Junglerice (*Echinochloa colona*) Growth and Development in Response to Temperature and Shade

Sosnoskie[1], Lynn M ; Ceseski[1], Alex ; Parry[2], Sarah; Shrestha[2], Anil; Hanson[1], Bradley D
University of California – Davis, Davis, CA 95616
California State University – Fresno, Fresno, CA 93740
lynn.weed.science@gmail.com, lmsosnoskie@ucdavis.edu, @LynnSosnoskie on Twitter

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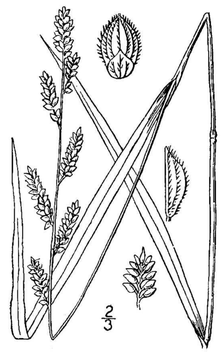

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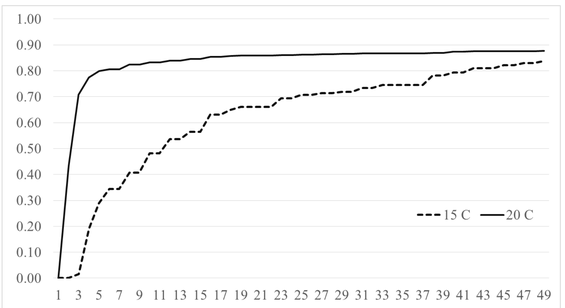
INTRODUCTION

Echinochloa colona (junglerice), a tropical summer annual, is an economically important weed of crops worldwide. In California, it is found in disturbed and summer-irrigated areas throughout the Sacramento and San Joaquin Valleys, the San Francisco Bay region, and the southern coastal and inland valleys. For growers, it is of particular concern in corn fields, orchards, and vineyards, though it can establish anywhere that is moist -but not saturated- throughout the summer growing season. Glyphosate-resistant junglerice was first reported in California in 2008 and confirmed in 2013; since then, a number of sites throughout the state have been shown to have suspected or confirmed glyphosate-resistant strains.

In 2015, we conducted several experiments to describe the germination, growth, and development of seven junglerice accessions from California to differing temperature (15, 20, 25, 30, 35, 40°C) and light conditions (0, 30, and 60% shade) that could be encountered in tree and vine crops throughout the Central Valley. These studies were conducted as part of a larger foundational research designed to describe the biology of the species, to elucidate the mechanisms and degrees of herbicide resistance within various populations, and to determine the invasiveness of the species in economically important crops in California.

MATERIAL AND METHODS – TEMPERATURE AND GERMINATION

- Six accessions of *E. colona* were evaluated in the study
- Seeds were scarified in concentrated H_2SO_4 for 30 minutes and then rinsed in H20
- 50 Seeds were placed petri dishes (plates) containing a single blotter paper and 7.0mL 0.2% Captan fungicide per plate
- Each temperature by biotype combination was replicated four times
- Plates were placed into growth chambers set to 15, 20, 25, 30, 35, and 40°C .
- Germination was determined when ~2mm radicle was protruded
- Each temperature run was terminated once half or more of the biotypes showed no germination for at least three consecutive days.
- The entire study is currently in the process of being replicated



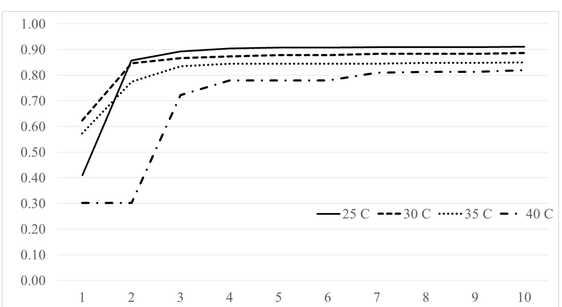


Figure 1.Proportion (cumulative) of junglerice seeds germinating over time (days) for each of six temperatures. Results for the 15 and 20°C temperatures are presented in Figure A; results for the 25 to 40 C temperatures are presented in Figure B. Data are averaged over all junglerice accessions.

RESULTS – TEMPERATURE AND GERMINATION

Junglerice germination occurred quickly in all temperatures but 15°C. Between 20 and 40°C, 50% of plated seeds had germinated within 1-4 days; at 15°C, it took 11-12 days to reach 50% germination. Similarly, the time to reach maximum germination (84-91%) was shorter in temps between 20 and 40°C as compared to 15°C. Some differences were observed among junglerice accessions with respect to germination rate and total germination; results from the repeated trial will help us to determine if/how accession origin affects this species potential for establishment in diverse environments.

