Predicting Emergence of Smallflower Umbrella Sedge for Improved Timing of Control in Rice Fields

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Introduction

Smallflower umbrella sedge (CYPDI; *Cyperus difformis*) management has been complicated by the evolution of herbicide-resistant biotypes. Knowledge on germination and emergence biology could enable for improved management by allowing for better control timing. In alternative rice establishment systems, such as the stale seedbed, Spring irrigation is employed to encourage weed seed germination and growth, although incertitude regarding the best moment for CYPDI control remains a major issue. Estimates of germination and emergence times could, therefore, fine-tune the use of the stale seedbed for CYPDI control, and improve use of the Leather's method by better estimates of postemergence weed control timing.

Objectives

To (1) evaluate germination patterns of ALS-R and –S CYPDI biotypes across varying temperature and moisture conditions in order to obtain cardinal temperatures and base water potential for germination, and (2) validate a population-based threshold model capable of predicting emergence of CYPDI in rice fields.

Materials and Methods

. Seeds from confirmed ALS-resistant (R) and susceptible (S) CYPDI biotypes [WA (R) and AS (S)], were stratified and placed to germinate on a thermogradient table. Experimental units consisted of 3.5-cm petri dishes with two filter paper discs, randomized in a split-plot design with either 3 (temperature trial) or 4 (water stress) replicates of ~100 seeds each.

. Germination was monitored 4 times a day for 15 days. Eight constant temperatures (from 13.3 up to 33.7 ºC) were maintained for elucidation of cardinal temperatures for germination, which was performed in aerobic conditions and 0 MPa. Alternatively, we simulated a moisture gradient using dishes prepared with PEG 8000 solutions, with water potential (*Ψ*) values of 0, -0.25, -0.45, and -0.65 MPa; such dishes kept at constant 22.3 ºC.

. Seedling emergence from rice soil collected in fields throughout California's Central Valley containing ALS-resistant CYPDI. Soil was transferred to plastic nursery flats and subjected to 3 alternative irrigation regimes: 1) flooding to 5 cm above the base of flat, resulting in a **water saturated** treatment; 2) daily application of 0.5 L water to create **minimum water stress** conditions, or 3) application of 1 L of water every 3 days to provoke **intermittent moisture stress**.

