Weedy Rice in California: what makes a pest a pest?

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What is “weedy rice”?

• Same species as cultivated rice:
  • Cultivar: *Oryza sativa* L.
  • Weedy rice: *Oryza sativa* f. *spontaneae*

• Considered one of the worst weeds of rice worldwide

• Can hybridize with cultivated rice

• Rice is considered to be a “selfing” crop (outcrossing of 1-2%)

• Weedy rice has an outcrossing rate approaching 10%

• Different populations present in each location
  • Different phenotypes, biotypes, etc.
Why is it important to control weedy rice?

It is rice, after all!

What makes one rice plant a weed, and the other a pest?

Weedy Characteristics

•Domestication syndrome:
  • Seed shattering
  • Seed dormancy (ability to remain viable in the soil)

Source: Siriwardana 2014, Photo: Timothy Blank, CCIA
Weedy Characteristics

Red pericarp = red bran

M-206 = Cultivar

Weedy rices
Why is it important to control weedy rice?

Can impact quality
- In white rice, extra milling required
- In brown rice, has to be sorted out

Can affect yields
- Shatters!
- If heavily infested, can reduce yields by more than 70%

Same species as rice!
- Herbicides ineffective
- No herbicides registered for spot-spraying
- Requires cultural management

Field in Arkansas. Image from:
https://www.bio.umass.edu/biology/sites/imladris.bio.umass.edu/biology/files/gbi-images/weedyredricefield.jpg
Background: California

- Weedy rice thought to be “not suited” to CA growing system:
  - Continuously flooded system
  - Strong seed certification program (1950’s to present)
  - Import restrictions and varieties bred specifically for CA
Weedy Rice in California: Timeline

• 1917, UC Report
  • “Most injurious rice seed pests in CA are water grass, red rice and rogue rices”

• 1939, Journal of the American Society of Agronomy
  • 1932 survey: 42% of seed samples from CA contained red rice (3-57 seeds/lb)
Weedy Rice in California: Timeline

- 1937-1949: 31% of seed samples showed red rice, 25 seeds/lb
- 1950s: certified seed widely adopted
- 1950s-2000s: ??
- 2003: 1 infested field, Glenn County
- 2006-2008: 4-5 infested locations across 2 counties
Survey: 2006-2008

- 2 counties
- 1 ecotype
Weedy Rice in California: Timeline

- 2009-2015: Suspected samples submitted to Rice Experiment Station

- 2015: California Crop Improvement Association (seed certification agency) reports seeing weedy looking rice plants in many fields
  • Report given at yearly grower meetings
Survey: 2016

- Over 10,000 acres
- 5 ecotypes
- Every major rice-growing county
Field Survey: 2017-2018

By the end of 2017, we had a total of:
• 53 samples submitted for testing
• Out of the 53, 22 confirmed to be weedy rice
• About 42% of the samples!

By the end of 2018, we had a total of:
• 22 samples submitted for testing
• 5 confirmed to be weedy rice
What happened?

• Poor definition of “weedy rice”
  • Many were defined as “colored bran” without checking for weedy characteristics

• Assumption that all weedy rices look the same

• Pest Control Advisors and growers not aware of the problem

• Looks a lot like watergrass (*Echinochloa* spp.)
  • Many growers have herbicide-resistant watergrass
Research and Extension Efforts (2016 to Present):

• Extension:
  • Focus on:
    • Identification
    • Proper sample collection for testing and to stop movement of seed
    • Best Management Practices
      • Stop movement of seed!

