Project No. RP-?

ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
January 1, 2023 – December 31, 2023

PROJECT TITLE: Emerging Weed Issues in Rice

PROJECT LEADER AND PRINCIPAL INVESTIGATORS:

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OBJECTIVES OF PROPOSED RESEARCH:

1. To continue to further refine identification of the different watergrass species
2. To create a new key for watergrass identification in rice
3. To field test combinations of herbicides for late season watergrass control

BACKGROUND AND SUMMARY:

Over the past several years, there have been several new weed species identified, including *Ludwigia decurrens* (winged water primrose), 6 biotypes of weedy rice, and possibly 2 new species or sub-species of *Echinochloa* spp. (watergrasses). Likewise, the California Department of Food and Agriculture has placed restrictions on Ludwigia and *Monochoria vaginalis* (false pickerelweed), in terms of seed production. For monochoria, this was partially because we were unable to establish a range for the weed. Only a couple of locations were recorded, although anecdotal evidence suggests that it is widespread throughout the rice-growing region. All of these instances occurred within the last 5-6 years and came as a relative surprise to the industry and growers. The last weed survey was conducted in the 1980's.

In 2017, at least 2 fields were identified with an unknown watergrass biotype. After extensive attempts at identification at both the UC Davis Herbarium, and with two *Echinochloa* experts at two other universities, we were unable to conclusively identify the species. An additional attempt at identification was undertaken in a joint effort with Amar Godar (former SRA with Kassim Al-Khatib) and Ellen Dean (at the UC Davis herbarium) using multiple samples from the herbicide resistance screening samples. These results were also inconclusive. Since identification appears difficult, the research team has been focusing on control methods in the meantime.

The overall goal of this research is to continue to address emerging weed issues promptly. In 2019, we collected a survey of soil samples from across the rice-growing region, to establish a baseline of the weed species and biotypes present across the California rice region. This was in response to the growing list of new weeds identified in the past 5 to 10 years. In 2020 we finished the baseline survey, concluded the herbicide screening for the 2018 watergrass samples, and conducted a larger watergrass survey. In 2021, we conducted the herbicide screening for the 2020 watergrass samples (two replications), and the phenotyping of the same samples (two replications). We submitted representative samples of each to the UC Davis herbarium. In 2022, we reanalyzed data from the herbicide screenings, sent reports to all 64 growers and PCAs, made contacts and connections to further our watergrass identification and studies, and finished the website hosting the ArcGIS maps for the 2019 rice weed survey.

In 2023, we continued to further analyze the data we collected for the watergrass field survey (collected in 2020), as well as the phenotypic study (collected in the same survey). Results of both will be published in peer-reviewed journals this year. The 2023 field studies yielded alternative foliar application alternatives to the double propanil applications that are being utilized across the valley.

OBJECTIVES AND EXPERIMENTS CONDUCTED, BY LOCATION, TO ACCOMPLISH OBJECTIVES:

Objective 1: 1. To continue to further refine identification of the different watergrass species
In 2021, we submitted 64 representative samples from our watergrass survey to the UC Davis herbarium. By spring of 2022, samples had dried enough to begin to work on identification. The samples are now housed permanently at the UC Davis herbarium, and can be accessed by other researchers in the future.

Brim-DeForest has been reaching out to scientists worldwide for assistance with the identification, and as of January 2023, has been in contact with a researcher from Texas who has the same species. She will be working with him to identify the species. She is also working on a genetic analysis with a professor from Japan who previously collaborated with Albert Fischer. All samples have been sent to him as of mid-2023.

As of late 2023, the species has been identified as *Echinochloa walteri* (Walter's barnyardgrass). The phenotypic analysis is in the process of being finalized, and should be published in 2024. This will assist in the development of a key.

Objective 2: To create a new key for watergrass identification in rice
A key will be developed in 2024, based on the analysis conducted in 2023, to be finished in 2024. The key will be published through UCANR, and will be widely available to growers and PCAs.

Objective 3: To field test combinations of herbicides for late-season watergrass control

3.1 Field Testing of Experimental Herbicides. A field experiment was conducted in a grower's field in 2019 in Yuba County in cooperation with an herbicide manufacturer (results are not available for publication at this time). The manufacturer had seen promising results in watergrass control in 2018 in an experimental trial in Butte County and wanted to see if the results were replicable in another location. This particular Yuba County field was first identified in 2017, and it had an unidentifiable watergrass population at the time that had not been controlled with several different herbicides (with multiple applications). In the 2019 experiment, we tested an experimental chemical against a registered chemical. Unfortunately, the results were not promising, showing little to no control of the watergrass in this field.