Results

1. Germination Responses to Varying Temperature and Moisture

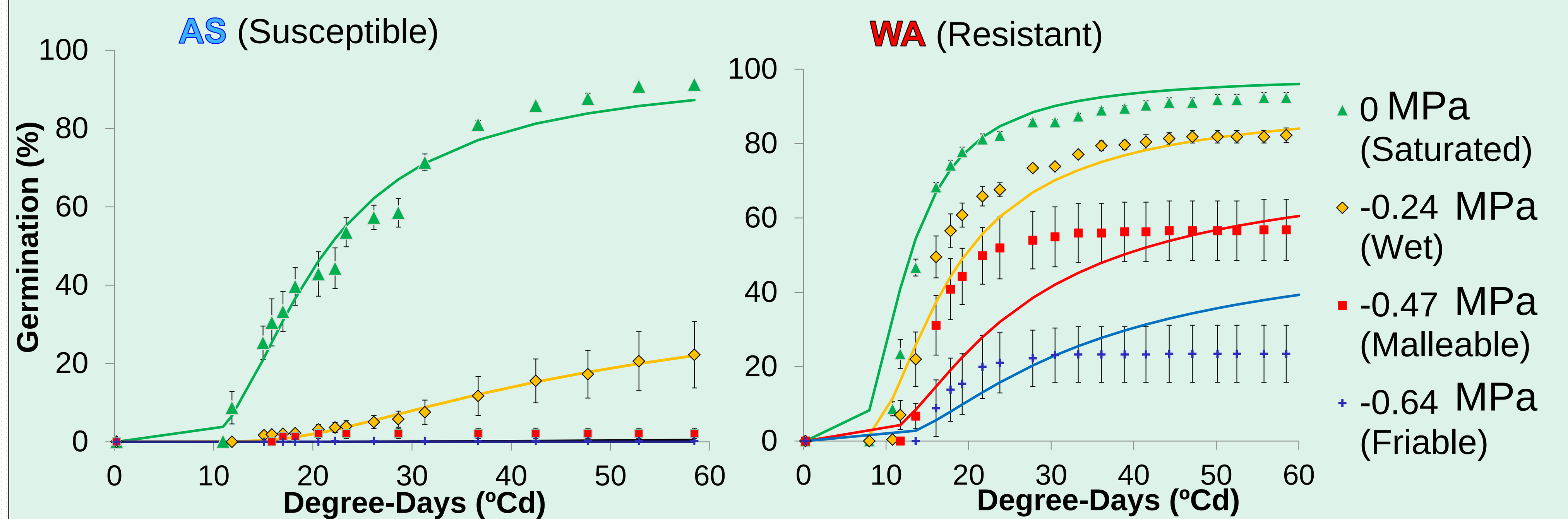

Fig. 1. Time-courses of observed (symbols) and predicted germination (lines) across 4 moisture regimes at 22.3 ºC as calculated by the equation $probit(g) = [\Psi - \theta_H / t_g(\Psi) - \Psi_b] / \sigma_{\Psi b}$ (parameters in Table 1).

Table 1. Final germination (G) for seeds placed at T ≥ 22.3 ºC, minimum or base temperature for germination (*Tb*), thermal time to 50% germination ($\Theta_{T(50)}$), and base water potential for germination ($\Psi b_{(50)}$).

Biotypes	Final G (%)	*Tb* (ºC ± SE)	$\theta_{T(50)}$ (ºCd ± SE)	$\Psi b_{(50)}$ (MPa ± SE)
WA (R)	94.5±1.0	16.75±0.8	16.11±1.7	-0.76 ± 0.02
AS (S)	94.1±1.2	17.01±0.4	21.09±0.7	-0.23 ± 0.04
$LSD_{0.05}$	3.45	1.39	3.25	0.12

The lowest temperature (*Tb*) at which herbicide-resistant CYPDI germinates is 16.75 ºC (62.2 ºF), and was similar for both biotypes. However, the R biotype germinates faster (lower $\theta_{T(50)}$) and under dryer conditions than the S biotype.

