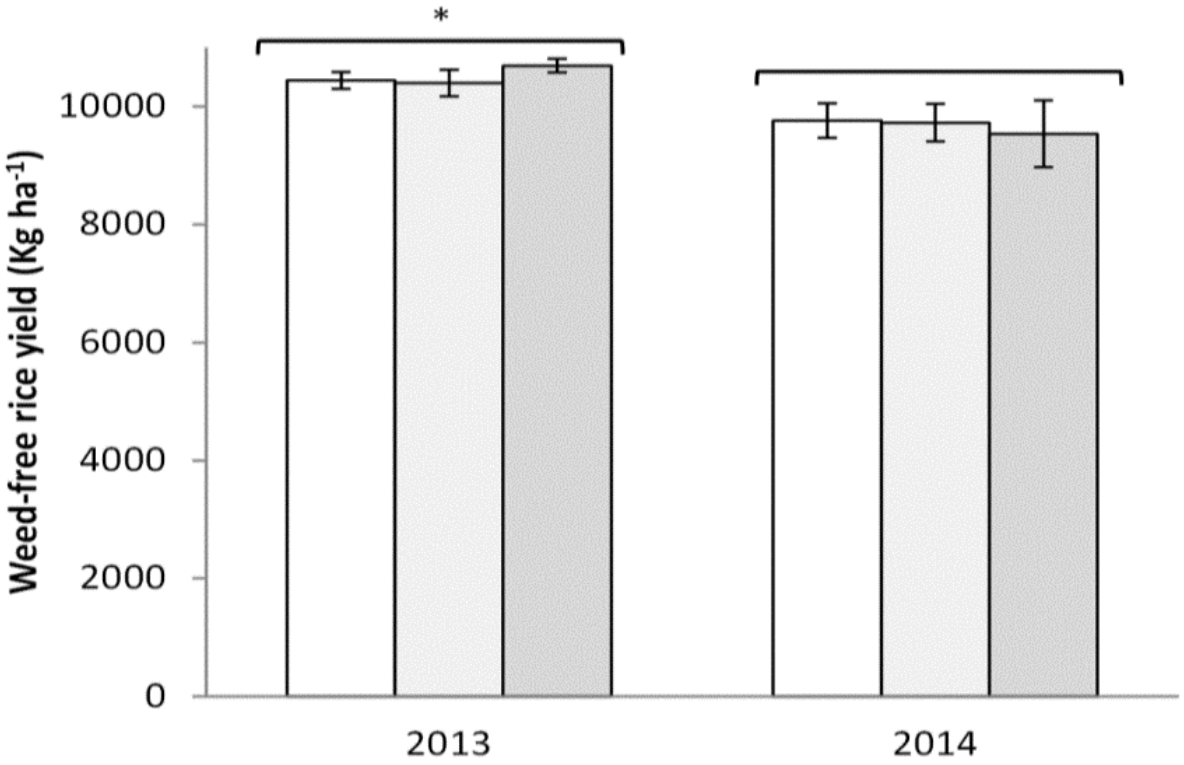


Note: Different letters indicate significant differences at $P < 0.05$

Brim-DeForest et al. 2017

Yields – Weedy vs Weed-Free





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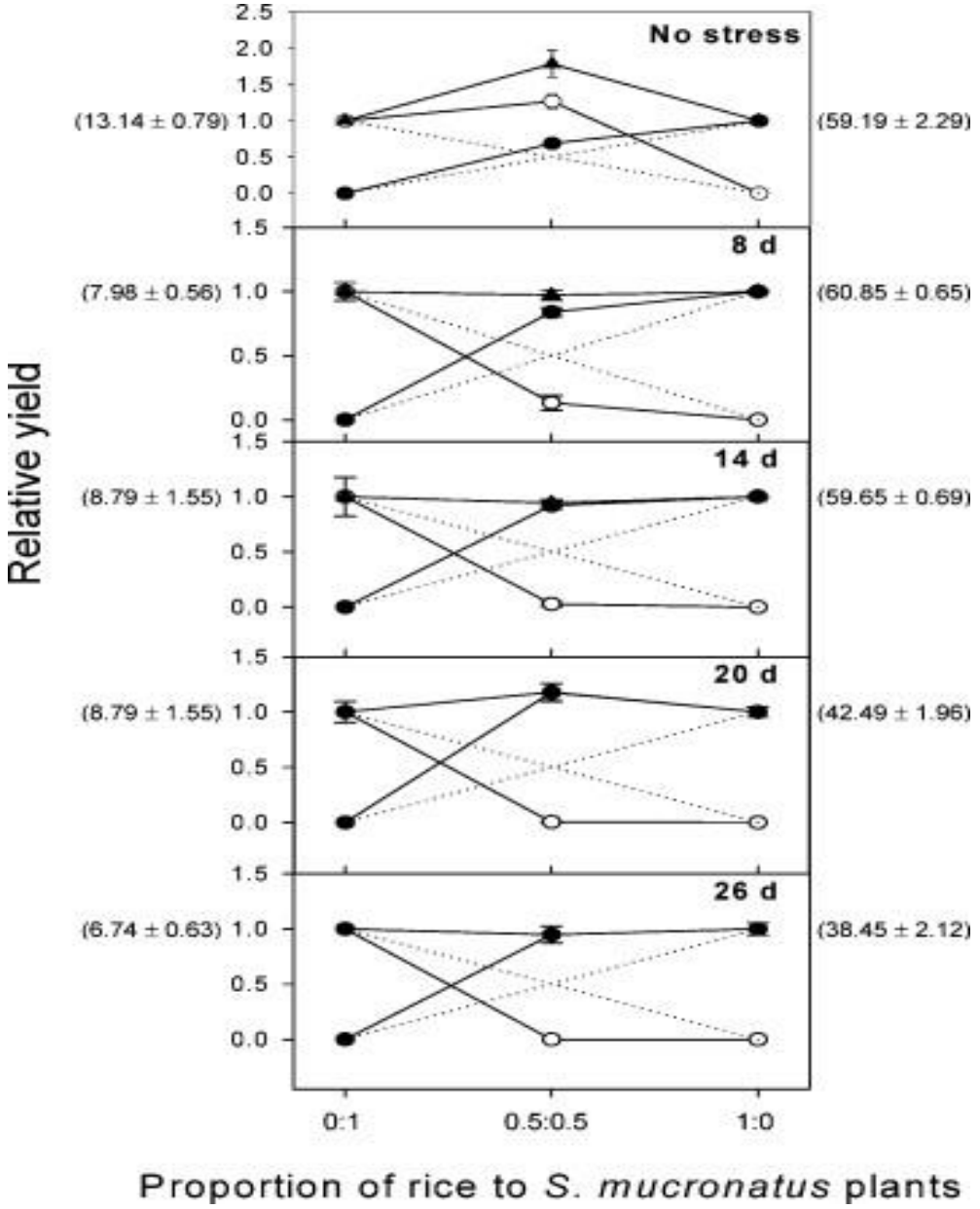
Brim-DeForest et al. 2017

Conclusions

- Water-seeded systems dominated by grasses, sedges and broadleaves
- Dry-seeded system dominated by grasses
- Due to 100% yield losses, DS-AWD is only a viable option with excellent weed control
- WS-AWD may be a viable means to reduce water usage while maintaining yields and weed control
  - Increase in smallflower umbrella sedge in WS-AWD system compared to WS-Control

Irrigation: Dry-Down

- For ricefield bulrush control
- Starts with deep flooding (up to 10 inches approx.)
  - Should reduce grass emergence
- Followed by drain
  - Timing recommendation from Fischer et al. 2010:
  - 34 DAS
- Unsure of average flood duration under field conditions (grower practices)
- Drain period (unsure)



rice (●) bulrush (○)

Fischer et al. 2010

Crop Rotation?

- Not a lot of data on this in California rice
- Mostly anecdotal
- Growers are practicing crop rotation, but how much is unknown