• Research:
  • Genetic mapping of populations (source??)
  • Phenotypic characteristics for identification
  • Management-relevant information
Extension
High Diversity

Photos: Timothy Blank, CCIA
Where is the weedy rice??
Weedy rice and late watergrass
Identification at Panicle Initiation

Ligule

Auricle
Identification at Panicle Initiation

1. Once all herbicide applications have been made to control watergrass...

2. Watergrass-like plants still visible in the field

3. Check plants to see if there is a ligule

4. If ligule absent, then it is a watergrass (*Echinochloa*) species

5. If ligule present, time to call UCCE Advisors for help!
Sample Collection Protocol

1. If suspected, DO NOT REMOVE FROM FIELD
2. Call UCCE Rice Advisor
3. Advisor will go to field to take sample
4. Sample will be processed and results reported to submitter
- All rice-growing counties (except for Colusa)

- Type 1:
  - Awnless
  - Straw hull color
  - Tall stature
  - No color on nodes
• Type 2:
  • Awnless
  • *Bronze hull color*
  • Tall stature
  • No color on nodes

• Butte, Sutter and Yuba Counties
- **Type 3:**
  - *Awned*
  - Straw hull color
  - Tall stature
  - No color on nodes

- Glenn and Colusa Counties
• Type 4:
  • *Awned*
  • *Black hull color*
  • *Short stature*
  • No color on nodes

• Currently in one location, Glenn County
• Type 5:
  • Awnless
  • Straw hull color
  • Tall stature
  • *Purple-colored nodes*

• Sutter, Yuba, and Yolo Counties
Type 6:
- Black-hulled
- Awned
- Awns are red in color before maturity
- Plant height is similar to other types
- 1 location (Butte County)
What is weedy rice? Weedy rice, a type of grass that is not native to California, can grow in and around rice fields. It can be harmful to rice crops and the environment. It is also a serious threat to rice farmers in California due to its ability to spread rapidly.

Weedy rice identification guidelines

The following are the weedy rice types identified in California so far:

Type 1
- Acre
- Short hull color
- Tall stature
- No color on nodes

Type 2
- Acre
- Tawny hull color
- Tall stature
- No color on nodes

Type 3
- Acre
- Short hull color
- Tall stature
- No color on nodes

Type 4
- Acre
- Black hull color
- Short stature
- No color on nodes

Type 5
- Acre
- Short hull color
- Tall stature
- Purple colored nodes

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Weedy Rice Reporter App

Add Photo
Add up to 6 photos. Larger images will be resized to 1024 pixels.

- Take Photo
- Select Photo

Next
Weedy Rice Reporter App

Add Location
Move map to refine location.

Add Details
- Contact name*
  Enter some text
- Contact number*
  Enter some text

Next  Save  Submit
Research
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 + Genotype characterizations
Possible Origins of California Weedy Red Rice

Neighbor-joining tree of each cluster in the data
Seed dormancy test

- RES Varieties
- Koshihikari
- Type 1
- Type 2.1
- Type 2.2
- Type 3
- Type 4
- Type 5.1
- Type 5.2

% Germination
Seed shattering measurement

Breaking Tensile Strength (BTS)

CA Weedy Rice
## Phenotypic Characteristics for Management:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Populations</th>
<th>Duration of time in soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>High dormancy, high shattering</td>
<td>Type 1, Type 3, Type 4</td>
<td>Long-term (may be 10 or more years)</td>
</tr>
<tr>
<td>Low dormancy, high shattering</td>
<td>Type 2, Type 5</td>
<td>Shorter (likely to be a few years, but only if more seed is not being put into the soil seedbank)</td>
</tr>
</tbody>
</table>
Phenotypic characteristics for identification

All weedy rices have lighter colored leaves than CA Rice Experiment Station varieties
All weedy rices are taller than CA Rice Experiment Station varieties
**Yield per Plant**

**Weedy rice density:**
- Significant reduction in M-206 yield per plant, with only 8 plants m$^{-2}$

![Graph of yield per plant against weedy rice density.](image-url)
Lessons Learned

1. Proper weed identification is vital!
2. Focused message (industry, university and growers!)
3. Do not penalize anyone for reporting infestations
4. Extension efforts should be practical and easy-to-understand
5. Research efforts should incorporate grower priorities and concerns
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Questions?