Results from this study are in agreement with those of Chauhan and Johnson (2009, Weed Sci. 57:235-240) who reported that junglerice (collected in the Philippines) could germinate equally well over a wide temperature range. This suggests that junglerice could germinate and emerge over time and space in California to interfere with crop production.

MATERIAL AND METHODS – TEMPERATURE AND GROWTH

- One seedling of each of seven junglerice biotypes was planted in 1600 cm plastic pots filled with a mixture of peat, compost, sand, and perlite
- Seedlings were grown out to the 3-tiller stage and then placed into growth chambers programmed to constant temperatures between 20-40°C (12 hr:12 hr day:night)
- Each temperature by biotype combination was replicated four times
- Plant growth and development was monitored for 28 days after which each specimen was destructively harvested and the aboveground biomass separated into three, distinct tissue classes (stems, leaves, and panicles), counted and weighed
- The entire study is currently in the process of being replicated

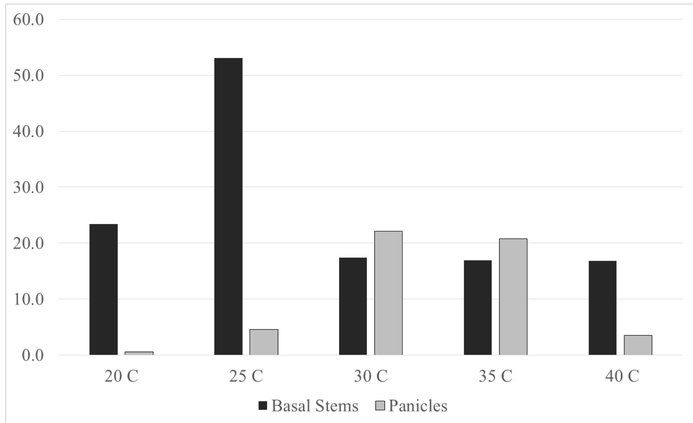


Figure 2. Junglerice stem and panicle production (number), averaged across accessions, in response to temperature at 28 days after initiation of the treatments

RESULTS – TEMPERATURE AND GROWTH

Results from this experiment demonstrated that junglerice growth and development can occur over a wide range of temperatures (20-40°C) (Figure 2); similar observations were noted for other *Echinochloa* species including *E. crus-galli* (Potvin. 1991. Can. J. of Botany 69:1577-1582 and Swanton et al. 2000. Agron. J. 92:1125-1134) and *E. utilis* and *E. frumentacea* (Muldoon et al. 1982. Annals of Botany 50:665-672). Maximum basal stem production occurred at 25°C and ranged from 37 stems per plant to 67 stems per plant with an average (across accessions) of 53 stems per plant. Muldoon et al. (1982) and Swanton et al. (2000) reported that maximum tiller production occurred when mean daily temperatures were less than 20°C and 30°C, respectively.
Per plant and panicle production was greatest at 30 to 35°C. Maximum panicle production ranged from 18 panicles per plant to 45 panicles per plant with an average of 24 panicles per plant (across all accessions).

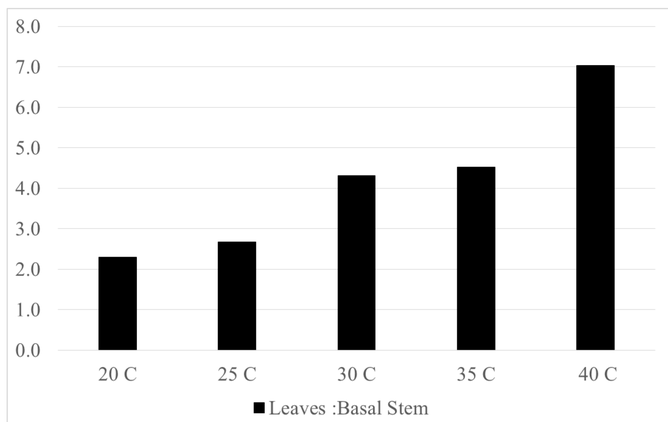


Figure 3. Junglerice leaf to basal tem ratios, averaged across accessions, in response to temperature at 28 days after initiation of the treatments

Total leaves per plant peaked at 25°C, fell at 30 and 35°C, and then rose again at 40°C. However, the leaf:basal stem ratio (Figure 4) mirrored the observations of Swanton et al. (2001), who reported that the ratio between leaves and stems for *E. crus-galli* increased with rising temperature.

As was observed with the germination studies, differences were observed among junglerice accessions. Current studies are investigating how this variability may affect competitive ability and establishment success.

