

Paddy Weed Species Appeared Naturally and Their Competition with Rice Crops under Elevated CO₂ and Air Temperature

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Objectives

The objectives were to investigate the effects of elevated atmospheric CO₂ concentrations ([CO₂]) and temperature (Ta) on weed species composition and their competition with rice crops.

Materials and Methods

- Controlled-environment chamber and experimental design: In 2005, of six temperature gradient chambers (TGCs) located in the irrigation paddies of Chonnam Nat'l Univ., Gwangju (126°92' E, 35°31' N), three TGCs were fumigated with [CO₂] of 592ppmV over season. The three remaining TGCs were maintained at natural ambient [CO₂] (av.386ppmV). There were two temperature plots in each TGC. The experiment was a split-plot design. Two levels of [CO₂] and Ta were the whole-plot treatment and the split-plot treatment, respectively.

- Plant culture: Rice (*Oryza sativa* L. cv. Donjinbyeon) seedlings were transplanted into the paddies inside TGCs at 30×15cm² hill spacing (3 seedlings /hill) on 4 June 2005. There were two herbicide-free (HF) plots (0.9m L × 1.2m W) with different Ta (≈ local ambient Ta and ambient +2°C) in each TGC, in order to investigate weed species appearance. Fertilizers were applied at the rate of 11, 4.5 and 5.7g m⁻² for N, P₂O₅ and K₂O, respectively. Other crop managements were similar to those used by local farmers.

- Plant sampling and measurements: At mid-ripening stage of rice, all weed species appeared from HF plots were sampled destructively and classified into each species group. Total biomass of each weed species was determined. For rice, six hills from each HF plot were harvested destructively including root at grain maturity. Total biomass and grain yield of rice crops were determined after oven-drying at 80°C over 1 week.

Results and Discussion

In this experiment, 15 weed species in HF plots appeared across [CO₂] and Ta treatments. Of these species, 4 species were perennial, the remaining 11 species were annual weed. Most of weed species appeared much more in ambient Ta (26.3°C) than in higher Ta (28.3°C) across [CO₂] levels (Fig. 1). As a result, total biomass of the weeds was greater in ambient Ta than in higher Ta (Fig. 2). This could be caused by TGCs structure, rather than by difference in Ta. The TGCs are open fully at air inlet (i.e. near ambient Ta plot into where probably allows an easy inflow of outside weed seeds with wind), whereas the higher Ta plot was located nearby air outlet of the TGC closed. However, elevated [CO₂] had little effect on total biomass of weeds (Fig. 2) while it increased significantly total biomass and grain yield of rice crops across Ta regimes (Fig. 3). In ambient Ta, consequently, rice biomass and grain yield loss by weeds were less in elevated [CO₂] (biomass: -9%, yield: -11%) than in ambient [CO₂] (biomass: -14%, yield: -20%), when compared with those of weed-free plots (data not shown). These results indicate that future expected elevated [CO₂] may be able to enhance a competitive capability of rice crops with weeds.