In 2020, the same experimental chemical was tested at a grower's field in Glenn County. The biotype in the field was multiple-herbicide-resistant late watergrass (*Echinochloa phyllopogon*), resistant to thiobencarb and ALS-inhibitors. The chemical did appear to have a small (but insignificant) amount of control on the late watergrass biotype.

In 2021, the same experimental chemical was tested at two different grower's fields, both in Colusa County. The biotypes in one field were late watergrass (unknown susceptibility, but was controlled by grower-applied herbicides in the surrounding field), and in the other field, the unknown biotype, late watergrass, and barnyardgrass. The grasses were not well-controlled in either field, but grass pressure was very high, especially in the second field.

In 2022, the experimental chemical was tested again, but unfortunately the field was oversprayed by propanil shortly after the experimental herbicide applications, and so no data was collected.

We also collaborated with UPL in 2022, to try a tank mix combination study for late season watergrass control, to provide alternative options to growers beyond the propanil-propanil application, as we are concerned about the development of resistance. Phytotoxicity was low with all of the combinations, with the exception of Regiment followed by SuperWham, which had severe stunting. Weed control (of watergrass) was good, with SuperWham + Shark and SuperWham + Loyant providing the best control. Yields were highest in the SuperWham-only treatment.

Testing resumed in 2023, at several fields located across Butte County. Four of the locations were in grower fields, and one was at the Rice Experiment Station. The grower fields all had watergrass populations that were known to be difficult to control. All fields had a base application of herbicide upfront (granular into-the-water), and the follow-up applications were made with foliar-applied combinations (Table 1). Treatments were made at tillering or later, at the timing that the growers made their follow-up applications. All were either propanil-based or bispyribac-sodium-based (Stam 80DF or Regiment). Most were tank mixes, but two were one foliar application followed by a second a week later (treatments 3 and 9). Both Stam 80DF and Regiment were applied alone as controls as well (treatments 2 and 8).

Table 1. *Application rates of foliar-applied herbicides. Applications were made at approximately tillering or later, based on grower application timings.*

	Treatment
1	Untreated Control
2	Stam 80DF (7 lb/A) + COC (2.5%)
3	Stam 80DF (3.75 lb/A)+ COC (2.5%) fb Stam 80DF (3.75 lb/A)+ COC (2.5%) (1 week later)
4	Stam 80DF (7 lb/A) + Abolish (2 pt/A)
5	Stam 80DF (7 lb/A) + Shark H2O (4 oz/A)
6	Stam 80DF (7 lb/A) + Loyant (1.33 pt/A) + MSO (0.5 pt/A)
7	Stam 80DF (7 lb/A) + Clincher (15 fl oz/A) + COC (2.5%)
8	Regiment (0.8 oz/A) + UAN (2%) + Dyneamic (5 fl oz/A)
9	Regiment (0.8 oz/A) + UAN (2%) + Dyneamic (5 fl oz/A) fb Stam 80DF (3.75 lb/A)+ COC (2.5%) (1 week later)
10	Regiment (0.8 oz/A) + Loyant (1.33 pt/A) + UAN (2%) + Dyneamic (5 fl oz/A)
11	Regiment (0.8 oz/A) + Clincher (15 fl oz/A) + UAN (2%) + Dyneamic (5 fl oz/A)
12	Regiment (0.8 oz/A) + Sandea (2 oz/A) + UAN (2%) + Dyneamic (5 fl oz/A)

Results

The results varied slightly across sites. The Rice Experiment Station location had very little watergrass pressure, so weed control was not averaged with the other locations (Figure 1). Control (%) was assessed at 7 Days After Treatment (DAT), 14 DAT, and 21 DAT. Results presented here are for final % control. Across all sites, Regiment followed by Stam 80DF (treatment 9) had the best weed control (applied 1 week apart). Stam 80DF + Abolish (treatment 4) also had good weed control across all sites. Stam 80DF followed by Stam 80DF (treatment 3) had good control, but as a treatment, it is not recommended, as it will likely select for propanil-resistance. The other two treatments that worked well across sites were the Stam 80DF alone and Stam 80DF + Shark H2O (treatments 2 and 5, respectively).

