California Rice Research Board

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# Stale Seedbed: Uses and Limitations for Weed Control in California Rice

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As everyone working in California rice knows, weeds are getting tougher and tougher to control, for a variety of reasons: herbicide resistance, new types and weed species, and regulations that make it difficult to apply certain herbicides in certain locations. Coupled with the fact that most products only control some weed species (most are not broad-spectrum), planning a program can sometimes feel impossible and overwhelming. Some new products are coming down the pipeline, but many have the same issue: not broad spectrum and little or no control of resistant types/species.

About 15 years ago, UC scientists started exploring the use of minimum tillage in rice systems. They compared conventional flooded rice (fall tillage, spring tillage, flood, and then water-seeded) to a minimum tillage system (fall tillage, no spring tillage, flushed in April, sprayed with glyphosate, then re-flooded and water-seeded) (Linquist et al, 2008). In the original paper, the timing is not spelled out exactly, on when to flush and when to apply glyphosate. However, the technique they used is what weed scientists call a "stale seedbed" or "false seedbed".

The stale seedbed method for weed control, is a management technique where the field (tilled or untilled at the beginning of the seedbed preparation) is flushed to allow the weeds to emerge before seeding of the crop. Once the weeds emerge (prior to the crop), they can be controlled either through shallow tillage or through application of a non-selective herbicide with broad-spectrum control (check with your local Agricultural Commissioner's office for guidance on herbicides that can be used in rice). After the weeds have died, then the field can be seeded and planted, by drill-seeder or by airplane. Care should be taken to not disturb the soil again after the weed control operation, to not bring up another flush of weeds.

In rice, the stale seedbed can be implemented prior to planting, or during a fallow period (over the summer), where the field can be flushed multiple times. Flushing during the winter is unlikely to have an effect on most rice weeds, as weed emergence periods are temperature-specific to each weed species, with most rice weeds emerging in the spring and summer.

## Weeds Controlled:
### Smallflower umbrella sedge

In the Linquist et al (2008) study, they found that a stale seedbed application of glyphosate (pre-plant) controlled some smallflower umbrella sedge (Table 1) over all three years of the study (2004-2006). In this particular study, the length of time for the emergence of smallflower umbrella sedge was not included. Another study by Pedroso et al (2019), shows that smallflower umbrella sedge has a relatively high minimum temperature at which it will start germinating (approximately 62 °F) in comparison to watergrass (48 °F) and japonica rice (50 °F). This means that it has to be much warmer to get smallflower to germinate, in comparison to the other weed species. It tends to germinate quickly, however, once it begins to germinate, so if growers see smallflower emerging, they should not have to wait long before spraying or tilling to control most of the first flush. There is evidence that a second flush of smallflower will emerge if the field is drained later in the season, so care should be taken to maintain a permanent flood, or another herbicide

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**Table 1**: *Weed recruitment in conventional till with no herbicide and in minimum till/stale seedbed* (table from Linquist et al, 2008)*

| | 2004 | | 2005 | | 2006 | |
|---|---|---|---|---|---|---|
| | Conventional | Minimum | Conventional | Minimum | Conventional | Minimum |
| | plants/sq. ft. | | | | | |
| Echinochloa | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 1.0 ± 1.7 | 0.1 ± 0.2 |
| Smallflower umbrellasedge | 18.4 ± 10.4 | 0.2 ± 0.1* | 137 ± 45.0 | 6.6 ± 2.7* | 25.5 ± 18.1 | 4.6 ± 2.1* |
| Ricefield bulrush | 0.1 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.2 ± 0.1 | 18.7 ± 11.9 | 1.6 ± 1.5* |
| Ducksalad | 1.7 ± 0.8 | 1.7 ± 0.8 | 4.1 ± 1.3 | 3.4 ± 1.6 | 5.8 ± 4.0 | 19.4 ± 10.6* |
| Redstem | 3.0 ± 0.0 | 0.4 ± 0.2* | 6.5 ± 1.5 | 6.5 ± 1.1 | 12.1 ± 7.7 | 5.1 ± 3.2 |

$P < 0.01$; *For a given year and weed species, asterisks (*) indicate significant ($P < 0.05$) differences between conventional and minimum-till weed densities. Values correspond to specific plot sections (weed recruitment areas) where glyphosate was applied (but no other herbicide used).

should be applied to control the second flush.

