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Dynamics of Plant Root Growth under Increased Atmospheric Carbon Dioxide

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ABSTRACT

Plant growth is influenced by above- and belowground environmental conditions and increasing atmospheric carbon dioxide (CO_2) concentrations enhances growth and yield of most agricultural crops. This review covers current knowledge on the impact of increasing CO_2 concentration on root dynamics of plants in terms of growth, root/shoot (R/S) ratio, root biomass, root length, root longevity, root mortality, root distribution, root branching, root quality, and the response of these root parameters to management practices including soil water and nutrients. The effects of CO_2 concentration on R/S ratio are contradictory due to complexity in accurate underground biomass estimation under diverse crops and conditions. Roots become more numerous, longer, thicker, and faster growing in crops exposed to high CO_2 with increased root length in many plant species. Branching and extension of roots under elevated CO_2 may lead to altered root architecture and ability of roots to acquire water and nutrients from the soil profile with exploration of the soil volume. Root turnover is important to the global C budget as well as to nutrient cycling in ecosystems and individual plants. Agricultural management practices have a greater impact on root growth than rising atmospheric CO_2 since management practices influence soil physical, chemical, and biological properties of soil, consequently affects root growth dynamics in the belowground. Less understood are the interactive effects of elevated CO_2 and management practices including drought on root dynamics, fine-root production, and water-nutrient use efficiency, and the contribution of these processes to plant growth in water and nutrients limited environments.