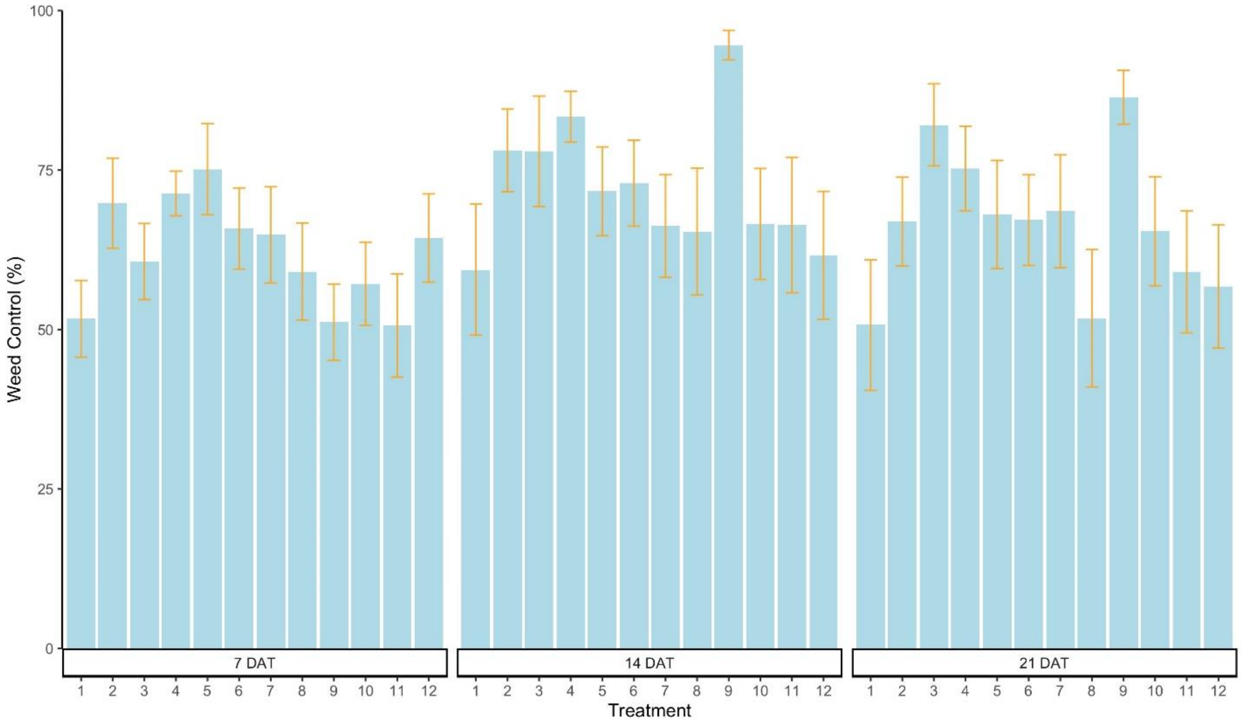

***Figure 1.** Percent cover of watergrass (Echinochloa spp) at 7, 14, and 21 Days After Treatment (DAT), averaged across all sites except for the Rice Experiment Station.*

Phytotoxicity

Phytotoxicity (tip burn) (Figure 2) was low in all treatments except for Stam 80DF + Shark H2O. The tip burn was very noticeable, similar to the results seen in 2022. However, it was most visible at 7 days after treatment, and had mostly dissipated by 14 days after treatment. Stunting (Figure 3) was relatively noticeable in all of the treatments treated with Regiment (treatments 8-12), but the rice recovered by 21 DAT. A small amount of stand reduction was noted in treatments 7, 9, 10 and 11 (Figure 4). The two tank mixes containing Clincher (mixed with Stam 80DF as well as Regiment), as well as the Regiment followed by Stam 80DF showed a loss. The Regiment + Loyant treatment showed stand loss as well.

Yield

Yields were generally low across all sites, compared to an average year (Figure 5). One of the sites had an extra propanil application, which resulted in severe blanking. Two sites were lodged at harvest, and the general weediness of the other two sites reduced yields in general. The highest yielding plots were Regiment followed by Stam 80DF (treatment 9), and Stam 80DF along (treatment 2), and Stam 80DF followed by Stam 80DF (treatment 3). Other higher-yielding plots were Regiment + Clincher (treatment 11) and Stam 80DF + Loyant (treatment 6).

