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Water Use Efficiency of Soybean under Water Stress in Different Eroded Soils

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Soil erosion has changed the effective storage of soil moisture and affected crop water use efficiency (WUE), which is a limiting factor for increasing grain yield, in the black soil areas of northeastern China. In this study, three black soils with different degrees of erosion were selected to study differences in the WUE of soybean and the crop's response to water stress, using pot experiments with controlled soil water content. Considering various water holding capacities for soils with different degrees of erosion, we used the relative water content to field capacity (FC) to control water content at 100%, 80%, 60%, and 40% FC. Although the optimal soil moisture conditions relative to FC varied for the different eroded soils in terms of biomass and yield (80% FC for light erosion conditions and 100% FC for moderate and severe erosion conditions), optimal WUE and evapotranspiration were not significantly different for the different soils (80% FC and 100% FC, respectively). Under the optimal water supply condition of 80% FC, the WUE of soybean was 9.36 kg ha^{-1} mm^{-1}, 8.90 kg ha^{-1} mm^{-1}, and 6.16 kg ha^{-1} mm^{-1} for the lightly, moderately and severely eroded soils, respectively. There was no significant difference between the light and the moderate erosion cases ($p < 0.05$) but a significant difference in the severe erosion case. By examining the relative water content, we found that the response functions of soybean yield to water stress were linear and not significantly different for the three eroded soils, and the yield response coefficients ranged from 1.10 to 1.12 for the entire growth period. The response functions of the WUE of soybean were also not significantly different for the three eroded soils ($p < 0.05$). Before the flowering stage, waterlogging stress existed under all the water supply conditions, while it was observed only in the cases of 80% FC and 100% FC after the flowering stage. Water stress was obvious under the low water supply conditions of 40% FC and 60% FC, and high stress factors of 0.012 and 0.015 were observed during the pod-filling and seed-filling periods.