- Effects on weeds, diseases, etc. not quantified

- Initial data collection (small survey) in 2019
- Larger survey of grower practices in 2020
  - More specific to those who rotate
  - Anecdotal (no data collected on pests, fertility, etc)

Survey Respondents

County	Number of farms managed	Average acreage managed	Std Deviation	Min	Max
Butte	39	754	828	5	300
Sutter	38	1087	1527	28	8500
Yuba	21	597	422	10	1500
Glenn	47	600	1043	24	7000
Colusa	30	991	1923	65	10000
Placer	10	415	224	95	900
Sacramento	9	295	253	40	925
Yolo	16	1837	2530	10	10000
San Joaquin	2	1100	0	1100	1100

Survey Respondents

Grower Demographic	
Rice Grower	145
Pest Control Advisor (PCA)	2
Both Rice grower and PCA	6
Other	3
Average Age	58
Std deviation	13
Min	25
Max	92

	n	%	Acreage
Grew organic rice	11	7.6%	2514
Do not grow organic rice	134	92.4%	1050

Crop Rotation

	Crop rotation
# of responses	139
% did in 2018	12.2%
Average acreage	965
Std deviation	989

Most common crops rotated:

- Sunflowers (10)
- Tomatoes (8)
- Wheat (5)
- Safflower (4)
- Vetch
- Corn
- Bell beans
- Forage hay
- Oatseed
- Pea seed
- Vineseed
- Melons
- Grain
- Dry beans
- Barley
- Wild rice
- Fallow

Why Crop Rotation in rice?

