

Effects of Irrigation at Different Times During the Freeze–thaw Period on Soil Evaporation

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Abstract

Controlling soil evaporation during the seasonal freeze–thaw period has important practical significance for alleviating the water shortage in northern China. To investigate the influence of different irrigation times on soil evaporation during the freeze–thaw period, a series of field soil evaporation experiments of bare soil and sand mulch treatments with six different irrigation times were conducted. Soil evaporation characteristics during the three freeze–thaw stage were determined, and the major factors influencing soil evaporation were analyzed using the Random Forest model. The results showed that the cumulative soil evaporation of bare soil irrigated at different times during the freeze–thaw period was 43.1–50.37 mm, which was 33.8%–56.4% higher than that of bare soil without irrigation, and soil evaporation decreased by 10.4%–39.2% after the addition of mulched sand. Shortly after irrigation, surface sand mulch exhibited a weak inhibitory effect on soil evaporation in the stable freezing stage and later thawing stage. Sand mulch with irrigation in the early unstable freezing stage had the most positive effect on soil moisture preservation, with 80.95% of the irrigation water stored in the soil during the freeze–thaw period. Simultaneously, the surface soil moisture content was the major factor affecting evaporation in irrigated treatments in the unstable freezing stage and stable freezing stage; surface soil temperature, surface soil moisture content, and average air temperature were the major factors affecting soil evaporation, and surface soil moisture content had the greatest contribution to soil evaporation in the thawing stage. The results suggest that the addition of irrigation water early in the winter along with sand mulch in agricultural fields may be a beneficial practice to reduce water stress in arid and semi-arid areas.

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