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Key physiological parameters related to differences in biomass production of maize and four sorghum cultivars under drought and free air CO_2 enrichment

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Abstract

Given the future increase in temperature and the decrease in summer precipitation, in temperate regions sorghum could be an alternative energy crop besides maize due its better drought tolerance. However, it remains open how future elevated atmospheric CO_2 concentrations ($[CO_2]$) may affect these interactions. To address this question four sorghum cultivars and one maize cultivar were grown at moderate climate condition in Germany under different levels of water (WET and DRY) and CO_2 supply (385 ppm and 600 ppm) using free air CO_2 enrichment (FACE) technique combined with rain shelters. The objectives of the study were to investigate whether there is genetic variation among sorghum cultivars and whether sorghum cultivars perform better than maize under drought and elevated $[CO_2]$. Following results were achieved: DRY plots received half as much water as compared to WET. Sorghum had higher stomatal density and transpiration rate at very high light as compared to maize. Maize had a higher biomass yield than sorghum under all growth conditions. Sorghum cultivars differed in their growth response to the treatments. Leaf growth of sorghum was delayed in early summer as compared to maize and thus caused differences in seasonal light absorption. Radiation (RUE) and water use efficiency (WUE) of biomass production under WET were highest for maize and varied among sorghum cultivars. CO_2 enrichment enhanced RUE and WUE under drought in all plants. Variation of RUE among sorghum cultivars seemed to be related to differences in cold tolerance. Consequently, maize is better adapted to the prevailing German weather conditions and thus has a higher biomass yield under drought and present or future $[CO_2]$ than current cultivars of sorghum.

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