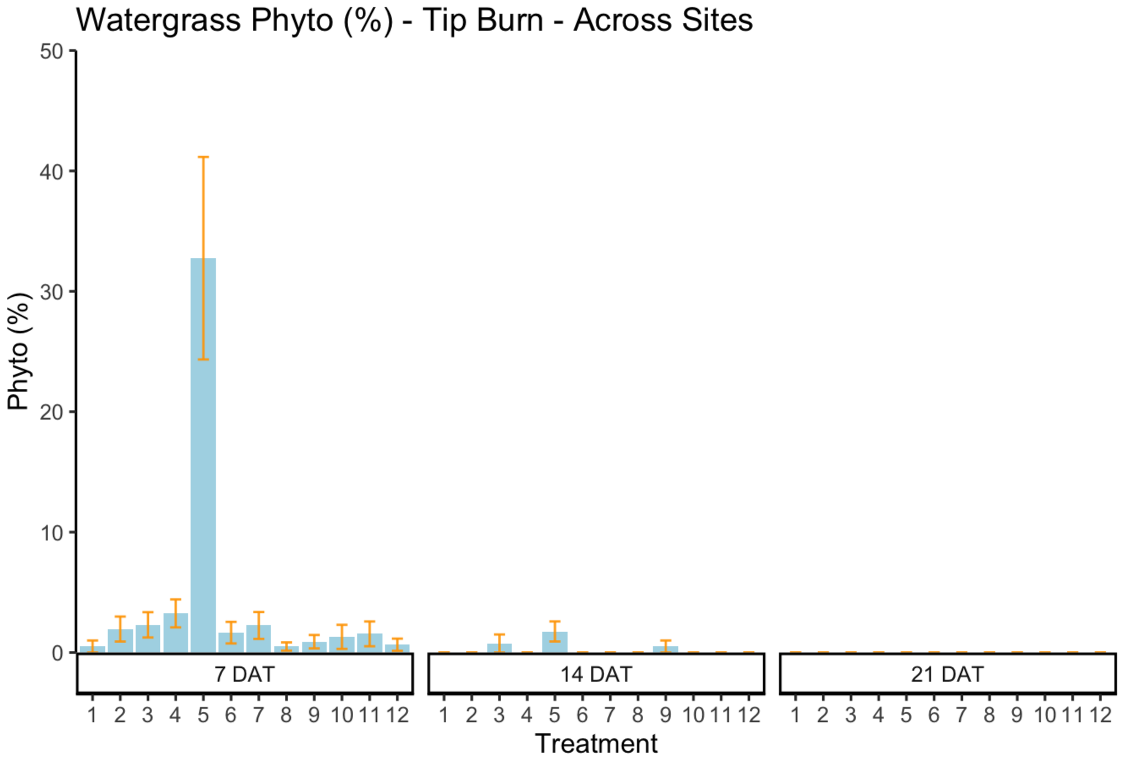

***Figure 2.** Percent phytotoxicity (tip burn) at 7, 14, and 21 Days After Treatment (DAT),*

averaged across all sites.

