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Effects of Elevated CO_2 concentration and High Temperature on Growth and Yield of Rice : I. The effect on development, dry matter production and some growth characteristics

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Abstract:

Phenological development, biomass production and the related growth characteristics of rice (cv Akihikari) in canopy were measured over the entire growth period under different CO_2 concentrations and air temperature regimes in temperature gradient chambers (TGCs), in order to clarify the effects of anticipated global climate change on rice production. The TGC is a plastic tunnel with the dimensions of 26m in length, 2.05m in width and 1.7m in height in which air was ventilated at varying rates to created a 4°C temperature gradient along its longitudinal axis. Two TGCs were used for this experiment; one was kept at ambient CO_2(≅350 μLL^{-1}) concentration and the other at 690 µLL-l throughout the entire growth period. CO_2×temperature treatmets were applied to potted rice plants displaced in TGC at the density of 20 hills m^{-2} in 1991, and on transplanted plants on soil bed in TGC at 25 hills m^{-2} in 1992. In both years, a sufficient amount of nutrition was applied in split. The nearly doubled CO_2 concentration (690 μLL^{-1}) accelerated phenological development of rice toward heading with more pronounced effects at higher temperatures. The number of days to heading of elevated CO_2 plants at 30°C was 11% less than that of ambient CO_2 plants. The elevated CO_2 concentration remarkably promoted both total and productive tiller numbers, whereas it gave a negligibly small effect on plant height. Also, the clevated CO_2 concentration gave minor effects on leaf area index except at the initial growth stage, coinciding with the previous workers' results. The elevated CO_2 concentration markedly promoted crop dry matter production, on which temperature appeared to give negligibly small effects. The relative enhancement rate by the doubled CO_2 on crop dry weight at maturity was estimated to be 24% as average over the entire temperature range (26～30°C) in both years. The insensitive temperature response in the enhancement rate was contrary to previous workers' results. This is considered to be due to previous workers' results being based on largely isolated plants where radiation might less limit the growth than in the present experiment in the

canopy condition.

Keywords:
Air temperature, Biomass production, CO_2 concentration, Global climate change, Growth and development, Rice, Root development, Temperature gradient chamber

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