## Watergrass

The Linquist et al (2008) study location did not have enough watergrass species (*Echinochloa* in Table 1) to determine if the stale seedbed could be used as a control method. However, we have preliminary data (Brim-DeForest, unpublished), on utilizing a stale seedbed for watergrass control in rice (Figure 1). In this field study, the field was flooded, and water was allowed to subside. At 12 days after initial irrigation, a glyphosate application was made (corresponding to 154 Growing Degree Days in °C). The late watergrass had emerged to approximately 75%, so control with glyphosate was 75% of the emerged plants. One week after seeding, there were noticeable differences in control between the conventional flood (no pre-plant herbicide) and the stale seedbed (pre-seeding application of glyphosate) (Figure 2).

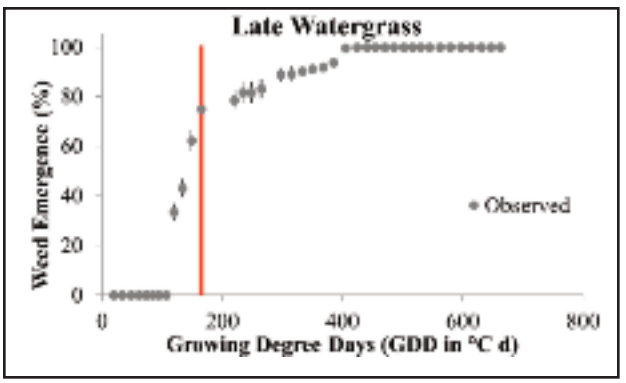


***Figure 1***. *Stale seedbed treatment on late watergrass in rice at the Rice Experiment Station. Timing for the glyphosate application (in red) was made at 12 days (154 Growing Degree Days) after water was applied to the field and allowed to subside, corresponding to control of 75% of the emerged plants.*


***Figure 2.*** *Stale seedbed treatment (left) and conventional flood (right). The emerging green plants are watergrass (Echinochloa spp), at one week after reflooding and seeding. No herbicide has been applied on the conventional flood, and only pre-plant glyphosate has been applied to the stale seedbed.*

## Weedy Rice

Weedy rice has become a significant pest in the past four years, with infestations found on about 14,000 acres (in 2018-2019). There are no herbicides registered to control weedy rice during the season, so utilizing a stale seedbed is currently one of the best options. In the past 2 years (2019-2020), we have been testing a stale seedbed at our research trial at UC Davis (Brim-DeForest, unpublished data). We had four of the weedy rice biotypes planted in the field (Type 1, Type 2, Type 3, and Type 5). The field was flooded, and water was allowed to subside. At 11 days after irrigation application, glyphosate was applied (Figure 3). The control varied depending on biotype: Type 1: 25% control, Type 2: 75% control, Type 3: 58% control, and Type 5: 0% control. This suggests that the number of Growing Degree Days for weedy rice types to emergence varies between types, so timing of stale seedbed and herbicide application will vary based on the type found in the field. The treatment was repeated in 2020 (results are forthcoming).

## Yields and Fertility:

One of the big questions about utilizing a stale seedbed in rice is whether yields are negatively impacted. Since the fields are flooded at the beginning of the season and then drained, there is potential nitrogen loss. The study by Linquist et al (2008) showed no significant yield differences over 3 years with a rate of 150 lb N/ac (2004-2006) (Table 2). They also tested a series of nitrogen applications, involving different combinations of application timings: preflush, preplant, and topdressing at PI. They found that as long as the field received at least 150 lb N/ac, the stale seedbed ("minimum" treatment in the table) there was not a yield loss, and in fact,

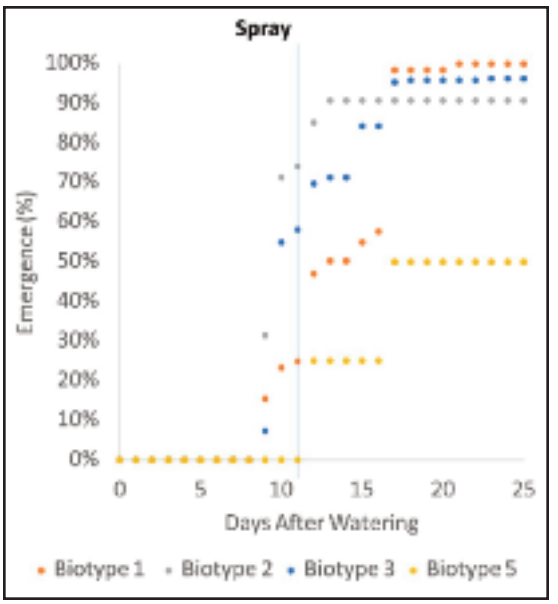


***Figure 3.*** *Stale seedbed treatment in 2019 at weedy rice trial in Davis, CA. Timing for the glyphosate application (in grey) was made at 11 days after irrigation application. Control varied depending on biotype: Type 1: 25% control, Type 2: 75% control, Type 3: 58% control, and Type 5: 0% control.*