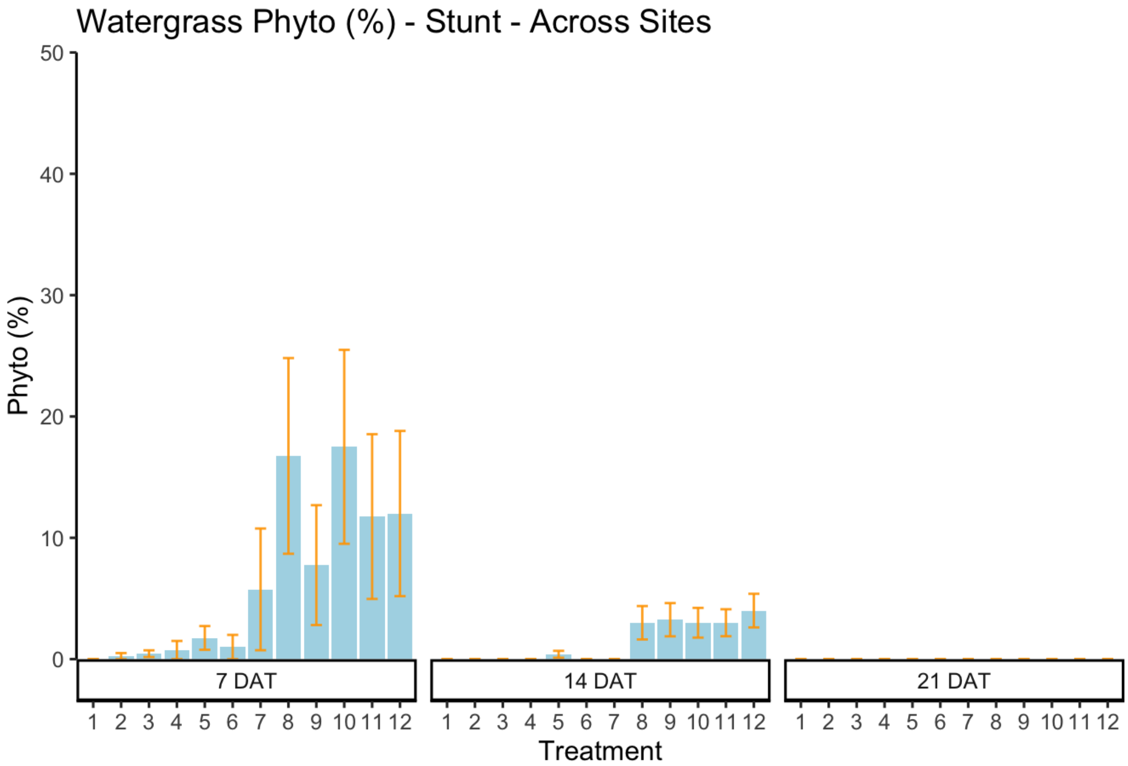

Figure 3. *Percent phytotoxicity (stunting) at 7, 14, and 21 Days After Treatment (DAT), averaged across all sites.*

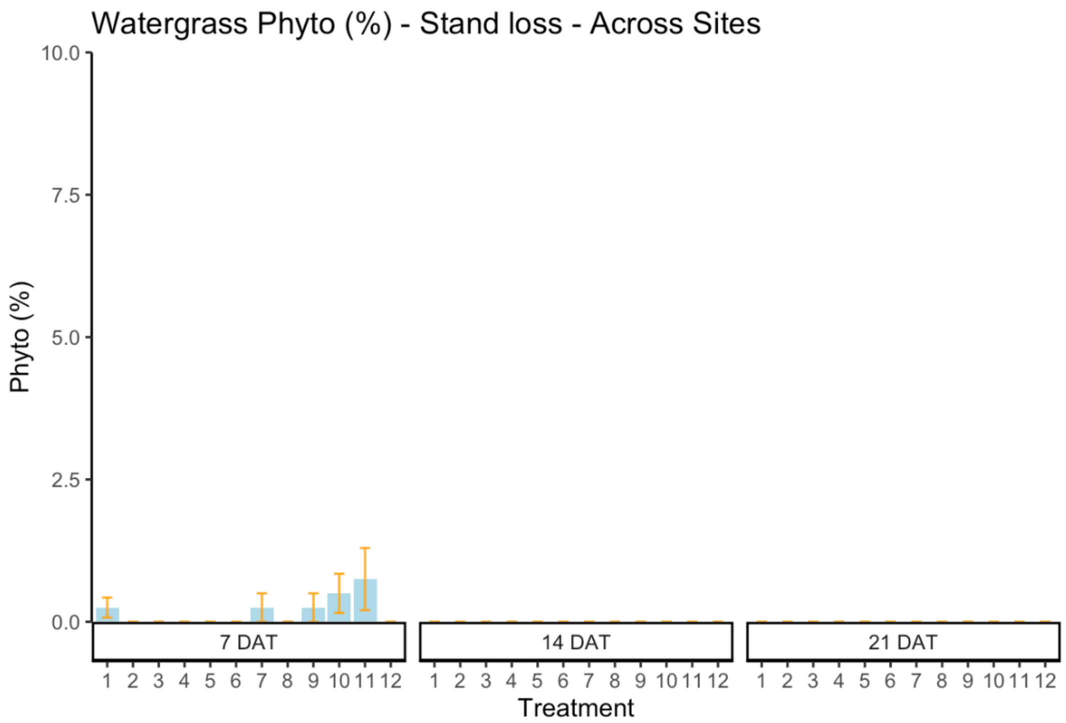

Figure 4. *Percent phytotoxicity (stand loss) at 7, 14, and 21 Days After Treatment (DAT), averaged across all sites.*