2. Emergence in Rice-field Soil Under Different Moisture Regimes

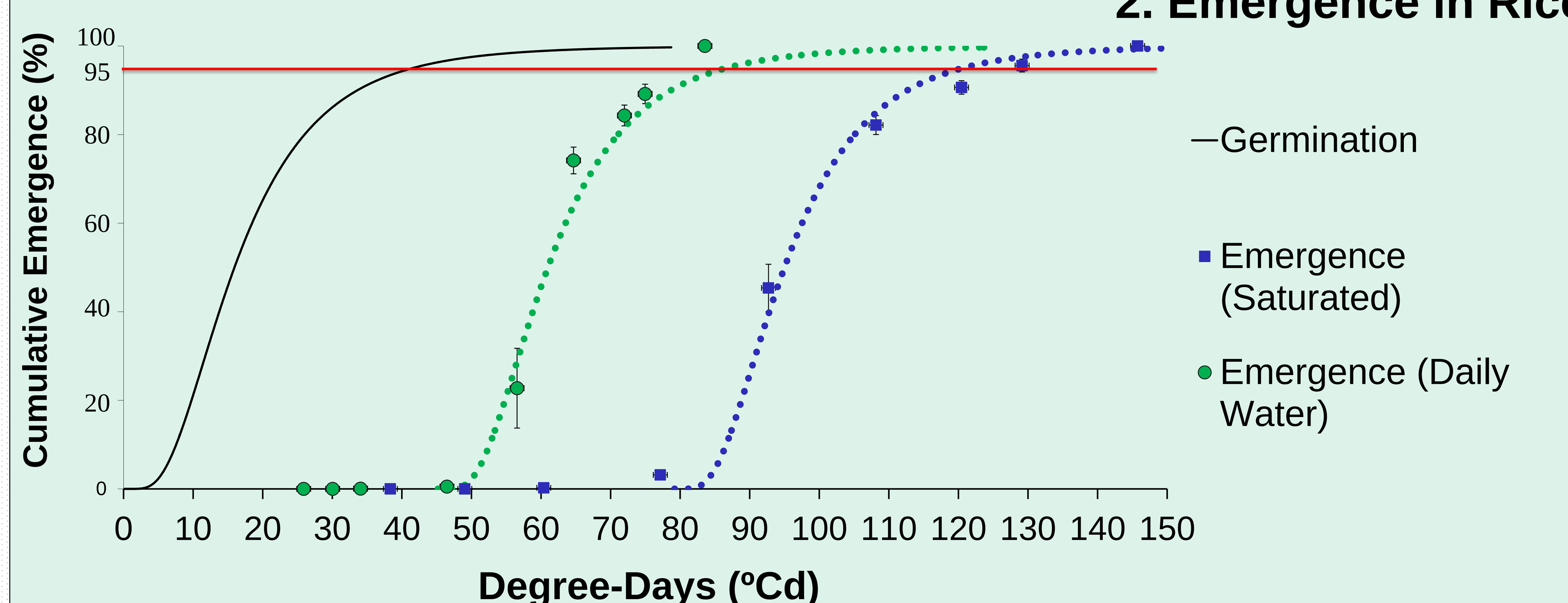

Fig. 2. Cumulative germination (black line) and emergence (symbols and dashed lines), for saturated and daily-watered soils; germination curve based on germination parameters of the R biotype (table 1). The 3-day flush did not allow for any emergence (fig. 3). Water potentials remained close to 0 MPa at the daily water regime (data not shown), thus predicted emergence is here presented as driven by temperature accumulation only.