- Allows for dry conditions
  - Different weed species emerge
- Can utilize tillage in some crops (not possible during the season in rice)
- Should reduce weed seed bank over time
  - Unlikely for aquatics, as they won't emerge under dry conditions:
    - Sedges, redstem, broadleaves
  - Might work for grasses
    - Weedy rice, watergrass, barnyardgrass, sprangletop?
- Unknown number of years or crops that will maximize weed seed reduction

CROP ROTATION

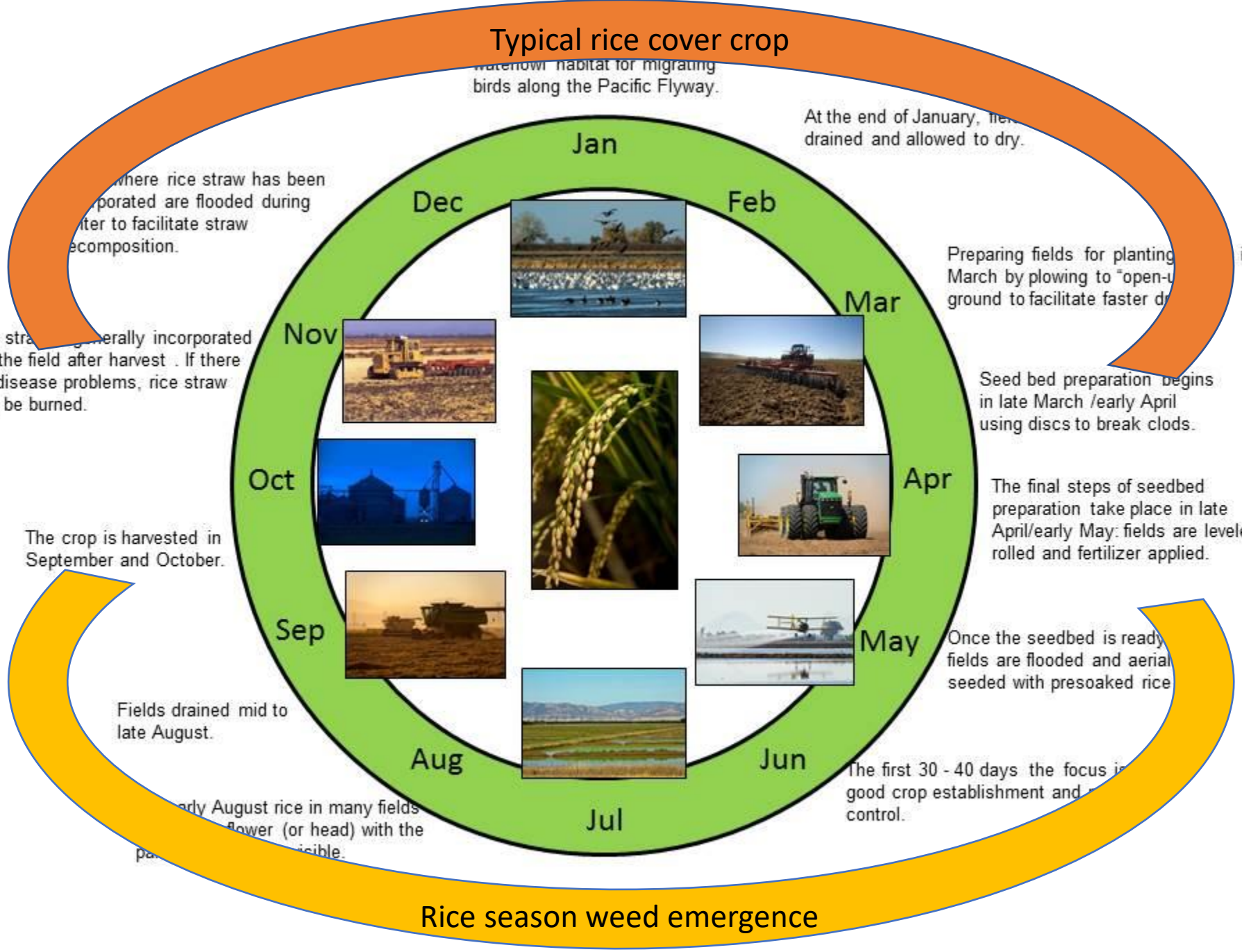
WEED OUTCOME	YEAR 1	YEAR 2	YEAR 3	YEAR 4
Poor				
Fair				
Better						
Best				

Cover Cropping

- Currently used in rice for adding nitrogen (and biomass/carbon) to the soil
- Planted in the fall, tilled under in the spring

- Can it be used for weed control?

Typical rice cover crop



Rice season weed emergence

Photos courtesy of California Rice Commission

When to use

- Cover crop season before not overwinter (as a rotation)
- Can maybe use cover crop for weed suppression if allowed to grow until April-May
  - No data to know effects
- Similar effects to crop rotation

Current use of non-chemical methods in rice

- Not a lot is known….
- Some preliminary data from our survey
- DID NOT include cover cropping

- More research is needed!
- Current studies:
  - Fall straw management effects on weeds of drill-seeded rice
  - Fallow effects on weedy rice
  - Fallow year with spring no-till effects on weeds in flooded systems

Growers: Practice

		Drill /dry seeding	Winter flooding	Burning	Stale seedbed	Crop rotation
	# of responses	152	151	150	143	139
	% did in 2018	9.2%	82.8%	25.3%	7.0%	12.2%
	Average acreage	756	835	108	272	965
	Std deviation	750	1108	115	321	989
Duration:	(122 responses)					
	<1 Month		3.3%			
	1 Month		2.5%			
	2 Months		13.1%			
	3 Months		56.6%			
	4 Months or more		24.6%			

Questions? What are your practices?