the yields were slightly higher in the stale seedbed treatment, possibly due to less weed competition at the beginning of the season. Timing of application (preflush, preplant, topdress) did not have significant impacts on yield. In the stale seedbed treatment, nitrogen was applied preplant to the soil surface, not incorporated or injected, to avoid soil disturbance.

## Efficacy in the Field:

There is not a lot of data on utilizing a stale seedbed in grower's fields. In the 2019 survey conducted by Brim-DeForest et al (in press), 7% of the growers surveyed (out of 143 total) reported utilizing a stale seedbed the previous season. Anecdotal evidence, from speaking to growers on farm calls indicates that many are using it for control of herbicide-resistant watergrass or weedy rice, sometimes applying it before planting, and sometimes in a fallow field, if the infestation is severe.

**Table 2:** *Rice yields under different establishment practices with treatment rate of 150 lb N/ac (table from Linquist et al, 2008)*

| Tillage system | 2004 | 2005 | 2006 | Mean |
|---|---|---|---|---|
| | .....lb/ac (14% moisture)..... | | | |
| Conventional | 9,511 | 7,295 | 7,923 | 8,243 |
| Minimum | 9,303 | 7,299 | 7,457 | 8,020 |

In 2019, a PCA in Sutter County called about a watergrass infestation that wasn't being controlled by multiple herbicide applications. Upon going to inspect the field, it was apparent that the herbicide program was not working, possibly due to resistance, possibly due to a new watergrass species. I suggested applying a stale seedbed, and the PCA and grower tested it in the field in 2020 (Figure 4). The preplant glyphosate application took care of most of the watergrass, to the extent that no follow-up into-the-water granular herbicide application was necessary in 2020, although there was a later herbicide application as a cleanup.

## Summary:

Current data indicates that a stale seedbed can be a useful weed control tool in rice, specifically for weedy rice, watergrass, and smallflower umbrella sedge, although there will be a significant delay in timing of planting if using it to control smallflower (maybe up to a month). At this time, there is little evidence for its use in the control of broadleaves, ricefield bulrush, or sprangletop. If used during the season (pre-plant), it is important to wait until most of the weeds have emerged, to make the application worthwhile. Suggested timing for watergrass or weedy rice control would involve waiting at least 10 days or more after application of water to the field, before herbicide application or tillage. Longer timing may be more effective (greater control).

As with any practice, there are tradeoffs. Implementing a stale seedbed can delay planting, but the increase in early weed control will reduce competition, increasing early rice growth, which can result in higher yield potential. The reduction in later herbicide applications can also be a cost savings.

For assistance in implementation and timing of a stale seedbed, contact your local CE Rice Advisor.

***Figure 4.*** *Grower fields with heavy watergrass infestation 2019 (above) and same field treated with stale seedbed technique in 2020 (below).*

## Weedy Rice Update, UCCE

### End of Year Report

During the 2020 season, 31 new suspected weedy rice samples were received and six were confirmed to be seedy rice. Three came from new sites in Sutter, Yuba, and San Joaquin counties. the other three came from already infested fields. Additionally, we received five samples which could not be identified and need to be tested in the lab to evaluate shattering and dormancy; results will be shared in 2021.

A few fields were found contaminated with weedy rice during the seed certification process (primarily with Type 5, seen below); these fields were not approved for seed and the grain marketed as paddy instead.

Weedy Rice - Type 5
* Awnless * Tall stature * Straw color hull * Purple-colored nodes

### Survey Completed

This summer,UCCE conducted a survey of all weedy rice infested fields found between 2016 and 2019. The survey allowed us to update our records and determine the degree of infestation on every field. For each field, we recorded how many basins were infested and their acreage. By recording only infected basins, we now have a better estimate of the acreage infested in California. **Out of 11,000 acres of inspected fields, only 2,300 were recorded as infested.** We found that several previously infested fields seem to be free of weedy rice. This reduction is in part thanks to the efforts of many growers and PCA's implementing measures to clean up the fields, such as roguing, fallowing, and rotating crops.

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