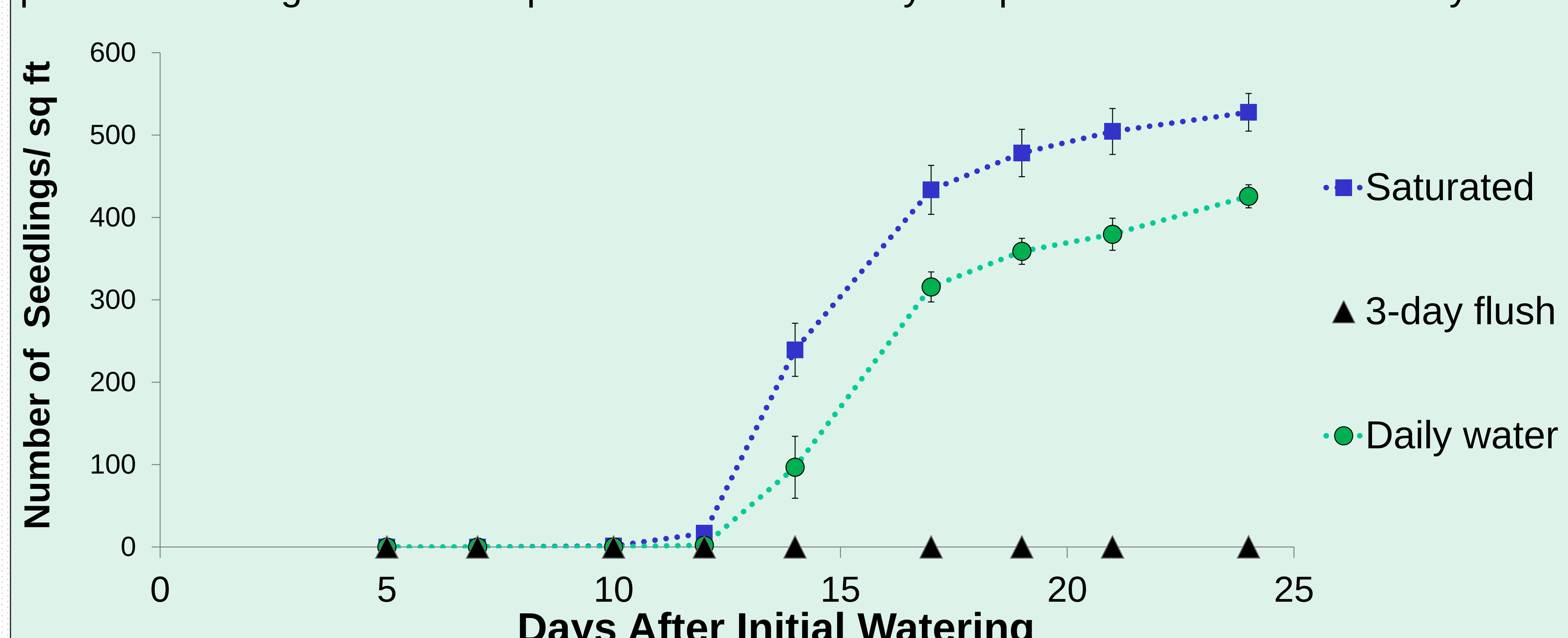

Fig. 3. Cumulative observed emergence from 3 water regimes, expressed in number of seedlings per square foot (area of 1 flat). Seedlings were counted and removed at the 2-leaf stage to approximate the usual chemical control timing. Bars represent standard errors (n= 5 replicates).

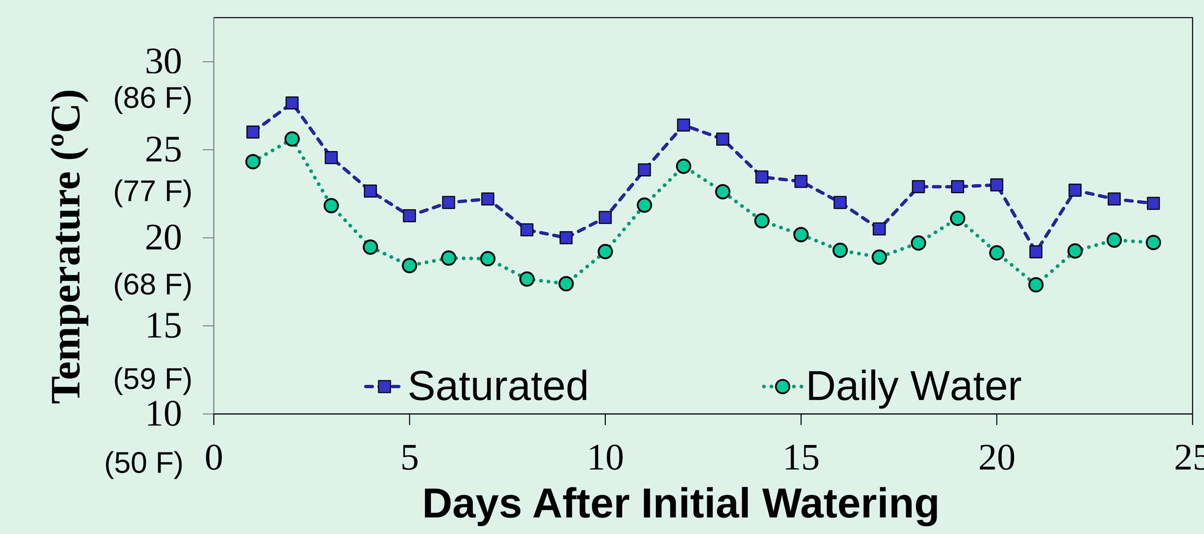

Fig. 4 (left). Soil temperatures recorded at the saturated and daily watering regimes; sensors were placed at 1-cm depth, and symbols represent 24-h averages (n=5 reps). The greater average temperatures in the saturated regime (blue squares) are attributed to the higher night temperatures (data not shown).