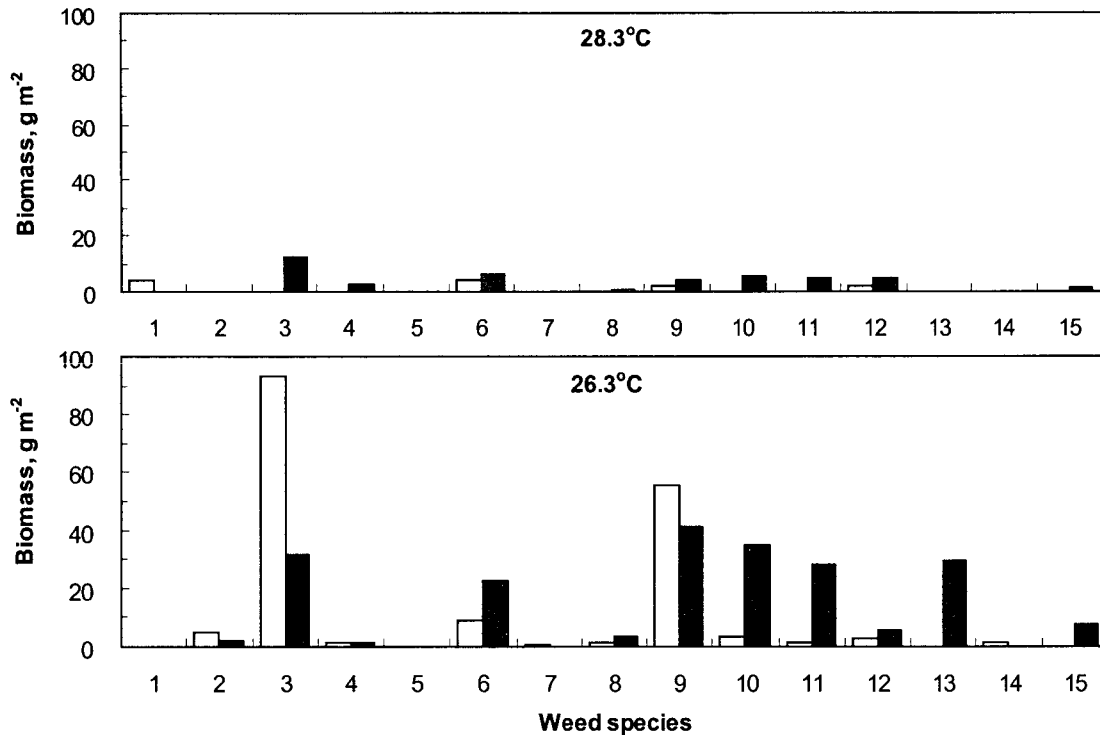


Fig 1. Biomass of weed species appeared naturally in the rice paddy under different [CO₂] and Ta regimes (□: ambient [CO₂], ■: elevated [CO₂]).

Note: 1-*Potamogeton distinctus* A. Benn, 2-*Bidens tripartita* L., 3-*Echinochloa crus-galli* var. *oryzicola* (Vasinger) Ohwi, 4-*Panicum bisulcatum* Thunb, 5-*Rotala indica* (Willd.) Koehne, 6-*Monochoria vaginalis* (Burm. F.) Presl var. *plantaginea* (Roxb.) Solm-Laub., 7-*Lindernia procumbens* (Krock.) Borbas, 8-*Scirpus triqueter* L., 9-*Cyperus difformis* L., 10-*Ludwigia prostrata* Roxb., 11-*Eleocharis kuroguwai* Ohwi, 12-*Scirpus juncoides* Roxb., 13-*Aeschynomene indica* L., 14-*Cyperus iria* L., 15-*Eclipta prostrata* L.

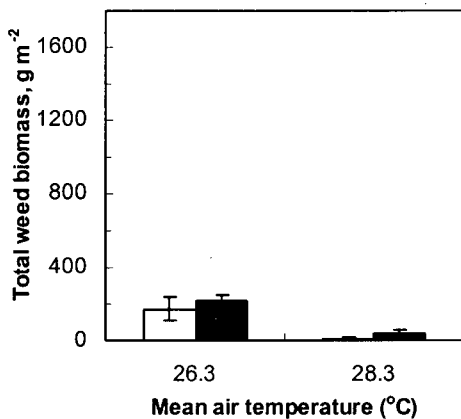


Fig 2. Total biomass of weed appeared naturally in the rice paddy under different [CO₂] and Ta regimes (□: ambient [CO₂], ■: elevated [CO₂]).

Anova results: Total weed biomass
 CO₂: ns
 Temp: **
 CO₂ × Temp: ns

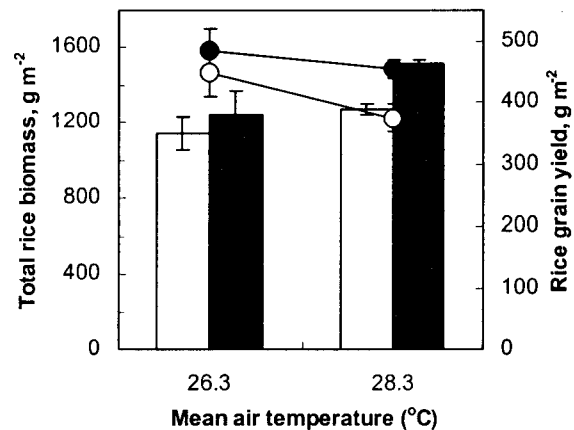


Fig 3. Total biomass (columns) and yield (circles) of rice grown in competition with weeds under different [CO₂] and Ta regimes (○ □: ambient [CO₂], ● ■: elevated [CO₂]).

Anova results: Biomass Grain yield
 CO₂: * *
 Temp: * ns
 CO₂ × Temp: ns ns