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Interaction of Carbon Dioxide Enrichment and Soil Moisture on Photosynthesis, Transpiration, and Water Use Efficiency of Soybean

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Abstract

Soybean (*Glycine max* (*L.*) Merrill) is one of the most important oil and protein sources in the world. Interactive effect of elevated carbon dioxide (CO_2) and soil water availability potentially impact future food security of the world under climate change. A rhizotron growth chamber experiment was conducted to study soil moisture interactions with elevated CO_2 on gaseous exchange parameters of soybean under two CO_2 concentrations (380 and 800 μmol·mol^{-1}) with three soil moisture levels. Elevated CO_2 decreased photosynthetic rate (11.1% and 10.8%), stomatal conductance (40.5% and 36.0%), intercellular CO_2 concentration (16.68% and 12.28%), relative intercellular CO_2 concentration (17.4% and 11.2%), and transpiration rate (43.6% and 39%) at 42 and 47 DAP. This down-regulation of photosynthesis was probably caused by low leaf nitrogen content and decrease in uptake of nutrients due to decrease in stomatal conductance and transpiration rate. Water use efficiency (WUE) increased under elevated CO_2 because increase in total dry weight of plant was greater than that of water use under high CO_2 conditions. Plants under normal and high soil moisture levels had significantly higher photosynthetic rate (7% to 16%) favored by optimum soil moisture content and high specific water content of soybean plants. Total dry matter production was significantly high when plants grown under elevated CO_2 with normal (74.3% to 137.3%) soil moisture level. Photosynthetic rate was significantly and positively correlated with leaf conductance and intercellular CO_2 concentration but WUE was significantly negatively correlated with leaf conductance, intercellular CO_2 concentration and transpiration rate. However, the effect of high CO_2 on plants depends on availability of nutrients and soil moisture for positive feedback from CO_2 enrichment.