MATERIALS AND METHODS – SHADE AND GROWTH

- In the summer of 2015, two to three seedlings (at the three tiller stage) of each of seven junglerice biotypes were transplanted into field plots (1 m wide by 15 m long) that were exposed to either full sunlight (0% shade; 260-360 W m^{-2} in Davis and 400-780 W m^{-2} in Fresno as measured by LICOR pyranometers at a height of 2m) or 30% and 60% shade environments
- The shade treatments were established by covering the entire plots with black, plastic fabric of differing mesh size on PVC frames
- Plant growth and development was monitored for 28 days, after which each specimen was destructively harvested, separated into three, distinct tissue classes (stems, leaves, and panicles), counted and the fresh vegetative and reproductive weights recorded
- Each shade environment was replicated three times and the entire study was conducted at two locations: UC Davis and CSU Fresno
- The study will be repeated in 2016

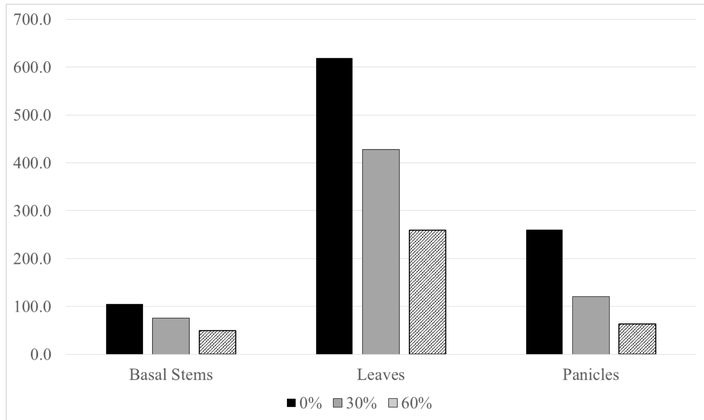


Figure 4. Junglerice stem, leaf, and panicle production (number), averaged across accessions and locations, in response to shade at 28 days after initiation of the treatments

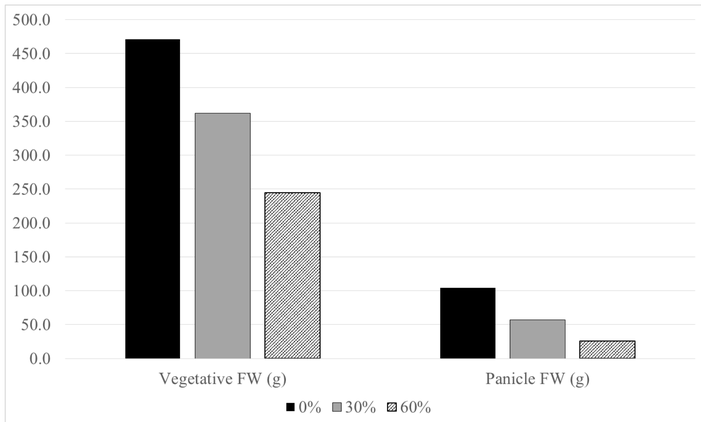


Figure 5. Junglerice vegetative and reproductive fresh weight (g), averaged across accessions and locations, in response to shade at 28 days after initiation of the treatments

RESULTS – SHADE AND GROWTH

Junglerice basal stem, leaf, and panicle numbers decreased with increasing amounts of shade; so, too, did vegetative and reproductive biomass (Figures 4 and 5). For example, stem number per plant averaged between 79 and 134 (avg = 106) at 0% shade; at 30% shade, stem number ranged from 62 to 88 per plant (avg = 76); At 60% shade, the mean number of basal stems per plant did not exceed 50. Mean leaf number per plant at 0, 30 and 60% shade was panicle number per plant at 0, 30 and 60% shade was 261 (range = 185-450), 120 (range = 96-146), and 64 (range = 43-94), respectively. These results are similar to those reported for *E. oryzoides* (Gibson and Fisher, 2001, Int. J. Pest Manage. 47:305-309), *E. phyllopogon* (Gibson et al., 2004, Weed Sci. 52:271-280) , and *E. colona, E. crus-galli,* and *E. glabrescens* (Chauhan, 2013, Crop Protect. 43:241-245).

THOUGHTS

The results from these trials describe the potential for junglerice growth and development under a diversity of conditions that could occur spatially and temporally in California's orchard production systems. Current studies are evaluating how differences in plasticity among our accessions affect junglerice establishment, competitive ability, and invasion potential in specialty crops.