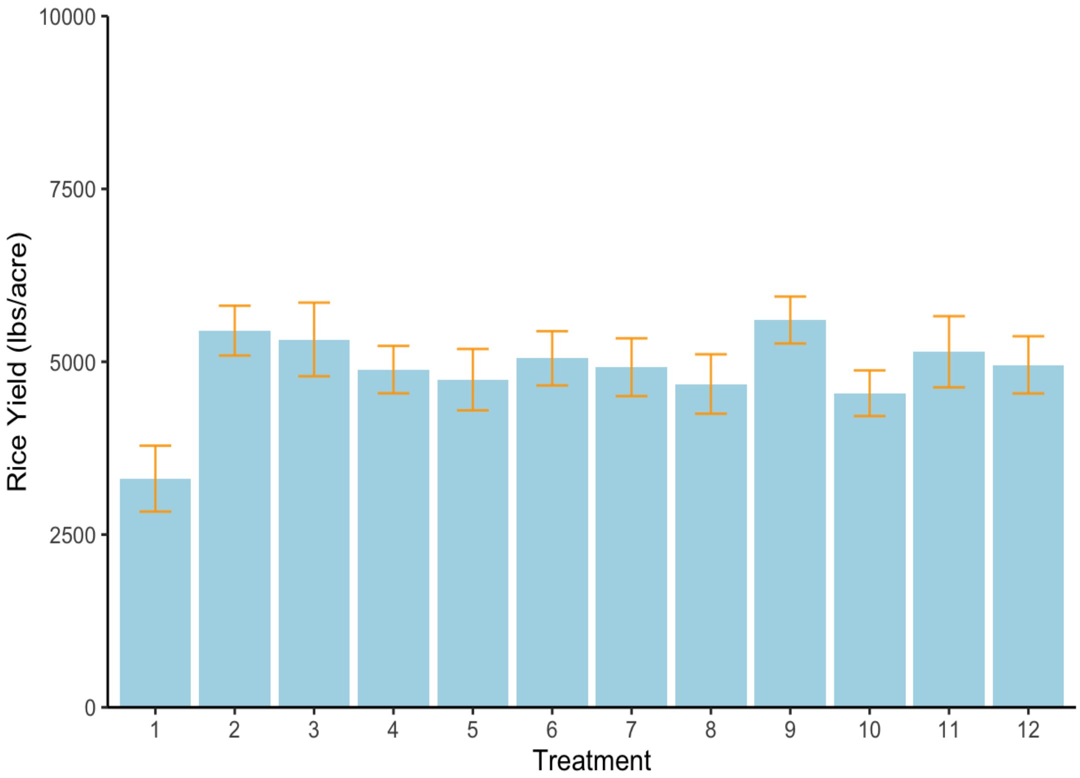

Figure 5. *Rice yields (lbs/A) adjusted to 14% moisture, averaged across all sites.*

GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

In 2019, we collected a survey of soil samples from across the rice-growing region, to establish a baseline of the weed species and biotypes present across the California rice region. This was in response to the growing list of new weeds identified in the past 5 to 10 years. The survey was completed in 2020, and we started working last year on putting the results online (in ArcGIS) into a database that can be used for reference of weed species distribution in California rice fields. In 2020, we also concluded the herbicide screening for the 2018 watergrass samples and conducted a larger watergrass survey (collecting 64 samples from across 8 counties). In 2021, we completed a phenotypic analysis for the 64 samples, submitted representative samples of each to the UC Davis herbarium, and completed an herbicide screening with all of the samples using all registered California grass herbicides. In 2022, we completed the ArcGIS maps of weed species, and they are now live at: **https://sites.google.com/ucdavis.edu/californiariceweedssurvey2019**. We reanalyzed the watergrass data to provide a better overall picture of the situation in California, and made several national and international weed science contacts to assist with identification and development of a new key. In 2023, we conducted testing of herbicide combinations in the field, for control of watergrass, especially for late-season control.

PUBLICATIONS OR REPORTS:

Peer-reviewed:

- Vulchi, R; Guan, T; Clark, T; Brim-DeForest, W (In press). Echinochloa spp response to Preemergence and Postemergence Herbicides in California. *Frontiers in Agronomy*. DOI: 10.3389/fagro.2024.1349008