Effects of water stress on photosynthesis, growth and yield in winter wheat

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Drought has become one of the major constraints on agricultural development, particularly in areas lacking water. By studying the effects of different water stresses on photosynthesis, growth, yield, water use efficiency (WUE) and other indicators of winter wheat, this study provides scientific irrigation strategies for developing water-saving agriculture. According to the size of the water field capacity, four different water stress levels were set, i.e., 30–40% water field capacity (severe stress), 40–50% (moderate stress), 50–60% (mild stress) and 60–80% (well-watered irrigation), through an automatic irrigation system to create different water stress gradients by controlling the irrigation amount. The results showed that the diurnal and seasonal changes in photosynthetic parameters such as net photosynthetic rate ($P_n$), intercellular carbon concentration ($C_i$), stomatal conductance ($G_s$), and transpiration ($E$) significantly decreased with water stress intensification. The $P_n$ of mild stress only slightly decreased compared to that of well-watered irrigation and was even higher than after May 16th, resulting in an increase in the dry biomass and 1000-grain weight under mild stress. Under all water stresses, the heights and stem weights of the winter wheat significantly decreased. Moderate and severe stress also significantly reduced the fresh weight of the aboveground biomass, dry weight, spike weight, grain weight, WUE and irrigation water productivity (IWP), while mild stress only slightly decreased the fresh weight of aboveground biomass, spike weight and grain weight. Mild stress increased the WUE and IWP. Thus, mild stress results in the optimal use of water resources without a significant reduction in yield. Therefore, mild stress can be considered as a suitable environment for winter wheat growth in arid areas.