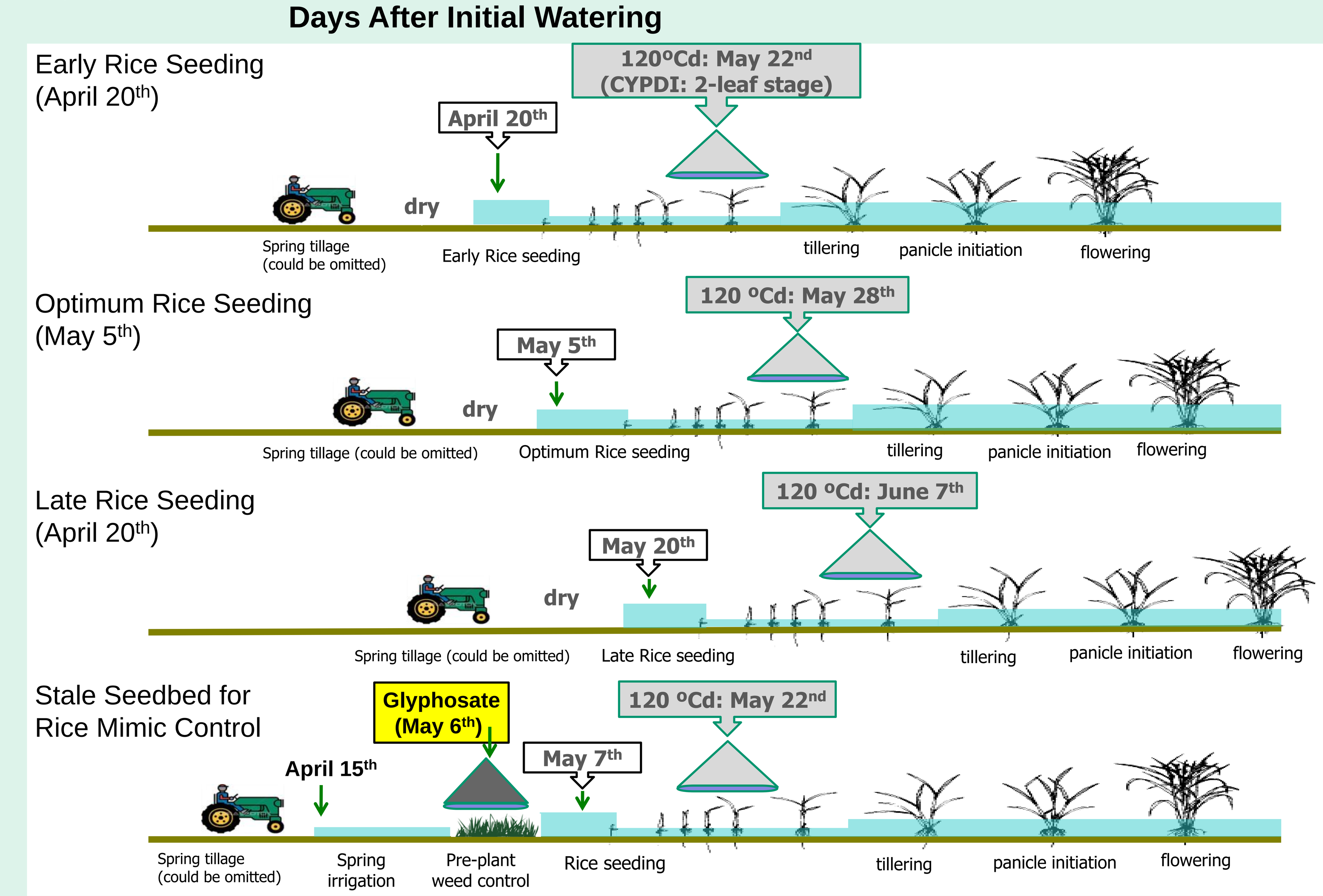

Fig. 5. POST control timing of CYPDI in fields under the Leathers' method (early-drain). The top 3 figures are control timing at 3 rice seeding dates. The bottom figure depicts control for farmers who use stale seedbed for control of late watergrass (rice mimic); spring irrigation allows CYPDI to emerge earlier in comparison to conventional systems.

Conclusions and Recommendations

- S plants required longer ($\theta_{T(50)}$) thermal time for germination than R plants (Table 1).
- Dry soil conditions strongly suppress CYPDI germination and emergence.
- Average temperature was higher at the saturated than at the daily watering regime (Fig. 4), leading to similar observed emergence dates (in days to emergence) in both regimes (Fig. 3) in spite of the differences in thermal time requirements (Fig. 2).
- Weed control dates shown in Figure 5 are based on 30-yr temperature data for Colusa County and will occur earlier in warmer-than-average years, and later in cold ones according to thermal time accumulation requirements (Fig. 2).
- Using a stale seedbed technique to control CYPDI prior to rice sowing would require seeding rice by May 22 if fields are irrigated by April 15 after Spring land preparation.